Developing Operational Requirements

A Guide to the Cost-Effective and Efficient Communication of Needs

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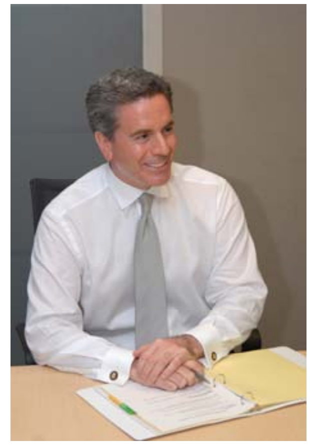

Tom Cellucci

Please find enclosed the expanded version of our popular book entitled "Developing Operational Requirements," which was published in May 2008 by the U.S. Department of Homeland Security (DHS). You will find many new and updated sections related to developing detailed operational requirements, numerous examples of Operational Requirements Documents (ORDs) and information on our recently implemented Commercialization initiative to cost effectively and efficiently develop products and services for DHS and other related users found in the first responder and critical infrastructure/key resources communities.

Please allow me to take this opportunity to thank the countless people in the Department, members of other various Federal Agencies and the private sector for providing us with valuable feedback on our earlier editions to make this edition even more useful to organizations both within and outside of the Department. I especially thank Mark Protacio, Sam Francis, Ryan Policay and Adam Porter-Price for their individual contributions in the preparation of the materials for this book.

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DHS S&T Commercialization Office

The DHS Science and Technology (S&T) Commercialization efforts are headed by the Chief Commercialization Officer (CCO), a position created in August 2007 within the Transition Office in S&T. The mission of the Commercialization Office is to develop and execute programs and processes that identify, evaluate and commercialize technology through the development of widely distributed products and/or services that meet the operational requirements of the Department of Homeland Security's Operating Components, First Responder community and other Department stakeholders when required. A primary function of the Commercialization Office is developing and managing S&T's outreach effort with the private sector to establish and foster mutually beneficial working relationships leading to the fielding of technology-based products and services to secure the nation. In order to achieve its mission, the Commercialization Office has organized the following initiatives to gather, articulate, communicate and facilitate the development of products and services based upon detailed operational requirements received from DHS' operating components and stakeholders:

<u>Requirements Development Initiative</u> – Efforts that enable the detailed articulation of operational requirements across the Department are implemented to ensure the accurate and timely development and deployment of products and services to aid in the implementation of the mission-critical objectives of the Operating Components, First Responders and other DHS stakeholders.

<u>Commercialization Process</u> – A new "hybrid" commercialization model has been created that combines the best attributes of the well-known Acquisition and "pure" Commercialization models. This hybrid model begins with DHS needs assessment and results in widely distributed products and services for use by DHS and its wide range of stakeholders.

<u>SECURE Program</u> – An innovative public-private sector partnership based on DHS's new commercialization model. DHS S&T conducts private sector outreach efforts to communicate DHS requirements along with potential available market information to create business case scenarios for possible private sector investment in technology and product development aligned to DHS needs.

<u>S&T Private Sector Outreach</u> – One of the key roles of the Chief Commercialization Officer is to act as a liaison with the private sector connecting DHS requirements and potential technology-based solutions offered by industry. Outreach efforts center on notifying the private sector about opportunities that exist for partnership to address the needs of the Department and its stakeholders. Several articles have been written about our Commercialization efforts. Outreach efforts are conducted through invited briefs to a number of venues reaching small, medium and large businesses. Efforts also extend to regularly meeting with minority, disadvantaged and HUB Zone groups as evidenced from our Private Sector Outreach Statistics.

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Introduction

The purpose of this guide is simple and straightforward: to enable the reader to articulate detailed requirements or needs and effectively communicate them (either internally within DHS or externally to other Federal agencies or the private sector) through an Operational Requirements Document (ORD) vehicle. Often, we have heard expressions like "It all boils down to a lack of communications," or "We're not sure what you need," or "DHS has been difficult to work with because they really don't have a clear picture of their problems, needs or requirements." We can remedy this situation by implementing some fundamental practices in a disciplined manner.

A well-written ORD can be an effective vehicle or tool to relay the needs of a given component, group or agency in an easily understood format to sedulously avoid the countless hours of time and other resources wasted speculating needs. Research conclusively shows that the foremost reason why programs or projects do not succeed is due to the lack of detailed requirements at the initiation of a program or project. Efforts invested up front to develop a clear understanding of the requirements pay dividends in the positive outcome of programs -- not to mention the savings in both time and money in corrective actions taken to get a program back on track (if it is even possible!).

We intend to make writing an ORD simple and easy. To that end, we have provided in this book an easy-to-follow ORD template, along with several real world examples of ORDs. In the numerous appendixes accompanying this book, you will find articles and briefings that provide additional context to the role that creating detailed operational requirements play in effective product realization. For your convenience, we have also included Appendix J, which contains the original *Requirements Development Guide (April 2008)* for those interested in a more detailed discussion on requirements development and product development life cycles.

If you have any questions or need any assistance – any at all – please feel free to contact Dr. Thomas A. Cellucci, DHS-S&T Chief Commercialization Officer at Thomas.Cellucci@dhs.gov.

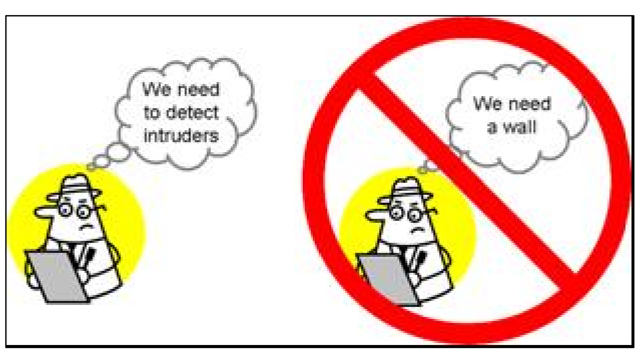
Product Realization

If you think about it, there are numerous examples in our professional and private lives where the lack of communication or unclear terminology has created misunderstandings, problems and a myriad of other issues. As in any worthwhile pursuit, effective communication is critical in the cost-effective and efficient interactions between various parties seeking a mutually beneficial relationship or partnership.

At every step of product development, it is critical to understand and meet user needs. The Commercialization Office has created a Product Realization Chart that is a useful guide that shows the due diligence necessary for the productive development of products or services (See Appendix H). Product development is not a trivial effort; but with proper planning, tracking and communication, successful product development can yield measurable positive results and provide DHS operating components with resources necessary to carry out their mission-critical objectives to protect our country.

The initial phase of product realization is a mission needs assessment. This assessment should be conducted relative to the overall mission for a given organization. This exercise identifies capabilities needed to perform required functions, highlights deficiencies in a functional capability and documents the results of the analysis. Some of these capabilities may already be addressed with existing products, systems or services currently accessible by an organization. Additionally, a mission needs assessment serves to identify deficiencies in current and projected capabilities. In the event that current products are not able to address a particular capability; a capability gap exists. Briefly, capability gaps are defined by the difference between current operational capabilities and those necessary capabilities needed to perform mission-critical objectives that remain unsatisfied. Capability gaps must be listed in terms of an overall need to perform a specific task and should avoid explaining how that task should be achieved. See appendix G for further reading.

For example, faced with the problem of potential intruders to a sensitive facility, we might define the requirement as “build a wall” whereas the real requirement is “detect, thwart, and capture intruders.” Our wall might “thwart” intruders (or might not, if they’re adept at tunneling), but it would not detect them or facilitate their capture. In short, the solution would not solve the problem.



The robust capability gap to "detect, thwart, and capture intruders" includes no preconceived solutions and prompts us to analyze alternative conceptual solutions and choose the best.

One way to ensure that we are defining a problem, rather than a solution is to begin the statement of the requirement with the phrase "we need the capability to …" It's nearly impossible to complete this sentence with a solution ("a wall"), and much easier to complete the sentence with a problem ("capability to detect intruders"). Capability gaps and requirements should address what a system should do, rather than how to do it. This approach is sometimes called capability-based planning. It is a very simple, yet powerful concept.

Properly defining clear and concise capability gaps is a necessary first step in product realization. This high-level understanding of a problem is a key part in the communication of needs. One may find that capability gaps are oftentimes common across multiple cross-sections of DHS operating components and supporting elements such as the first responder community and private sector critical infrastructure owner/operators. Discovering these commonalities is a fundamental aspect of the DHS S&T Capstone IPT Process, which seeks to reduce duplication of efforts and expedite product transition. See Appendix B for further information.

Why Requirements?

A *requirement* is an attribute of a product, service or system necessary to produce an outcome(s) that satisfies the needs of a person, group or organization. Requirements therefore define "the problem." In contrast, "the solution" is defined by technical *specifications*.

Defining requirements is the process of determining what to make before making it. Requirements definition creates a method in which appropriate decisions about product or system functionality and performance can be made before investing the time and money to develop it. Understanding requirements early removes a great deal of guesswork in the planning stages and helps to ensure that the end-users and product developers are "on the same page."

Requirements provide criteria against which solutions can be tested and evaluated. They offer detailed metrics that can be used to objectively measure a possible solution's effectiveness, ensuring informed purchasing decisions on products, systems or services that achieve the stated operational goals. A detailed requirements analysis can uncover hidden requirements as well as discover common problems across programs and various DHS operating components. Detailed operational requirements will guide product development so that solutions specifications actively solve the stated problems.

We could save ourselves a lot of work if we jump straight to "the solution" without defining "the problem." Why don't we do that? Because if we take that shortcut we are likely to find that our solution may not be the best choice among possible alternatives or, even worse we're likely to find that our "solution" doesn't even solve the problem!

Defining requirements and adhering to developing solutions to address those needs is often referred to as "requirements-pull." In this situation, user requirements drive product development and guide the path forward as the requirements dictate. This is a powerful circumstance in which fulfilling requirements becomes the central focus of product development and no possible solution is disregarded given it facilitates

At the other extreme from the "requirements-pull", approach is its opposite: "technology push." Here we start with a solution (perhaps a new technology) and see what problems it might enable us to solve. The danger in this approach is to become enamored of "the solution" and neglect to ensure that it actually solves a problem. With technology push, it is likely that actual user requirements may be modified, or even ignored in order to "force-fit" the desired solution. A historical example was the product known as Picture Phone introduced (and discontinued) in the 1960s when the advance of telecommunications technology first made possible the transmission and display of video as well as voice. Picture Phone, which allowed telephone users to see each other during a call, was a technological success but a market disaster. It turned out that callers generally don't want to be seen, as a bit of unbiased market analysis would have disclosed.

Technology push should not be ignored, but if the goal is successful transition to the field with acceptable risk, the technology being pushed must be compared with alternative solutions against a real set of user requirements.

Aside from assuring that the "solution" actually solves the "problem," requirements-driven design has a further advantage in that the requirements provide criteria against which a product's successful development can be measured. Specifically, if the product was developed to address a set of quantified operational requirements, then its success is measured by Operational Test and Evaluation (OT&E) to validate that an end-user can use the product and achieve the stated operational goals.

Prior to OT&E, it is common practice to subject products to Developmental Test and Evaluation (DT&E). The purpose of DT&E is to verify that the product meets its technical specifications, which are the engineers' interpretation of the operational requirements. Such DT&E does not obviate the need for OT&E, which validates that the engineers' solution is not only technically successfully but also represents a successful interpretation of the end users' needs, satisfying the original operational requirements (not just the technical specifications) when operated by representative users.

Often requirements are stated in terms of "threshold values" and "objective values," where the "objective value" is the desired performance and the "threshold value" is the minimum acceptable performance. This formalism is useful in allowing stretch goals to be asserted without saddling the system development with unacceptable risk.

The Requirements Hierarchy and Traceability

To reiterate the definitions above, the documents that govern product realization include requirements, which define the problem, and specifications, which define the solution. Nevertheless, the hierarchy of requirements and specifications is more complex than that simple dichotomy, as depicted in Figure 1.

The hierarchy is divided into two domains, operational requirements and technical requirements, highlighted in yellow and blue in the figure, representing the "problem space" and the "solution space" respectively. The DHS Operating Component, representing the end users in the field (the operators), is responsible for all operational requirements, from the top-level mission requirements to the detailed system-level operational requirements. A system developer is responsible for translating the operational requirements into a system solution, documented in a hierarchy of technical specifications.

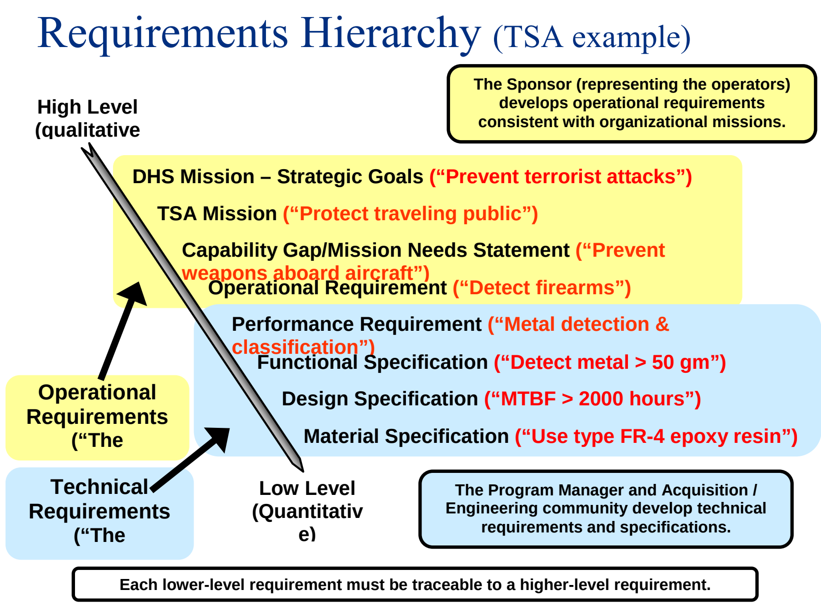


Figure 1. The requirements hierarchy

The highest-level type of technical "specification" is actually called a performance "requirement." A performance requirement actually represents a bridge from operational requirements to the engineering interpretation of those requirements. Put another way, in the course of developing a new system it is necessary to transform the system operational requirements, which are stated from a given Operating Component's perspective as required outcomes of system action, into a set of system performance requirements, which are stated in terms of engineering characteristics.

Working through the requirements hierarchy, requirements development is the process of decomposing the problems broadly outlined in the capability gaps gleaned from the mission needs assessment.

The requirements and specifications are described below, first those that define the problem and then those that define the solution:

- **Problem Definition**
  - **Mission Needs Statement (MNS)** is required by the DHS *Investment Review Process* (Management Directive 1400, Appendix G) and is developed by the DHS sponsor (S&T's customer) who represents the end users. The MNS provides a high-level description of the mission need (or, equivalently, capability gap), and is used to justify the initiation of an Acquisition program.
  - **Operational Requirements Document (ORD)** is also required by the DHS *Investment Review Process* and, like the MNS, is developed by the DHS sponsor. The ORD specifies operational requirements and a concept of operations (CONOPS), written from the point of view of the end user. The ORD is independent of any particular implementation, should not refer to any specific technologies and does not commit the developers to a design.
- **Solution Definition**
  - **Performance Requirements** represent a bridge between the operationally oriented view of the system defined in the ORD and an engineering-oriented view required to define the solution. Performance requirements are an interpretation, not a replacement of operational requirements. Performance requirements define the functions that the system *and its subsystems* must perform to achieve the operational objectives and define the performance parameters for each function. These definitions are in engineering rather than operational terms.
  - **Functional Specifications** define the system solution functionally, though not physically. Sometimes called the "system specification" or "A-Spec," these specifications define functions at the system, subsystem, *and component level* including:

    - Configuration, organization, and interfaces between system elements
    - Performance characteristics and compatibility requirements
    - Human engineering
    - Security and safety
    - Reliability, maintainability and availability
    - Support requirements such as shipping, handling, storage, training and special facilities

  - **Design Specifications** convert the functional specifications of ***what*** the system is to do into a specification of ***how*** the required functions are to be implemented in hardware and software. The design specifications therefore govern the materialization of the system components.

- **Material Specifications** are an example of lower-level supporting specifications that support the higher-level specifications. Material specifications define the required properties of materials and parts used to fabricate the system. Other supporting specifications include **Process Specifications** (defining required properties of fabrication processes such as soldering and welding) and **Product Specifications** (defining required properties of non-developmental items to be procured commercially).

Characteristics of Good Requirements

Requirements engineering is difficult and time-consuming, but must be done well if the final product or system is to be judged by the end users as successful. From the International Council of Systems Engineers (INCOSE) Requirements Working Group[1], here are eight attributes of good requirements:

Necessary:	Can the system meet prioritized, real needs without it? If yes, the requirement isn't necessary.
Verifiable:	Can one ensure that the requirement is met in the system? If not, the requirement should be removed or revised.
Unambiguous:	Can the requirement be interpreted in more than one way? If yes, the requirement should be clarified or removed. Ambiguous or poorly worded requirements can lead to serious misunderstandings and needless rework.
Complete:	Are all conditions under which the requirement applies stated? In addition, does the specification include all known requirements?
Consistent:	Can the requirement be met without conflicting with any other requirement? If not, the requirement should be revised or removed.
Traceable:	Is the origin (source) of the requirement known, and is there a clear path from the requirement back to its origin?
Concise:	Is the requirement stated simply and clearly?
Standard constructs:	Requirements are stated as imperative needs using "shall." Statements indicating "goals" or using the words "will" or “should” are not imperatives.

[1] Kar, Pradip and Bailey, Michelle. Characteristics of Good Requirements. International Council of Systems Engineers, Requirements Working Group. INCOSE Symposium, 1996. Found online: http://www.afis.fr/nav/gt/ie/doc/Articles/CHARACTE.HTM.

Developing Operational Requirements (ORDs): Customer Input

So far, we've discussed operational requirements but have not provided any insight into how to develop them. In an effort to provide a basic framework for the articulation and documentation of operational requirements, the Operational Requirements Document (ORD) was created. ORDs provide a clear definition and articulation of a given problem, providing several layers of information that comprise the overall problem. Using resources such as this book and the accompanying template, we have tried to simplify and streamline the process of communicating requirements. ORDs can be used in Acquisition, Procurement, Commercialization and Outreach Programs –any situation that dictates detailed requirements (e.g. RFQ, BAA, RFP, RFI, etc.). It's clear to see that it's cost-effective and efficient for both DHS and all of its stakeholders to communicate needs clearly and effectively.

Let's first look at the contents of a typical Operational Requirements Document (ORD) shown in Figure 2.

OPERATIONAL REQUIREMENTS DOCUMENT

1.0 General Description of Operational Capability
- 1.1. Capability Gap
- 1.2. Overall Mission Area Description
- 1.3. Description of the Proposed System
- 1.4. Supporting Analysis
- 1.5. Mission the Proposed System Will Accomplish
- 1.6. Operational and Support Concept
  - 1.6.1. Concept of Operations
  - 1.6.2. Support Concept

2.0 Threat

3.0 Existing System Shortfalls

4.0 Capabilities Required
- 4.1 Operational Performance Parameters
- 4.2 Key Performance Parameters (KPPs)
- 4.3 System Performance
  - 4.3.1 Mission Scenarios
  - 4.3.2 System Performance Parameters
  - 4.3.3 Interoperability
  - 4.3.4 Human Interface Requirements
  - 4.3.5 Logistics and Readiness
  - 4.3.6 Other System Characteristics

5.0 System Support
- 5.1 Maintenance
- 5.2 Supply
- 5.3 Support Equipment
- 5.4 Training
- 5.5 Transportation and Facilities

6.0 Force Structure

7.0 Schedule

8.0 System Affordability

Appendixes

Glossary

Figure 2. The contents of an Operational Requirements Document

The complexity of the intended system and its operational context will govern the required level of detail in the ORD. The most difficult sections to develop are probably Section 4.0, which describes the capabilities required of the system to be developed, and Section 1.6, which describes the operational and support concepts.

There is no "silver bullet" to solve the potential challenges in developing an ORD, but since the issues are universal, there is a wealth of literature that offers approaches to requirements development. As an example, here are nine requirements-elicitation techniques described in the *Business Analyst Body of Knowledge* (from the International Institute of Business Analysis)[2].

1. Brainstorming
   - o Purpose
     - An excellent way of eliciting many creative ideas for an area of interest. Structured brainstorming produces numerous creative ideas.
   - o Strengths
     - Able to elicit many ideas in a short time period.
     - Non-judgmental environment enables outside-the-box thinking.
   - o Weaknesses
     - Dependent on participants' creativity.
2. Document Analysis
   - o Purpose
     - Used if the objective is to gather details of the "As Is" environment such as existing standard procedures or attributes that need to be included in a new system.
   - o Strengths
     - Not starting from a blank page.
     - Leveraging existing materials to discover and/or confirm requirements.
     - A means to crosscheck requirements from other elicitation techniques such as interviews, job shadowing, surveys or focus groups.
   - o Weaknesses
     - Limited to "as-is" perspective.
     - Existing documentation may not be up-to-date or valid.
     - Can be a time-consuming and even tedious process to locate the relevant information.

[2] International Institute of Business Analysis. *A Guide to the Business Analyst Body of Knowledge*, Release 1.6. 2006. Found online: http://www.theiiba.org/Content/NavigationMenu/Learning/BodyofKnowledge/Version16/BOKV1_6.pdf.

3. Focus Group
   - Purpose
     - A means to elicit ideas and attitudes about a specific product, service or opportunity in an interactive group environment. The participants share their impressions, preferences and needs, guided by a moderator.
   - Strengths
     - Ability to elicit data from a group of people in a single session saves time and costs as compared to conducting individual interviews with the same number of people.
     - Effective for learning people's attitudes, experiences and desires.
     - Active discussion and the ability to ask others questions creates an environment where participants can consider their personal view in relation to other perspectives.
   - Weaknesses
     - In the group setting, participants may be concerned about issues of trust, or may be unwilling to discuss sensitive or personal topics.
     - Data collected (what people say) may not be consistent with how people actually behave.
     - If the group is too homogenous, the group's responses may not represent the complete set of requirements.
     - A skilled moderator is needed to manage the group interactions and discussions.
     - It may be difficult to schedule the group for the same date and time.
4. Interface Analysis
   - Purpose
     - An interface is a connection between two components. Most systems require one or more interfaces with external parties, systems or devices. Interface analysis is initiated by project managers and analysts to reach agreement with the stakeholders on what interfaces are needed. Subsequent analysis uncovers the detailed requirements for each interface.
   - Strengths
     - The elicitation of the interfaces' functional requirements early in the system life cycle provides valuable details for project management:
     - Impact on delivery date. Knowing what interfaces are needed, their complexity and testing needs enables more accurate project planning and potential savings in time and cost.
     - Collaboration with other systems or projects. If the interface to an existing system, product or device and the interface already exist, it may not be easily changed. If the interface is new, then the ownership, development and testing of the interface needs to be addressed and coordinated in both projects' plan. In either case, eliciting the interface requirements will require negotiation and cooperation between the owning systems.

- Weaknesses
    - Does not provide an understanding of the total system or operational concept since this technique only exposes the inputs, outputs and key data elements related to the interfaces.

5. Interview
    - Purpose
        - A systematic approach to elicit information from a person or group of people in an informal or formal setting by asking relevant questions and documenting the responses.
    - Strengths
        - Encourages participation and establishes rapport with the stakeholder.
        - Simple, direct technique that can be used in varying situations.
        - Allows the interviewer and participant to have full discussions and explanations of the questions and answers.
        - Enables observations of non-verbal behavior.
        - The interviewer can ask follow-up and probing questions to confirm own understanding.
        - Maintain focus using clear objectives for the interview that are agreed upon by all participants and can be met in the time allotted.
    - Weaknesses
        - Interviews are not an ideal means of reaching consensus across a group of stakeholders.
        - Requires considerable commitment and involvement of the participants.
        - Training is required to conduct good interviews. Unstructured interviews, especially, require special skills. Facilitation/virtual facilitation and active listening are a few of them.
        - Depth of follow-on questions may be dependent on the interviewer's knowledge of the operational domain.
        - Transcription and analysis of interview data can be complex and expensive.
        - Resulting documentation is subject to interviewer's interpretation.
6. Observation
    - Purpose
        - A means to elicit requirements by assessing the operational environment. This technique is appropriate when documenting details about current operations or if the project intends to enhance or change a current operational concept.
    - Strengths
        - Provides a realistic and practical insight into field operations by getting a hands-on feel for current operations.

    - Elicits details of informal communication and ways people actually work around the system that may not be documented anywhere.
  - Weaknesses
    - Only possible for existing operations.
    - Could be time-consuming.
    - May be disruptive to the person being shadowed.
    - Unusual exceptions and critical situations that happen infrequently may not occur during the observation.
    - May not well work if current operations involve a lot of intellectual work or other work that is not easily observable.
7. Prototyping
  - Purpose
    - Prototyping, when used as an elicitation technique, aims to uncover and visualize user requirements before the system is designed or developed.
  - Strengths
    - Supports users who are more comfortable and effective at articulating their needs by using pictures or hands-on prototypes, as prototyping lets them "see" the future system's interface.
    - A prototype allows for early user interaction and feedback.
    - A throwaway prototype is an inexpensive means to quickly uncover and confirm user interface requirements.
    - A revolutionary prototype can demonstration what is feasible with existing technology, and where there may be technical gaps.
    - An evolutionary prototype provides a vehicle for designers and developers to learn about the users' interface needs and to evolve system requirements.
  - Weaknesses
    - Depending on the complexity of the target system, using prototyping to elicit requirements can take considerable time if the process is bogged down by the "how's" rather than "what's".
    - Assumptions about the underlying technology may need to be made in order to present a starting prototype.
    - A prototype may lead users to set unrealistic expectations of the delivered system's performance, reliability and usability characteristics.
8. Requirements Workshop
  - Purpose
    - A requirements workshop is a structured way to capture requirements. A workshop may be used to scope, discover, define, prioritize and reach closure on requirements for the target system. Well-run workshops are considered one of the most effective ways to deliver high quality

requirements quickly. They promote trust, mutual understanding, and strong communications among the project stakeholders and project team, produce deliverables that structure, and guide future analysis.

- Strengths
  - A workshop can be a means to elicit detailed requirements in a relatively short period of time.
  - A workshop provides a means for stakeholders to collaborate, make decisions and gain a mutual understanding of the requirements.
  - Workshop costs are often lower than the cost of performing multiple interviews.
  - A requirements workshop enables the participants to work together to reach consensus which is typically a cheaper and faster approach than doing serial interviews as interviews may yield conflicting requirements and the effort needed to resolve those conflicts across all interviewees can be very costly.
  - Feedback is immediate, if the facilitator's interpretation of requirements is fed back immediately to the stakeholders and confirmed.
- Weaknesses
  - Due to stakeholders availability it may be difficult to schedule the workshop.
  - The success of the workshop is highly dependent on the expertise of the facilitator and knowledge of the participants.
  - Requirements workshops that involve too many participants can slow down the workshop process thus negatively affecting the schedule. Conversely, collecting input from too few participants can lead to overlooking requirements that are important to users, or to specifying requirements that do not represent the needs of the majority of the users.

9. Survey/Questionnaire
   - Purpose
     - A means of eliciting information from many people, anonymously, in a relatively short time. A survey can collect information about customers, products, operational practices and attitudes. A survey is often referred to as a questionnaire.
   - Strengths
     - When using 'closed-ended' questions, effective in obtaining quantitative data for use in statistical analysis.
     - When using open-ended questions, the survey results may yield insights and opinions not easily obtainable through other elicitation techniques.
     - Does not typically require significant time from the responders.
     - Effective and efficient when stakeholders are not located at one place.
     - May result in large number of responses.

        - Quick and relatively inexpensive to administer.
    - Weaknesses
        - Use of open-ended questions requires more analysis.
        - To achieve unbiased-results, specialized skills in statistical sampling methods are needed when the decision has been made to survey a sample subset.
        - Some questions may be left unanswered or answered incorrectly due to their ambiguous nature.
        - May require follow up questions or more survey iterations depending on the answers provided.
        - Not well suited for collecting information on actual behaviors.

Addressing Requirements versus Proposing Solutions

When employing efforts to elicit and explain requirements using any of these methods, it is imperative to steadfastly avoid requirements that define potential solutions or otherwise restrict the potential solution space. While it is necessary and useful to understand the current state-of-the-art within a given technology space and knowledge about potential solutions that may already be in development, requirements are meant to simply define problems. Properly drafted requirements allow for a variety of solutions, each with their own advantages and disadvantages, to be considered as potential ways to address a problem. Solution-agnostic requirements prevent limiting and defining the outcome of product realization. Within the context of the Operational Requirements Document Template described in detail below, the solution definition aspect of the Requirements Hierarchy is purposefully not addressed.

This is useful given that an open and honest review of one's needs might show that a preconceived notion about a desired solution may turn out not to be the best solution, or that modifications to existing products or services may be necessary and useful to end users.

Operational Requirements Document Template:

1. General Description of Operational Capability

In this section, summarize the capability gap which the product or system is intended to address, describe the overall mission area, describe the proposed system solution, and provide a summary of any supporting analyses. Additionally, briefly describe the operational and support concepts.

1.1. Capability Gap

Describe the analysis and rationale for acquiring a new product or system, and identify the DHS Component, which contains or represents the end users. Also, name the Capstone IPT, if any, which identified the capability gap.

1.2. Overall Mission Area Description

Define and describe the overall mission area to which the capability gap pertains, including its users and its scope

1.3. Description of the Proposed System

Describe the proposed product or system. Describe how the product or system will provide the capabilities and functional improvements needed to address the capability gap. Do not describe a specific technology or system solution. Instead, describe a conceptual solution for illustrative purposes.

1.4. Supporting Analysis

Describe the analysis that supports the proposed system. If a formal study was performed, identify the study and briefly provide a summary of results.

1.5. Mission the Proposed System Will Accomplish

Define the missions that the proposed system will be tasked to accomplish.

1.6. Operational and Support Concept

1.6.1. Concept of Operations

Briefly describe the concept of operations for the system. How will the system be used, and what is its organizational setting? It is appropriate to include a graphic that depicts the system and its operation. Also, describe the system's interoperability requirements with other systems.

1.6.2. Support Concept

Briefly describe the support concept for the system. How will the system (hardware and software) be maintained? Who will maintain it? How, where, and by whom will spare parts be provisioned? How, where, and by whom will operators be trained?

2. Threat

If the system is intended as a countermeasure to a threat, summarize the threat to be countered and the projected threat environment.

3. Existing System Shortfalls

Describe why existing systems cannot meet current or projected requirements. Describe what new capabilities are needed to address the gap between current capabilities and required capabilities.

4. Capabilities Required

4.1. Operational Performance Parameters

Identify operational performance parameters (capabilities and characteristics) required for the proposed system. Articulate the requirements in output-oriented and measurable terms. Use Threshold/Objective format and provide criteria and rationale for each requirement.

4.2. Key Performance Parameters (KPPs)

The KPPs are those attributes or characteristics of a system that are considered critical or essential. Failure to meet a KPP threshold value could be the basis to reject a system solution.

4.3 System Performance.

4.3.1 Mission Scenarios

Describe mission scenarios in terms of mission profiles, employment tactics, and environmental conditions.

4.3.2 System Performance Parameters

Identify system performance parameters. Identify KPPs by placing an asterisk in front of the parameter description.

4.3.3 Interoperability

Identify all requirements for the system to provide data, information, materiel, and services to and accept the same from other systems, and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together.

4.3.4 Human Interface Requirements

Discuss broad cognitive, physical, and sensory requirements for the operators, maintainers, or support personnel that contribute to, or constrain, total system performance. Provide broad staffing constraints for operators, maintainers, and support personnel.

4.3.5 Logistics and Readiness

Describe the requirements for the system to be supportable and available for operations. Provide performance parameters for availability, reliability, system maintainability, and software maintainability.

4.3.6 Other System Characteristics

Characteristics that tend to be design, cost, and risk drivers.

5. System Support

Establish support objectives for initial and full operational capability. Discuss interfacing systems, transportation and facilities, and standardization and interoperability. Describe the support approach including configuration management, repair, scheduled maintenance, support operations, software support, and user support (such as training and help desk).

5.1 Maintenance

Identify the types of maintenance to be performed and who will perform the maintenance. Describe methods for upgrades and technology insertions. Also, address post-development software support requirements.

5.2 Supply

Describe the approach to supplying field operators and maintenance technicians with necessary tools, spares, diagnostic equipment, and manuals.

5.3 Support Equipment

Define the standard support equipment to be used by the system. Discuss any need for special test equipment or software development environment

5.4 Training

Describe how the training will ensure that users are certified as capable of operating and using the proposed system.

5.5 Transportation and Facilities

Describe how the system will be transported to the field, identifying any lift constraints. Identify facilities needed for staging and training.

6. Force Structure

Estimate the number of systems or subsystems needed, including spares and training units. Identify organizations and units that will employ the systems being developed and procured, estimating the number of users in each organization or unit.

7. Schedule

To the degree that schedule is a requirement, define target dates for system availability. If a distinction is made between Initial Capability and Full Operational Capability, *clarify the difference between the two in terms of system capability and/or numbers of fielded systems.*

8. System Affordability

Identify a threshold/objective target price to the user at full-rate production. If price is a KPP, include it in the section on KPPs above.

Signatures

Sponsor's Acquisition Program Manager [print and sign] Date

Sponsor's Representative [print and sign] Date

S&T Project Manager [print and sign] Date

S&T Division Head [print and sign] Date

Please Note : See Appendix A for a full set of real-world examples ORDs that clearly illustrate how to effectively use this template and other previously described requirements elicitation methods.

DHS Implements a Commercialization Process to Harness Requirements

The U.S. Department of Homeland Security (DHS) possesses an "Acquisition Mindset," as do so many government agencies. While the Acquisition model has been utilized effectively in developing "custom, one-off" products such as aircraft carriers, it is not particularly germane to a majority of the needs at DHS as well as the first responders (a DHS ancillary market). The timely design, development and deployment of lower priced, widely distributed products for both DHS operating components and the first responder communities represents a critical step in protecting our nation. Recognizing this fact, the Department recently started implementing a "Commercialization Mindset" in order to leverage the vast capabilities and resources of the private sector through an innovative "win-win" private-public partnership called the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program.

DHS experienced several challenges merging twenty-two disparate organizations into a cohesive organization with a unified mission and culture. Those familiar with Merger and Acquisition activities realize that while integration of organizations poses difficulties, it also represents opportunities to infuse new processes and values into the newly created organization. Through both "top-down" and "bottom-up" approaches, DHS has been successful in developing, socializing and now implementing an innovative commercialization framework that has started to gain traction throughout the agency. The creation of a "Commercialization Mindset" has caught the attention of DHS managers and employees and has been embraced by senior management because of its significant benefits to the Department's internal and external activities.

Why is there a need for a Commercialization Mindset in DHS? DHS requirements, in most instances, are characterized by the need for widely distributed COTS (Commercial-Off-The-Shelf) products. Oftentimes, the need is for thousands, if not millions, of products for DHS' seven operating components and the fragmented, yet substantial first responder and critical infrastructure markets. The DHS commercialization process relies on providing two key pieces of information to potential solution providers in order for them to invest their valuable time, money and resources to develop products and services for use by DHS Operating Components, First Responder communities, Critical Infrastructure and Key Resources (CIKR) owner/operators and other stakeholders: 1) a clear and detailed delineation and explanation of the operational requirements, and 2) a conservative estimate of the potential available market for a potential commercialization partner to offer potential solution(s). We have forged and promulgated the development of Operational Requirements Documents (ORDs) through the publication of several books, training materials and articles to address the first half of this equation, and the following pages of a comprehensive market potential template address the latter.

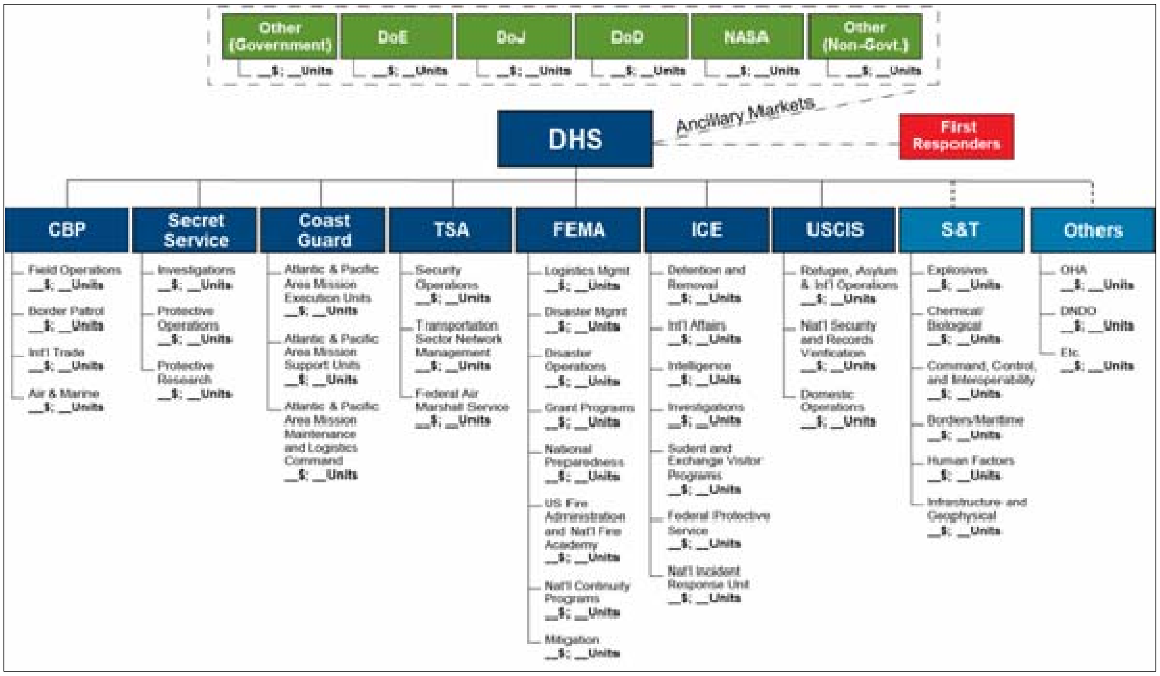


Figure 3 This market potential template maps out many portential available markets to which DHS has direct control and responsibility or acts as a "conduit" For more information on market potential templates, please refer to Appendix I.

Conservative Estimates of Potential Available Markets

It is important to understand not only the detailed operational requirements necessary to provide DHS stakeholders with mission-critical capabilities, but also understand the volume of potential users of these solutions. DHS itself can represent a substantial potential available market; in many instances requiring hundreds, if not thousands of product or service units to address unsatisfied needs. Couple to this the fact that DHS has responsibility for so many ancillary markets (e.g. First Responders, Critical Infrastructure and Key Resources, etc.) representing large potential available markets, it is evident that substantial business opportunities exist for the private sector as these large pools of potential customers and users represent the "lifeblood" for a business (see Figure 3). We first outline top level markets. In turn, each "branch" of the template has been further segmented to hone in on detailed market opportunities.

Figure 4 shows the major differences between a "pure" Acquisition versus "pure" commercialization processes, along with the recently developed and implemented DHS "hybrid" commercialization process.

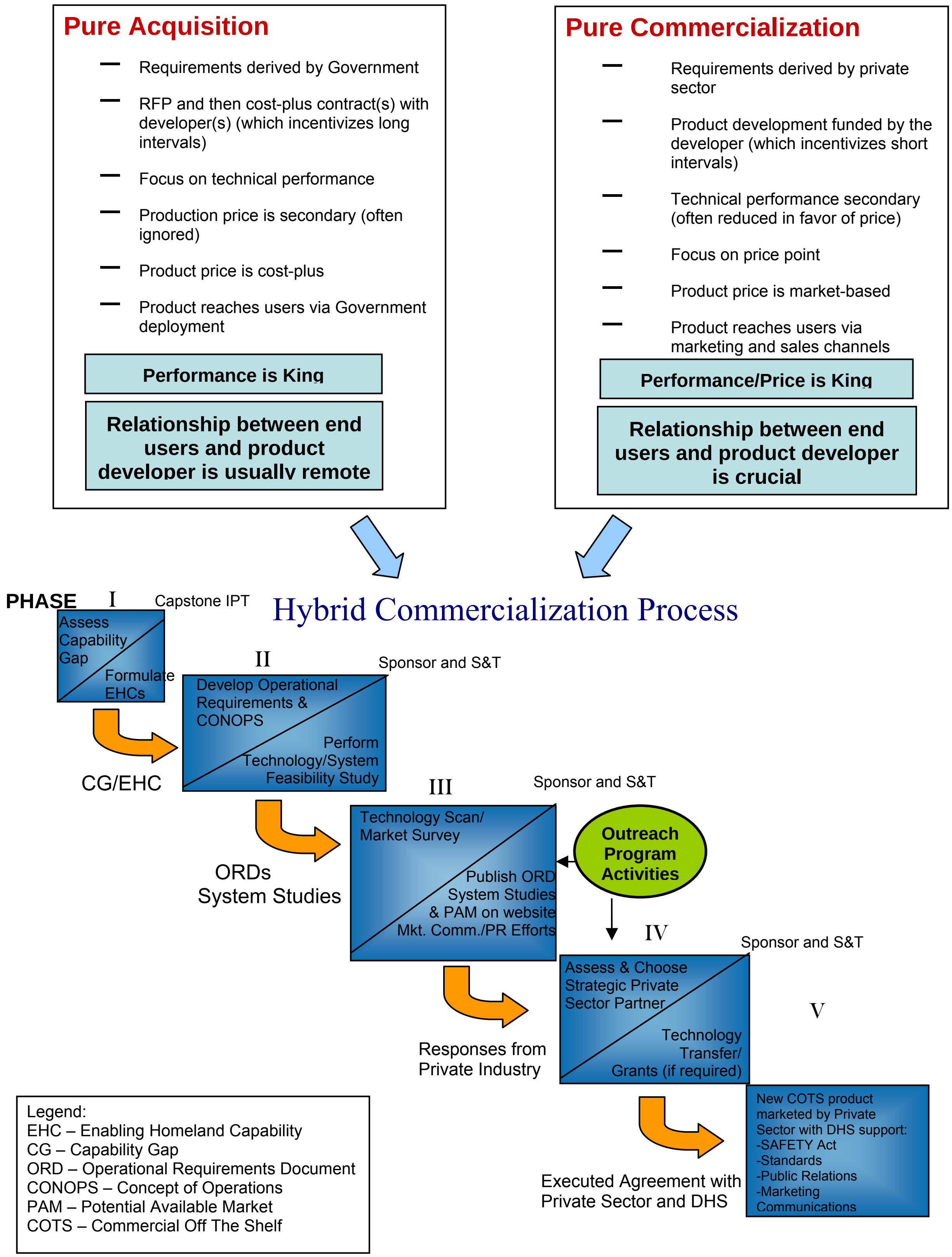


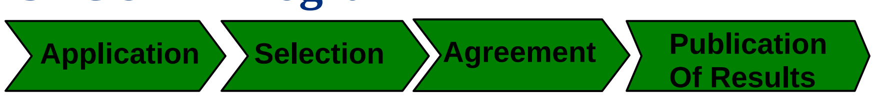
Figure 4 Comparison of "Pure Acquisition" versus "Pure Commercialization" models for product/system

Figure 5 delineates the overall description of DHS' new commercialization model and its first private sector outreach program called the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program to develop products and services in a private-public "win-win" partnership described in detail at www.dhs.gov/xres/programs/gc_1211996620526.shtm. Briefly, the SECURE Program is based on the simple premise that the private sector is willing and able to use its own money, resources, expertise and experience to develop and produce fully developed products and services for DHS if significant market potential exists. The private sector has shown remarkable interest in devoting its time and resources to such activities, if and when an attractive business case can be made related to large revenue/profit opportunities, which certainly exist at DHS and its ancillary markets. As previously stated, the private sector requires two pieces of critical information from DHS: 1. detailed operational requirement(s), and 2. a conservative estimate of the potential available market(s). This information can then be used to generate a business case for possible private sector participation in the program.

A New Model for Commercialization…

- Develop Operational Requirements Documents (ORDs)
- Assess addressable market(s)
- Publish ORD and market assessment on public DHS web portal, solicit interest from potential partners in a way that is open to small, medium and large businesses
- Execute no-cost (CRADA-like) agreement with multiple private sector entities and transfer technology and/or IP(if necessary)
- Develop supporting grants and standards as necessary
- Assess T&E findings after product is developed to assure DHS and ancillary markets that product meet its published specifications
- New Commercial-Off-The-Shelf (COTS) product marketed by private sector with DHS support

SECURE Program



- Application – Seeking products/technologies aligned with posted DHS requirements
- Selection – Products/Technologies TRL-5 or above, scored with internal DHS metrics
- Agreement – One-page CRADA-like document that outlines milestones and exit criteria
- Publication of Results – Recognized third-party T&E conducted on TRL-9 product/service. Results verified by DHS, posted on DHS web-portal to provide confidence to potential customers at DHS and its ancillary markets that product(s) meet or exceed their published specifications in reference to their actual performance.

Early response from groups within DHS, the private sector, and first responders about this guide and programs like SECURE has been very favorable[3-4]. The Department plans to regularly update its website with Operational Requirements Documents (ORDs) to continually expand this innovative private-public partnership. In addition, as evidenced in Figure 6, the taxpayers, private sector and public sector view programs like this as "win-win-win."

Benefit Analysis – "Win-Win-Win"		
Taxpayers	**Public Sector**	**Private Sector**
1. Citizens are better protected by DHS personnel using mission critical products	1. Improved understanding and communication of needs	1. Save significant time and money on market and business development activities
2. Tax savings realized through private sector investment in DHS	2. Cost-effective and rapid product development process saves resources	2. Firms can genuinely contribute to the security of the Nation
3. Positive economic growth for American economy	3. Monies can be allocated to perform greater number of essential tasks	3. Successful products share in the "imprimatur of DHS"; providing assurance that products really work.
4. Possible product "spin-offs" can aid other commercial markets	4. End users receive products aligned to specific needs	4. Significant business opportunities with sizeable DHS and DHS ancillary markets
5. Customers ultimately benefit from COTS produced within the Free Market System – more cost effective and efficient product development	5. End users can make informed purchasing decisions with tight budgets	5. Commercialization opportunities for small, medium and large business

Figure 6 The SECURE Program is viewed positively by DHS stakeholders. The success of the program lies in the fact that all participants receive significant benefits.

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[3] See Cellucci, T. "Opportunities for the Private Sector," 2008, 43pp. [Available online: http://www.dhs.gov/xres/programs/gc_1211996620526.shtm].

[4] Margetta, R. "S&T Official Working to Move Product Development Out of DHS, Into Private Sector," Congressional Quarterly Homeland Security. June 27, 2008.

Summary

This document has offered a brief summary of the role of requirements at DHS, with particular emphasis on the requirements hierarchy including defining capability gaps and demonstrating that operational requirements govern the development of an end-user system. Acknowledging the difficulty of requirements development, it presented nine best practices to elicit requirements from an end-user community and eight criteria to judge the "goodness" of requirements. It illustrated how an Operational Requirements Document (ORD) is generated using an ORD template. We also several provided real-world examples. The additional readings listed below are a collection of short articles that provide a number of explanations on the importance of requirements development as well as some additional methods not described in this resource. We encourage you to seek out supplemental information on the topic of requirements development as this book is just one resource among many that can be of value to those developing and understanding requirements in a detailed and thoughtful way. Please take the effort to review the carefully prepared appendixes that follow as they reveal important and practical knowledge in developing operational requirements to enhance our nation's security in a cost-effective and efficient manner. For your convenience, we have also included Appendix J, which contains the original *Requirements Development Guide (April 2008)* for those interested in a more detailed discussion on requirements development and product development life cycles.

Additional Requirements Development Readings

AntFarm, Inc. "Uncovering Hidden Customer Needs to Grow Your Services Business". 2007. http://www.antfarm-inc.com/docs/Growing_Services.pdf.

Byrd, T.A., Cossick, K.L. and Zmud, R.W. A Synthesis of Research of Requirements Analysis and knowledge Acquisition Techniques. MIS Quarterly, 16 (1). 117-138.

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Sisson, Derek. “Requirements and Specifications”. Philosophe.com. January 9, 2000. http://www.philosophe.com/design/requirements.html.

U.S. Department of Defense. Defense Acquisition Guidebook, Chapter 4. Dec. 2004. https://akss.dau.mil/DAG/TOC_GuideBook.asp?sNode=R&Exp=Y.

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Wiegers, Karl E., and Sandra McKinsey. “Accelerate Development by Getting Requirements Right.” 2007. http://www.serena.com/docs/repository/products/dimensions/accelerate-developme.pdf.

Wilson, William. “Writing Effective Requirements Specifications.” NASA Software Assurance Technology Center. April 1997. http://satc.gsfc.nasa.gov/support/STC_APR97/write/writert.html.

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Appendix A: ORD Examples

Learn by Doing:

Developing a detailed Operational Requirements Document (ORD)

Thomas A. Cellucci, Ph.D., MBA

Chief Commercialization Officer

U.S. Department of Homeland Security

November 2008

Requirements Development Initiative – Operational Requirements Document (ORD) Examples

This compilation of ORDs is meant to present the reader with several real-world examples of detailed operational requirements drafted by implementing an easy-to-use ORD template that provides a basic framework in guiding the understanding and articulation of needs.

Please keep in mind the following points as you consider writing an ORD to describe and define an existing problem:

1. Writing an ORD is **not** as difficult as you think → so just "jump in" and give it a try
2. We're here to help! Please use the many resources available online at http://www.dhs.gov/xres/programs/gc_1211996620526.shtm and https://dhsonline.dhs.gov/portal/jhtml/community.jhtml?index=15&community=S%26T&id=2041380003 for guidance:
   - ORD templates
   - Example ORDs
   - "Developing Operational Requirements" (Version 2)
3. Some simple things to remember:
   - **Requirements** define problems while **specifications** define solutions
   - An ORD describes a problem, not a solution
   - Make sure your ORD is product/service/solution agnostic (that is, it does **not** presuppose a certain solution)
   - Make the solution space as wide as possible
   - Keep it simple and make it easy for a reader to understand your problem/requirement
4. Review the attached ORD template examples and contact us if you have any questions or comments!
   - SandT_Commercialization@dhs.gov

ORD Template and Examples

Template Only

OPERATIONAL REQUIREMENTS DOCUMENT TEMPLATE

[Name of System or Product]

to be developed by the
[Name of Acquisition Program]

[Name of Program Manager]
Program Manager, [Name of Acquisition Program]
[Name of PM's Organization]

[Name of Sponsor]
Sponsor, [Name of Acquisition Program]
[Name of Sponsor's Organization]

[Name of S&T Project Manager]
Project Manager, [Name of S&T Project]
[Name of S&T Division]
Science and Technology Directorate

Date
Version X.X

Template Only

Contents

1. General Description of Operational Capability

In this section, summarize the capability gap which the product or system[4] is intended to address, describe the overall mission area, describe the proposed system solution, and provide a summary of any supporting analyses. Additionally, briefly describe the operational and support concepts.

1.1 Capability Gap

Describe the analysis and rationale for acquiring a new product or system, and identify the DHS Component which contains or represents the end users. Also name the Capstone IPT, if any, which identified the capability gap.

1.2 Overall Mission Area Description

Define and describe the overall mission area to which the capability gap pertains, including its users and its scope

1.3 Description of the Proposed Product or System

Describe the proposed product or system. Describe how the product or system will provide the capabilities and functional improvements needed to address the capability gap. Do not describe a specific technology or system solution. Instead, describe a conceptual solution for illustrative purposes.

1.4 Supporting Analysis

Describe the analysis that supports the proposed system. If a formal study was performed, identify the study and briefly provide a summary of results.

1.5 Mission the Proposed System Will Accomplish

Define the missions that the proposed system will be tasked to accomplish.

1.6 Operational and Support Concept

1.6.1 Concept of Operations

Briefly describe the concept of operations for the system. How will the system be used, and what is its organizational setting? It's appropriate to include a graphic which depicts the system and its operation. Also describe the system's interoperability requirements with other systems.

1.6.2 Support Concept

Briefly describe the support concept for the system. How will the system (hardware and software) be maintained? Who will maintain it? How, where, and by whom will spare parts be provisioned? How, where, and by whom will operators be trained?

2 Threat

If the system is intended as a countermeasure to a threat, summarize the threat to be countered and the projected threat environment.

[4] In this document, the terms "product" and "system" are synonymous. The word "system" is used to refer to either.

3 Existing System Shortfalls

Describe why existing systems cannot meet current or projected requirements. Describe what new capabilities are needed to address the gap between current capabilities and required capabilities.

4 Capabilities Required

4.1 Operational Performance Parameters

Identify operational performance parameters (capabilities and characteristics) required for the proposed system. Articulate the requirements in output-oriented and measurable terms. Use Threshold/Objective[5] format and provide criteria and rationale for each requirement.

4.2 Key Performance Parameters (KPPs)

The KPPs are those attributes or characteristics of a system which are considered critical or essential. Failure to meet a KPP threshold value could be the basis to reject a system solution.

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4.3.1 Mission Scenarios

Describe mission scenarios in terms of mission profiles, employment tactics, and environmental conditions.

4.3.2 System Performance Parameters

Identify system performance parameters. Identify KPPs by placing an asterisk in front of the parameter description.

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Identify all requirements for the system to provide data, information, materiel, and services to and accept the same from other systems, and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together.

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Discuss broad cognitive, physical, and sensory requirements for the operators, maintainers, or support personnel that contribute to, or constrain, total system performance. Provide broad staffing constraints for operators, maintainers, and support personnel.

4.3.5 Logistics and Readiness

Describe the requirements for the system to be supportable and available for operations. Provide performance parameters for availability, reliability, system maintainability, and software maintainability.

4.3.6 Other System Characteristics

Characteristics that tend to be design, cost, and risk drivers.

---

[5] The threshold value for a requirement is the minimum acceptable performance. The objective value is the desired performance.

5 System Support

Establish support objectives for initial and full operational capability. Discuss interfacing systems, transportation and facilities, and standardization and interoperability. Describe the support approach including configuration management, repair, scheduled maintenance, support operations, software support, and user support (such as training and help desk).

5.1 Maintenance

Identify the types of maintenance to be performed and who will perform the maintenance. Describe methods for upgrades and technology insertions. Also address post-development software support requirements.

5.2 Supply

Describe the approach to supplying field operators and maintenance technicians with necessary tools, spares, diagnostic equipment, and manuals.

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Define the standard support equipment to be used by the system. Discuss any need for special test equipment or software development environment

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Describe how the training will ensure that users are certified as capable of operating and using the proposed system.

5.5 Transportation and Facilities

Describe how the system will be transported to the field, identifying any lift constraints. Identify facilities needed for staging and training.

6 Force Structure

Estimate the number of systems or subsystems needed, including spares and training units. Identify organizations and units that will employ the systems being developed and procured, estimating the number of users in each organization or unit.

7 Schedule

To the degree that schedule is a requirement, define target dates for system availability. If a distinction is made between Initial Capability and Full Operational Capability, clarify the difference between the two in terms of system capability and/or numbers of fielded systems.

8 System Affordability

Identify a threshold/objective target price to the user at full-rate production. If price is a KPP, include it in the section on KPPs above.

9 Signatures

Sponsor’s Acquisition Program Manager [print and sign] Date

Sponsor’s Representative [print and sign] Date

S&T Project Manager [print and sign] Date

S&T Division Head [print and sign] Date

10 Appendixes

11 Glossary

Example Only

OPERATIONAL REQUIREMENTS DOCUMENT

National Emergency Response Interoperability Framework and Resilient Communication System of Systems

Example Only

Contents

1 General Description of Operational Capability for a National Emergency Response Interoperability Framework and Resilient Communication System of Systems

1.1 Capability Gap

Interoperability and compatibility of First Responder communication systems is a mandate of the National Incident Management System (NIMS). However, as of 2008, the only interoperability systems widely in use are expensive and complicated proprietary voice-over-radio systems. These aptly described "patchwork" interoperability systems are unable to scale without additional, costly equipment coupled with costly on-site support provided by highly trained technicians. This current mode of operations is not feasible in the critical first minutes and hours of an incident response.

The vast majority of Emergency Responders are limited in their ability to communicate and collaborate with each other. They are unable to communicate with command, support teams and other responding organizations present at an incident scene. In 2008, almost 7 years after the tragic lessons learned by 9/11, the overwhelming majority of Emergency Response Organizations (ERO) does not have the basic capability for any of their team members to establish communications at an incident site. They have to wait hours for large trucks and/or trailers with very expensive[1] and complicated communications equipment delivered to the site. In the case of a catastrophic incident causing a scorched earth[2] environment, it may take days to get the necessary equipment and communication support personnel to the incident site.

It is not only the complexity and cost of existing systems that inhibit NIMS compliance; most systems often render previous technology investments obsolete or require a need for costly upgrades to legacy systems proving impractical or unaffordable. A system is required that creates a communications framework enabling the ability to allow not only interoperability of disparate systems, but also the ability to interconnect legacy systems and new systems.

Another major capability gap is in providing an affordable solution for the interoperability and interconnection of communication systems that support IPv4 routing with those systems that answer the Department of Defense mandate for IPv6 compliance. The cost of phasing out an IPv4 system (which is prevalent in the vast majority of state and local ERO's, Non-Government Organizations and private sector security) is beyond realistic budgetary feasibility and would take years to accomplish.

Yet, closing this gap is mandatory. The NIMS mandate for interoperability is unattainable without a cost-effective, easy-to-implement system that provides a framework for the interoperability of data and video between responders and EROs. Data is as critical as voice communications within an incident site. If noise levels inhibit voice communications or silent communications are necessary, instant messaging is an effective tool. Video from an inexpensive webcam on a responder's laptop may make a critical difference by providing a visual assessment to the ERO. Maps and other files needed at the incident site must get to the response team without the need to deliver files physically via courier, currently the most widely-used solution[5].

Existing interoperable voice, data and video communications require fixed private networks or access to the Internet via a Virtual Private Network (VPN) requiring authentication servers and server-based network management systems. This requirement for access to remote servers creates an insurmountable capability gap for interoperable communications among responders in the hours or days they must wait for communications trucks and/or trailers to arrive at the incident scene. This ORD requires a system that provides peer-to-peer interoperability between responders and EROs without the requirement for remote servers or dedicated networks. The requirement is for secure peer-to-peer communication between any responder using any type of voice, video or data communication device and any other responder or ERO without requiring the receiving communication to be of similar device type or dedicated network. Responders at an incident site must be able to establish incident area peer-to-peer communications within minutes of responding and interoperate with EROs both at the incident site and/or remotely across readily available disparate communications networks without the need for third-party services or servers.

Even more problematic is the fact that most EROs still depend on vulnerable radio or cellular infrastructure to support expensive communication and command vehicles. Network failures caused by destruction of critical infrastructure, such as radio towers, landlines and network control centers, represent a major challenge for the public and private sectors. If they do have systems, the majority is not portable enough for easy transport to the incident scene by a first responder; or is so complicated, extensive training is required to operate the system. Very few EROs currently have portable systems whose capabilities allow a responder to establish interoperable voice, data and video communications at the incident site without technical support in ten to twenty minutes. All EROs require this capability.

Dramatically illustrated in the aftermath of the 2004-2005 hurricane season, which resulted in catastrophic damage across the Gulf States, is the ultimate example of the capability at hand. Vast areas realized devastating damage to their communications infrastructure. There was no communications resiliency. The available response recovery solutions were inadequate or failed altogether, leaving many areas where lives were at risk without communications for days.

Many critical infrastructure facilities of importance to the security of the region did not have effective communications for weeks.[3] Belle Chase Naval Air Station, critical for the staging of over 30,000-rescue operations south of New Orleans, did not have reliable voice communications for nearly 96 hours after the landfall of Hurricane Katrina. With a system that meets the requirements of this ORD, the Coast Guard Rescue Operations in New Orleans would have had telephone capability and data communications within 10 to 20 minutes of beginning the emergency response. This communication could have been established by anyone at the staging area regardless of whether they had training in deploying communication networks or not.

Almost all communication systems in 2008 still require some type of fixed infrastructure in order to work and the presence of qualified technicians or engineers is required. Yet many disaster situations result in no useable infrastructure to support either local area or wide area communications.

> According to an **Associated Press report in 2005**, “Downed telephone lines and damaged cellular towers left emergency crews confused and isolated in the aftermath of Hurricane

Katrina." The report, quoting experts, said communications systems eroded as the waters rose and only got worse.

"We had no way to communicate except by line of sight. Our radios were not operable, most landlines and cell phones were useless and our communications centers were under water. When help arrived, we could not communicate with them either." **Juliette Saussy, director of Emergency Medical Service of New Orleans, told regulators.**

"Some three million telephone lines were knocked out as the violent storm hit the Gulf Coast on August 29, 2005. At least 38 911-call centers went down, and more than 1,000 cellular towers were out of service. As many as 20,000 calls failed to go through the day after the storm, and about 100 TV and radio stations were knocked off the air…" **FCC Chairman, Kevin Martin said.**

There must be a framework for enabling communications, interoperability and collaboration that is affordable. The biggest gap in 2008 is that existing solutions are too expensive for most EROs and funding for staffing communication technicians to operate these solutions reduces the ability of most EROs to equip and staff for other vital capabilities necessary for mission effectiveness. Billions of dollars in grants are provided for solutions that will not meet the NIMS requirements. This ORD requires, not only that the technology work, but that it is affordable.

The local incidents as well as the wide area natural disasters within the past seven years clearly identify the capability gap to enable First Responders to communicate, interoperate and collaborate with each other, their command, and their support teams or with other organizations present at an incident scene within minutes of arriving at an incident site. This ORD provides the system requirements to close this vital gap in the NIMS, saving lives and increasing security.

1.2 Overall Mission Area Description

First Emergency Response Providers (FERP) by definition are the professionals who first arrive at an incident site to provide emergency medical services, security, law enforcement, assessment of the scope of the incident and recommend and coordinate an extended response if required. The mission area covered by this ORD is to outline the capabilities needed to enable FERPs to communicate and collaborate with each other, their command and interoperate with mutual aid, support teams and other responding organizations within minutes of arriving at an incident site. This ORD will also address the capabilities needed to provide interoperable voice and data systems to command in control of the incident; dynamically managing the incident as the response grows and scaling communications as required; increasing collaboration and extending the chain of command across jurisdictions. Finally, this ORD will identify the requirements of the proposed system capabilities and provide a communications framework for the creation of a dynamic, interoperable system of systems.

1.3 The Description of Resilient Portable Communications Responder Kits that Create a System of Systems.

The primary system solution that closes the capability gap and accomplishes the mission of this ORD is actually a system of systems (SoS). The SoS must meet three primary requirements. First, the SoS must be dynamic, enabling interoperability between any combinations of different communication device types; converge any type or number of disparate networks on-demand at any incident site. The SoS also fosters dynamic communications with EROs, elected officials whose districts are affected by the incident, supporting emergency operations centers (EOC), medical facilities, NGOs, military bases and private sector security involved in the area of the event. There cannot be any operational restrictions on the number of or combination of systems available to support the incident response. The requirement is the EROs and FERPs use the same software-based framework that is freely distributable at the incident site and can be loaded on or accessed by any device in minutes.

In order to create a dynamically interoperable SoS, the SoS must be based on software that converges network protocol types and provides network presence awareness. The SoS is required to enable data interoperability among any combinations of ad hoc, terrestrial data, telephony or satellite networks that are immediately available to the FERP or will be introduced to the SoS by other FERPs or EROs as the response develops.

The second primary requirement that must be in place to meet the mission of this ORD is human portable resilient communication systems that can provide connectivity to the interoperability framework. These systems will be in a kit form that has everything a FERP needs, to be hand-carried to the incident site, transported by car, helicopter or small watercraft. The kit must be able to provide voice, video and data communication peer-to-peer among FERPs at the incident site as well as capability across any available network. If normal network infrastructure is unavailable, the kit will contain a broadband satellite system to insure connectivity beyond the incident site. The Resilient Portable Communications Kit (RPCK) will be easy to setup and in operation in 10 to 20 minutes by any FERP. The kit will require zero technical support to setup. The RPCK must seamlessly participate in an expanding system of systems. The kit will be available in multiple form factors providing EROs the flexibility to have kits carried by hand in cases, mounted in vehicles, installed in mobile EOCs or any other type of response apparatus. If an ERO needs to support large-scale recovery operations, the RPCK will be modifiable to meet the requirement of the ERO.

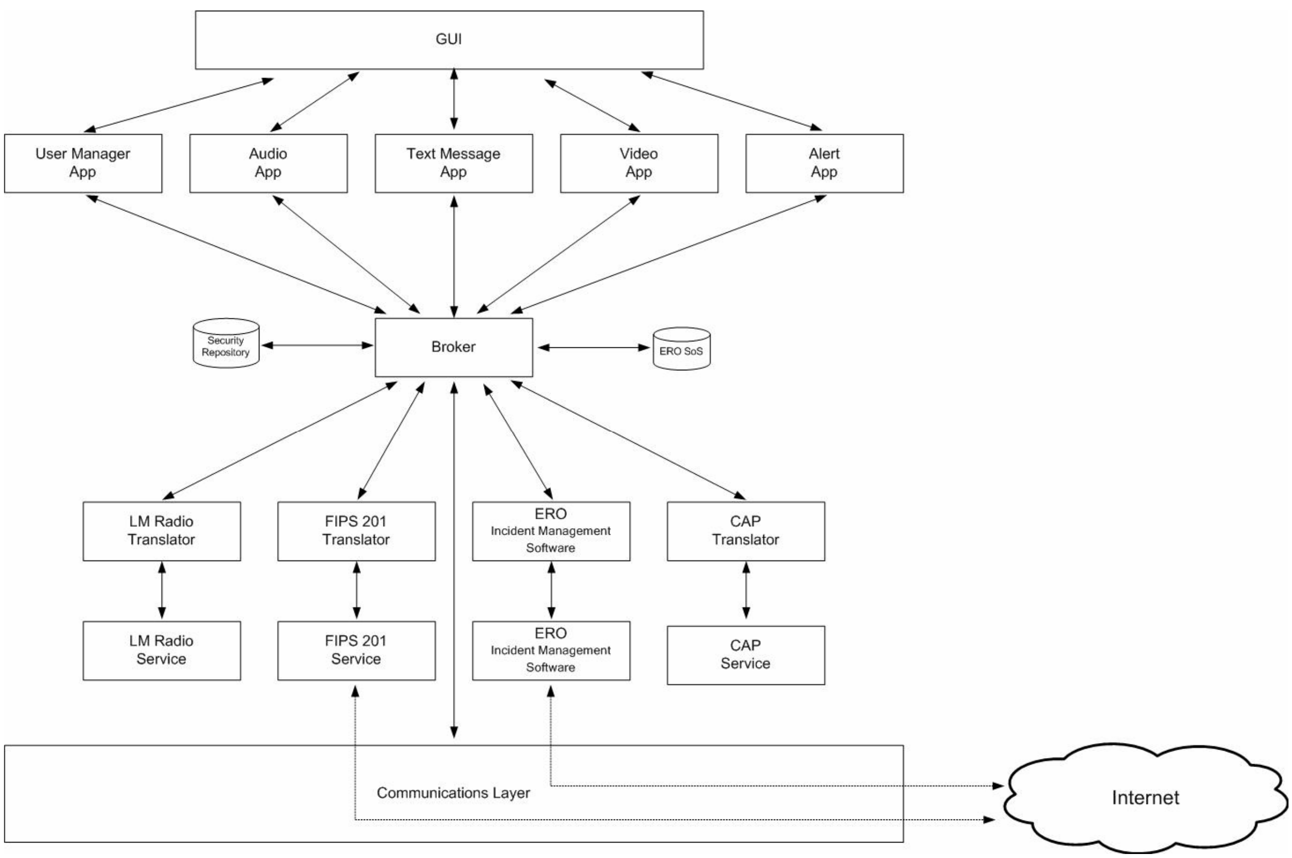
The communication capabilities of the RPCK require:

- the ability to operate via both AC and DC power without requiring filtering. It will directly connect with any 12-volt battery, vehicle cigarette lighter adaptor, generator, tactical solar array or tactical fuel cell.
- a full featured VoIP PBX with at least 5 handsets (wired or wireless) with the ability to scale the support of VoIP handsets for every FERP at the incident site.
- wired Ethernet connectivity for a minimum of 4 external devices.
- wireless access to the network for any 802.11-enabled COTS computer at the incident site. The system’s wireless coverage will be scalable simply by deploying software definable wireless routers operating on AC or DC power deployable by the FERP.
- network management software converging data, telephony and video protocols while interconnecting seamlessly and without configuration with IPv4 and/or IPv6 networks and devices.
- IPv6 and IPv4 network routing with a software firewall as well as allowing external firewalls and VPNs to be used if required.
- simple operating instructions with color-coded connections allowing any FERP to deploy the network without prior exposure or training to the RPCK.
- the capability to add IP-based devices and peripherals as needed to support an extended response or recovery operation.

- the ability to interconnect with any Land Mobile Radio Network (LMR) or cellular "push to talk" (CPT) phone patchwork interoperability system, enabling LMR or CPT devices to interoperate with any other type of device on the SoS, such as a laptop computer. This ability allows EROs utilizing IP-based devices (laptop, PDA, desktop computer) to have voice communications with LMR or CPT devices
- interoperability support with cellular systems.

The third primary requirement is the kit must be affordable and scalable. The SoS fails if the FERP does not carry resilient communications to the incident. EROs will need multiple Rocks. If the kits are too expensive they will not be available where they are needed most as an integral part of any FERP's support equipment. The RPCK should be affordable for DHS to rapidly fund the distribution of enough kits across the United States, enabling the deployment of a resilient SoS, which in turn creates a National Communication Resiliency Network (NCRN). Even if parts, or all, of the national power and communications infrastructure are compromised or destroyed, the NCRN would survive.

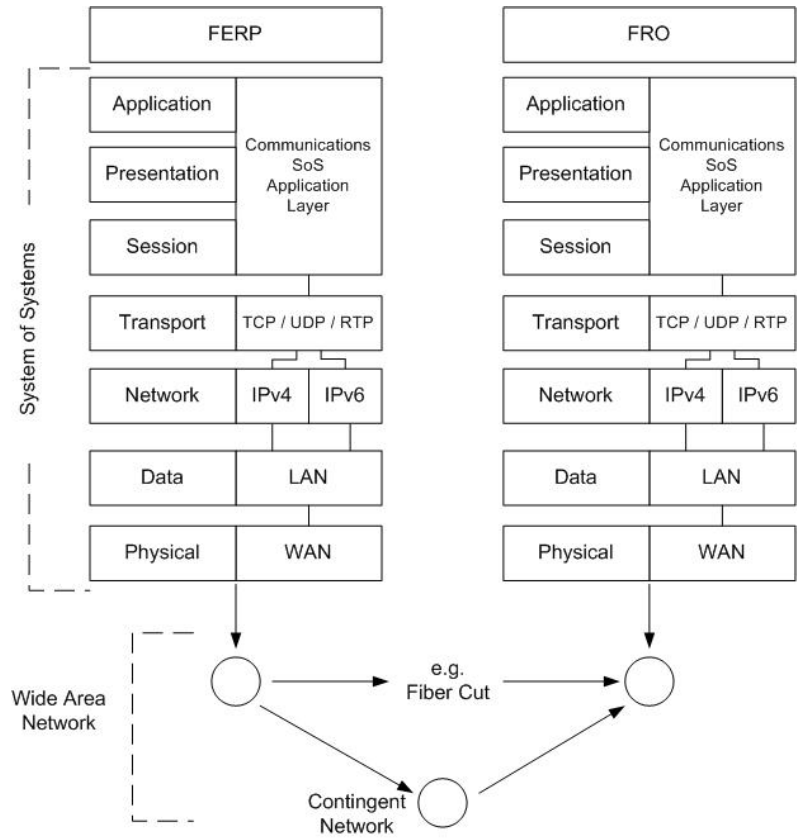
The following diagram details the architecture needed to create the framework of a SoS:



The kits are required to interconnect with any available IPv4 or IPv6 data network that the FERP has permission to use; providing Wide Area Network (WAN) connectivity without requiring any configuration or modifications by the FERP. By enabling the IPv6 capability, the system provides the ERO the ability to create secure collaboration with supporting agencies anywhere in the world, on-demand. The following diagram details the capability of creating secure peer-to-peer collaboration on-demand without the need of a server.

1.4 Supporting Analysis

The following diagram is the position of components on the OSI stack necessary to support interoperability.



The contingent network in the diagram above is any available WAN connection. If a WAN connection is not available at the incident site, the RPCK will include a small broadband satellite system, with active service.

Example Only

1.5 Mission the Proposed System Will Accomplish

February 28, 2003, President George W. Bush issued Homeland Security Presidential Directive 5 (HSPD-5) which in mandating the National Incident Management System (NIMS) calls for the creation of a system that enables,

> "Federal, State and Local governments to work effectively and efficiently together to prepare for, respond to and recover from domestic incidents, regardless of cause, size or complexity. To provide for interoperability and compatibility among Federal, State and Local capabilities, the NIMS will include a core set of concepts, principles, terminology, and technologies covering the incident command system, multiagency coordination systems; unified command; training; identification and management of resources (including systems for classifying types of resources); qualifications; and certification; and the collection, tracking and reporting of information and incident resources."

The proposed SoS and RPCK would enable the accomplishment of this directive. If FERPs and EROs cannot communicate, they fail. The proposed system creates the communication resiliency necessary for an 'interoperable and compatible response' to an incident.

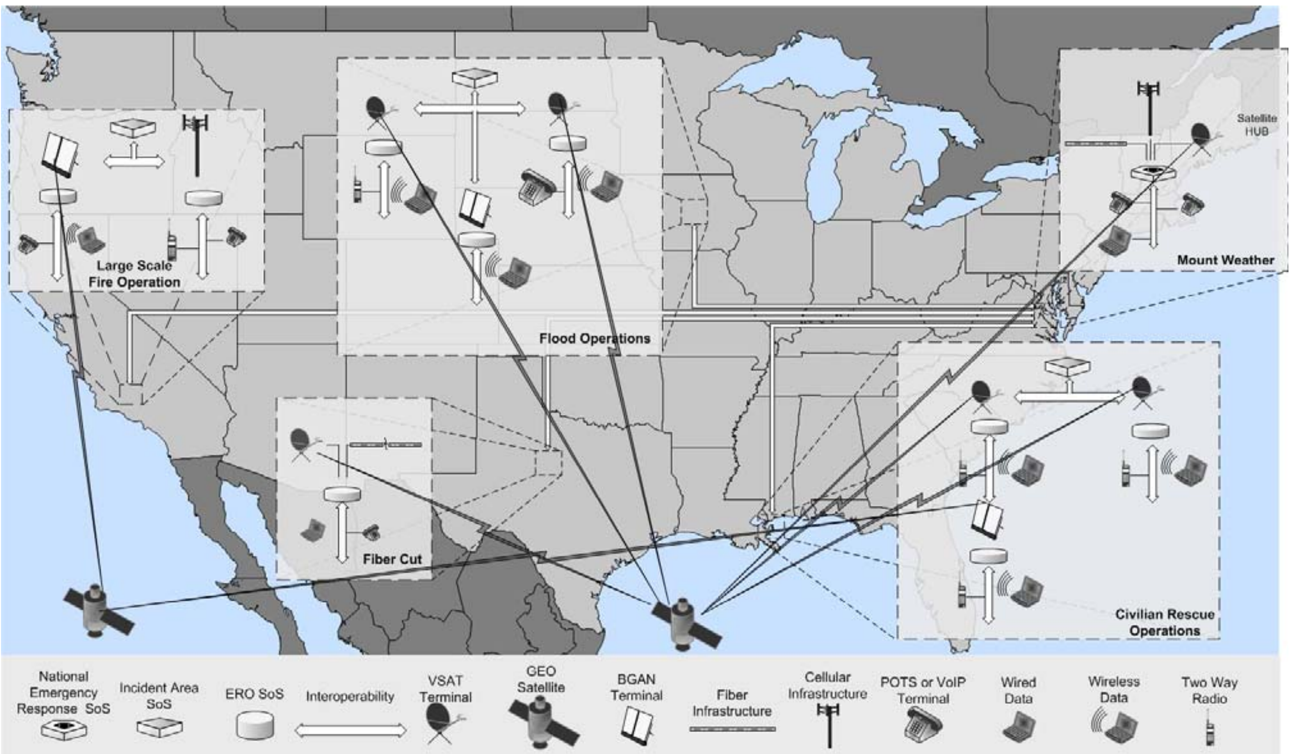
Specifically the proposed system will accomplish this mission by:

- providing a communication framework that creates dynamically interoperable communications on-demand.
- providing any FERP the capability to communicate at an incident site with other responders and with anyone else who has data or telephony capability anywhere in the country with what the FERP brings to the incident site, there is no need for additional equipment.
- enabling any responder, even if it is the first time the FERP has used the kit, to set up the system in 10 to 20 minutes.
- interoperating with other systems, creating a system of systems for voice, data and video interoperability.
- providing the ability to log communications among FERPs for reporting purposes.
- interconnecting command systems in a multi-agency response across disparate networks on-demand.
- creating visibility among responders to know what resources are available and coordinate the use of those resources.
- enabling the creation of 'ad hoc" incident site, area, regional and national communication networks as needed within minutes.
- providing peer-to-peer communications that enable instant alerts, warnings and advisories that can be viewed and responded from anywhere in the country.

1.6 Operational and Support Concept

1.6.1 Concept of Operations

The RPCK and a SoS framework can establish communications anywhere and anytime without any other support. These systems will be a part of the FERP team's basic response tools. The system creates a system of systems with other systems and will interoperate with any other IP-based network. If FERP vehicles in every locality in the country carried the RPCK /SoS system or used the software that provides the system capabilities for legacy systems, in effect, the NCRN is created that provides communication capability even in the aftermath of a large scale infrastructure disaster. The diagram below illustrates the NCRN.



The NCRN will be available to as many FERPs and EROs as possible on a 24x7 basis. The system creates the communication resiliency and provides the capabilities to accomplish the mission only if the SoS is available to the FERP teams and their commanders. Every EOC, fire station, police station, hospital emergency room, private security force at critical infrastructure sites should have a RPCK in order to create a system of systems on-demand. In addition, key response vehicles, apparatus and command vehicles will also have systems in order to be apart of the system of systems. Finally, civilian and political leaders who are integral to the NIMS should also travel with the RPCK to guarantee their availability to collaborate by having personal communication resiliency.

Sites and agencies not affected by the loss of communication capabilities, but who still need to be a part of the SoS can simply do so by running the proposed system software on their existing systems. This ability to run SoS software on any network from any location will provide the capability of a virtual on-demand NCRN, resilient by design. The SoS communication framework is agnostic of device type or network type. The SoS system framework simply requires a MAC or IP address within an IPv4 or IPv6 network.

Billions of dollars has been spent on interoperability since the NIMS mandate, but today there is no capability for interoperability of voice, video and data that can be used on a local, state, regional and national basis immediately following an incident. The proposed RPCK/SoS will provide that capability for far less than the cost of alternative systems that do not have the capability of meeting the mandate. Implementation of a program that would use the system is called for. Meeting this requirement saves hundreds of millions of taxpayer dollars while also being rolled out nationally within three short years.

1.6.2 Support Concept

The very nature of the SoS means providing connectivity when and where it is needed. A staff of network convergence engineers would support the system around the clock. The support engineer must have the ability to troubleshoot problems in real-time. The support engineer would have the ability to run remote diagnostics on any supported system. Because one of the major requirements of the ORD is hardware components be minimized when possible by providing network functionality with software. The majority of support issues would more than likely be related to the convergence software running the RPCK or the framework software running the SoS.

Software updates will be pushed to all systems in a planned and coordinated manner. Because the SoS is a peer-to-peer framework, updates will automatically be logged to the support database with an acknowledgement of a successful update. If updates are required at the incident site, the support engineer would have the ability to remotely update the RPCK at the incident.

If there are hardware failures with the RPCK, replacement systems and parts will be staged at regional logistic depots, which would guarantee a maximum delivery time of 8 hours to the ERO. Spare parts should be included with each RPCK for repairs that can be made by the FERP.

Live interactive webinars will be held daily on a regional basis allowing any FERP to not only receive training, but also ask for advice and share ideas with other FERPs. These webinars will be coordinated and monitored by a national support staff. Because every RPCK would provide peer-to-peer video capability, enhanced support would be provided to any FERP when needed.

2 Threat

If FERPs and EROs cannot communicate, they cannot respond effectively. Lives have been lost because communications systems were not resilient or could not interoperate with other systems at the incident. Rescue operations cannot be coordinated; assets requested or deployed all while valuable time is lost without critical communications capability.

On a local level incident response, too many missions are compromised because under-funded EROs cannot afford easy-to-use resilient communication systems. The systems sold to them are too expensive and require costly support. Complex systems requiring this type of support take resources away from other critical roles.

In most cases, as communications systems funding becomes available, EROs do not possess the knowledge or experience to adequately obtain a system that addresses all the communication risks they will face in a disaster. There are no standards published that give them guidance on possible solutions that will meet the demands necessary to implement this ORD. Instead, they rely on existing relationships with vendors or salespeople, who themselves are not skilled or adept in disaster recovery communications. These resources work for very large companies whose business model relies on proprietary technology that does not allow other manufacturers' products to integrate. Often times EROs find that what they get is not what they thought they were buying. There are dozens of anecdotal stories of EROs spending millions to deploy systems that do not accomplish the intended mission and when they complain they are informed they will need to spend millions more to actually get the system to do what they need, if indeed the system can do what they need.

On a state and regional level where interoperability exists, only certain types of radio systems have this ability. These systems depend on an infrastructure with no resiliency. Major budget dollars spent on incident management software and services by EROs to manage incidents on a regional or state basis will not work if they do not have connectivity to the Internet. Alert and warning systems have become a major business since the Virginia Tech tragedy, but they all depend on networks that provide no resiliency. If power fails, campus communications fail. You cannot send a SMS alert and have any guarantee the message was received if you are depending on a highly vulnerable cellular network. If you send an emergency email, there is no way to guarantee that the multiple e-mail servers required for the delivery of the email will be available and able to deliver the increased amounts of email generated due to an event. Not only are EROs creating plans that will fail without resilient and an interoperable communication framework, they are spending hundreds of millions of dollars building a false sense of readiness.

There currently is no interoperable resilient national communication solution across federal, state and local EROs. Solutions that will take decades, costing billions of dollars and do not provide resilient interoperability are a major threat to homeland security. Big budget telecommunications projects follow the failed philosophy of "you throw enough money at a problem it will be fixed", thus leading EROs to ignore the existing vulnerabilities that could be addressed by less costly and more practical solutions. Too many telecommunications professionals are still pushing 20th century technologies to address 21st century problems. A response to a pandemic, major terrorist strike at key infrastructure, cyber attack on telecommunication centers, super regional earthquakes and catastrophic oil shortages planned to cripple the US economy or any other scenario with national impact will fail because current communications infrastructure will be compromised or worse yet, destroyed. Without communications, EROs are blind, deaf and mute to any coordinated national response. There is no capability to create a national "ad hoc" communications network for a coordinated national response. This inability leaves NIMS vulnerable to failing on a catastrophic level.

Finally, the greatest threat is ignoring the plurality of our system of government. Incident response always starts at the local level; expenditures must happen at the local level. It is impractical to implement a federally mandated one-size-fits-all system. William Waugh of Georgia State University in Atlanta points out in his paper "*Terrorism, Homeland Security and the National Emergency Management Network*"

> "On September 11, 2001, officials and agencies that are part of the national emergency management system orchestrated the responses to the collapse of the World Trade Center towers and the fires at the Pentagon. The efforts of local, state, and federal emergency

> agencies were augmented by nonprofit organizations, private firms, and organized and unorganized volunteers. The system reacted much as it would have for a major earthquake or similar disaster. In the rush to create federal and state offices to deal with the threat of terrorism and, ultimately, to create a Department of Homeland Security, the very foundation of the nation's capacity to deal with large-scale disasters has been largely ignored. Although the human and material resources that the emergency management network provides may again be critical in a terrorist-spawned catastrophe, the new Homeland Security system may not be capable of utilizing those resources effectively. The values of transparency, cooperation, and collaboration that have come to characterize emergency management over the past decade seem to be supplanted in the new command-and-control-oriented Homeland Security system. If that occurs, when the resources of the national emergency management system are needed most, the capacity to utilize the system may be severely damaged and cultural interoperability will be a serious problem."

Avoiding this problem lies in a communication system that is based on the concepts of the SoS called for by this ORD. All of the efforts of the National Emergency Management Network (NEMN) is wasted without a NCRN. Ham radios alone will not coordinate the management of a national response effort. EROs and FERPs need resilient voice and data communication capability that will interoperate with other EROs and FERPs.

3 Existing System Shortfalls

Why do current systems fall short of providing the capability to meet the NIMS requirements?

> "To provide for interoperability and compatibility among Federal State and Local capabilities, the NIMS will include a core set of concepts, principles, terminology, and technologies covering the incident command system, multi-agency coordination systems; unified command; training; identification and management of resources (including systems for classifying types of resources); qualifications; and certification; and the collection, tracking and reporting of information and incident resources."

Specifically, current systems fall short in these areas:

- Most systems are not resilient. Systems that depend on a fixed infrastructure, dedicated networks and proprietary technology are not reliable in a response to a major disaster or infrastructure failure. Most systems take days if not weeks to restore when they fail. Without communications, NIMS plans fail.

- The requirements published for NIMS compliance by EROs lack a communications framework that simplifies the process of implementing a system that meets the requirement for interoperability and compatibility. Most EROs lack the technical resources to filter through the plethora of available systems. In many cases, communications specialists who are making these decisions are only experienced in analog radio systems or telephony and are being forced to make IP networking decisions in which their lack of knowledge leads them to spend their budget on systems that only provide part of the capability they need. EROs need options that work within a communications framework that will guarantee interoperability and compatibility with any agency or ERO.

- Systems are too expensive. The ERO buys a system that is limited by budget or grant realities. This result is limited capability. They have what they can afford, not what they need. Every ERO and FERP need full resilient communications capability.

- Systems are too complicated. One major provider of systems that any ERO would deem reliable is selling a solution that requires three (3) certified technicians to operate. The ERO has a powerful system that will cost more in five years to operate than it cost to purchase. A FERP will not have the needed communication capability if the technician cannot get to the incident scene. This could take hours in most cases and in the case of a major disaster, days.
- Many systems rely on proprietary technology that can only integrate with like devices. The major providers of communication systems provide systems based on proprietary technology that drives up the price for the ERO to not only acquire and support, but also make it difficult and expensive to interoperate with other EROs. In some scenarios, voice, video and data interoperability between different proprietary systems is not feasible.

- Many systems will fail to provide resilient communication because they are so cumbersome they require dedicated power and transportation, rendering them useless to the FERP in the first critical minutes of a response. Semi-trailers cannot travel over roads blocked by fallen trees and downed power lines. Due to the flooding, responding to Katrina meant having to fly systems and technicians in by helicopter or small planes, taking days to provide communication capabilities for rescue operations. If the systems are simple to use and FERP-portable, they could and should go to the incident site with the FERP.

- Since there is no current framework to create a system of systems today, even the grant process for funding systems is slowed down. Without a framework, it is a daunting challenge for a multi-agency grant process to verify what is being bought by the ERO is necessary and will meet the mission requirements. With a SoS, it becomes feasible to require systems be compliant with the framework, making purchasing decisions and grant processes easier.

- Most ERO systems networks are IPv4 and not IPv6 compliant. The majority of FERPs would not even notice the difference, but a system that is not IPv6 compliant is more difficult to secure in trying to support interoperability. These security concerns by themselves can cause any mutual response to fall short of the requirement for interoperability and compatibility.

- Current systems also fall short because, due to a lack of an interoperability framework supporting systems being apart of a system of systems, it is problematic if not impossible to allow EROs not only to interoperate with other EROs and FEMA, but NGOs, military and private sector security as well. Without a communications framework supporting communications across organizations, a mutual-aid response will likely fall short on what is needed for an effective response and rapid recovery.

4 Capabilities Required

4.1 Operational Performance Parameters

The SoS and RPCK must meet the NIMS mandate. To do so the RPCK, at a minimum must be able to:

- converge multiple protocols and networks to provide interconnectivity to any IPv4 or IPv6 network or optimally a system that will interconnect to IPv4 and IPv6 networks wired or wireless, and terrestrial or satellite (O/T)
- support IPv6 connectivity and be capable of routing to an IPv4 LAN. (O/T)
- to run two or more RPCKs at the same incident site (T) to run two or more RPCKs at multiple sites across a large area and support collaboration of every RPCK or IP network being used in the response. (O)
- operate on either AC or DC power (T), directly connect to any 12-volt battery, vehicle cigarette lighter, generator, tactical solar array or tactical fuel cell. (O)
- support interoperable voice, video and data applications at the incident site (T), the ability to support secure interoperable voice, video and data from the incident site with any other location in the country (O).
- provide two form factors, one portable and one that can be mounted in a mobile transport in less than one hour (T), multiple form factors enabling the ability to put a RPCK anywhere. (O)
- be carried by a FERP to an incident on foot, by small watercraft, car or SUV, helicopter or small plane (T) or, the RPCK is small enough to fit in a bag or case that the FERP is using to carry other gear into the incident (O).
- mount in fire apparatus or emergency response vehicle (T) or, small enough to fit in any ERO network rack or any mode of transportation available in the response. (O)
- setup in 20 minutes by the FERP (T) in less than ten minutes. (O)
- require no more than six steps to setup (T) no more than three steps to setup. (O)
- provide VoIP calling anywhere in the United States (T) anywhere in the world. (O)
- provide a software VoIP PBX that supports at least three phone calls at one time using a single toll-free DID (T) or able to support thirty phone calls at one time using a single toll-free DID. (O)
- support extension-to-extension dialing over the incident area (T) or support extension dialing across a WAN. (O)
- create a LAN for the incident site (T) or create a "no setup required" LAN for the incident site with software providing secure IPv4 and IPv6 routing and the ability to support organizational security requirements. (O)
- interconnect with any available network providing Internet connectivity (T) or the ability to connect to multiple networks and rollover to a backup network when the primary fails or load balance between the two. (O)
- provide 10mb network connectivity between users on the LAN (T) or 54mb network connectivity between users on the LAN. (O)

- support interoperable peer-to-peer networking (T) support peer-to-peer video, audio and data connectivity. (O)
- provide a minimum 400mw 802.11 a/b/g wireless access point that can support non-line-of-sight wireless access to the incident LAN from up to 100 yards (T) or a minimum 400mw 802.11 a/b/g wireless access point that can support the same access from up to one mile. (O)
- support up to twenty-five users on the network at one time (T) or support up to one hundred users on the network at one time per RPCK. (O)
- provide one VoIP handset (T) or five VoIP handsets with the option of adding up to twenty-five handsets per RPCK. (O)
- support any IP-over-satellite network access (T) or have the ability to provide satellite service for the RPCK without having to increase the size of the RPCK. (O)
- provide complete instructions for setup and trouble shooting (T) or complete color-coded instructions with pictures that a FERP with an elementary education can setup. (O)
- be affordable enough to purchase and maintain (T) or affordable enough for the ERO to have RPCKs at all supporting sites with enough RPCKs to support every FERP responding to the incident. (O)
- meet COTS requirements or optimally DHS should purchase specified systems in quantity and distribute as equipment grants to NIMS compliant EROs.

The SoS at a minimum must:

- create a system of systems at an incident site simple enough for a FERP to setup in 10 to 20 minutes or optimally extend the system of systems to any system in the country, if the system has access to the Internet or mutually accessible dedicated network. Nothing more should be required other than entering the location code of the SoS.
- create a communications framework for interconnecting disparate local area data networks, video networks and radio networks and enable automatic interoperability between all interconnected networks at the incident site or optimally securely interconnect disparate networks anywhere in the country creating a WAN on-demand.
- support the interoperability of peer-to-peer communications of voice, video and data or optimally support peer-to-peer and one-to-many and many-to-many connectivity of all users within the SoS.
- provide a framework for collaboration or optimally a framework for collaboration that can provide application functionality by writing an XML document.
- support presence management and optimally will include a self aware application that several times a minute updates the SoS user list enabling dynamic collaboration and peer-to-peer communication.
- support multiple applications or optimally multiple applications and services, including multiple security services.
- operate at level 4 of the IP communication layer and optimally as much functionality as possible should operate at layer 5, 6 and 7.
- Support the Federal efforts to provide extended alerting:
  - Commercial Mobile Alert System (CMAS)
  - Common Alerting Protocol (CAP)
  - existing broadcast alert services.
- Provide a mechanism for Trusted Identity Management:

- National Incident Management System (NIMS) requirements (SP 800-73, SP 800-78, SP 800-79, IR 6887)
- Homeland Security Presidential Directive 12 (HSPD-12) and Federal Information Processing Standard (FIPS) 201 compliance and support.
- First Responder Identification Credential (FRAC) support
- Public Law 110-53 compliance .

4.2 Key Performance Parameters (KPPs)

The key performance parameters for the SoS and the RPCK are:

- Resiliency - interoperable communications must be able to establish voice and data communications within 15 minutes from the time of arrival at the incident site. The system must provide required communications capability even if all communications infrastructure is compromised or destroyed. Redundant communication must be provided with the RPCK. If the VoIP services are not working, the FERP should be able to have peer-to-peer voice capability with anyone on the SoS. If conditions are not favorable for audio communications, the FERP should be able to send private and public instant messages or alerts and advisories using the SoS software.

- Accessibility - Communications must be established by a FERP without the need for technical support. No configuration of the software should be required to setup the RPCK. The system will be connected to the best available network and connected to an AC or DC power with phone and Internet services available to all FERPs.

- Portability – The FERP must have a portable solution they can carry with them to the incident to assure they will have communications capability immediately upon arrival. RPCKs must be man portable and operate independent of large vehicles and/or trailers.

- Interoperability - The SoS provides full interoperable voice, video and data communications among FERPS and supporting agencies and EROs regardless of communication device types. The interoperability must be dynamic. Dynamic interoperability is the ability to connect any user across any network and have the ability to connect any IP communication device with any other IP communication device. The interoperability must be at level 4 or 5 of the communication layer enabling the SoS to connect any network and run on any IP device. The SoS should also enable interoperability between interoperable radio and telephone switching systems and any data user of the SoS.

- Expandability - The SoS must not have any limitation on the number of users it can support. The number of interconnected networks cannot be limited. The RPCK must be scalable either by linking multiple RPCKs together or by running the SoS on a larger Resilient Communication Command System (RCCS). A RCCS should be able to support hundreds of users exactly as a RPCK supports dozens of users. The RCCS must also be tactical and transportable, but the need for greater scalability will limit the method of transportation to an SUV or pick-up truck. Except the RCCS should not only offer the same features and functionality as a RPCK, but also be as easy to setup and come in a kit form. Because of the greater processing power of a RCCS, the area of coverage will increase, providing greater flexibility.

- Visibility - The SoS must be able to allow span of control and mutual assessment and collaboration at and beyond the incident area site. The software interface must support a span of control over the users allowing for grouping users into manageable groups and sub-groups without compromising security. The ability to group should be as simple as entering a code that will direct the user to their group, while allowing incident command the ability to see all resources. Peer-to-peer voice, video and data communication must allow users on demand the ability to have private one-on-one communication or private group conversations, while at the same time having incident wide communications.

- Transparency - The SoS must not only enable the interoperability of voice, video and data communications, but it must also interconnect and support other systems and networks providing alert, warnings and advisories. The SoS software will enable alerts and advisories between any FERP or ERO without needing anything but the SoS software. The alerts and advisory capability will expand to provide public advisories.

- Flexibility - The RPCK must provide a full featured software PBX that is configurable from an easy-to-use GUI interface providing QoS and options to meet the ERO and FERP requirements. The PBX should provide a toll-free DID and support hundreds of extensions if needed. The PBX will have defined calling features available for configuration by the ERO. The RPCK must support as many simultaneous calls as the backhaul will allow. The SoS should also support both IPv4 and IPv6 networking and the RPCK should provide IPv6 capability to EROs who only have IPv4 capability.

- Usability - The RPCK and SoS must work with both AC and DC power, be network agnostic and able to work in any type of weather or climate that the FERP is operating in. The RPCK should require no special environmental conditions. The RPCK must converge the network protocols involved in providing voice, video and data so that network configurations are automatically provided to the user. The FERP should be able to connect color-coded cable, power the system up and have full communication capability.

- Adaptability - The SoS communication framework must be built using XML to allow for the rapid implementation of services and development or integration of applications used for collaboration. The FERP must be able to create a system of systems, enabling scalability, interconnectivity and rapid data convergence among all responders in minutes, for all responding mutual aid agencies, remote support and chain of command. This capability will not require dedicated technical resources to maintain. The SoS and RPCK must function in any environment without need of other systems if they are not available, but seamlessly interconnect to those systems without requiring the FERP to do anything. The RPCK will turn any vehicle into a forward command post for areas that have been cut-off or are a HAZMET site. The system will go anywhere in the country and work without modifications or additional configurations.

- Affordability - The SoS is affordable to the ERO. The software enabling peer-to-peer interoperability will be freely distributed with the ERO only paying for the delivery medium. The cost of the communications framework software should decrease with the number of groups within the ERO's span of control and should be available as a software service if the ERO has limited technical resources for organizational installation and system administration. The RPCK must be COTS compliant and provide volume-pricing incentives.

4.3 System Performance.

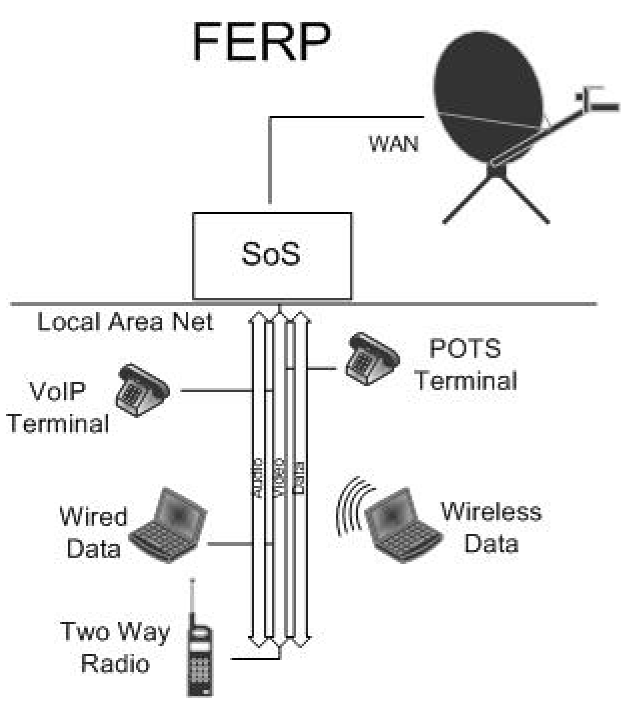
There are many types of disasters in the United States, but the most common emergencies are:

Chemical Emergencies
Dam Failure
Earthquake
Fire or Wildfire
Flood
Hazardous Material
Heat
Hurricane
Landslide
Nuclear Power Plant
Emergency
Pandemics
Terrorism
Thunderstorm
Tornado
Tsunami
Volcano
Wildfire
Winter Storm

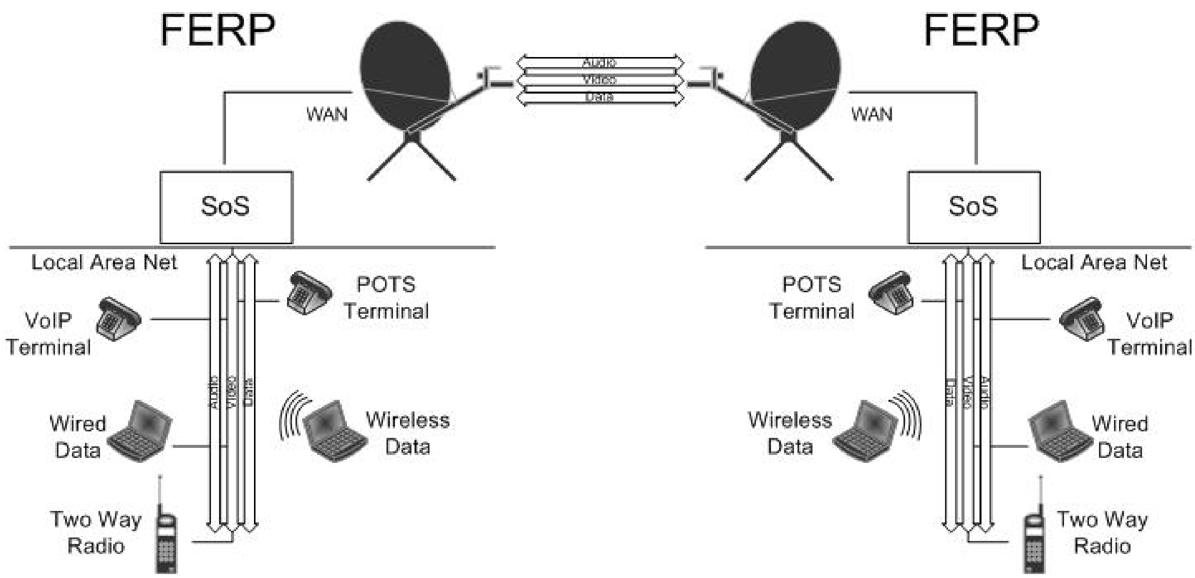
4.3.1 Mission Scenarios

Preparation and/or planning for these scenarios are paramount to enable recovery. The first and foremost consideration must be the lives of any potential victims or personnel within the immediate area of the incident site. Secondly, no situation, no matter how small, should ever be viewed in any other term than worse case scenario. If emergency responders are prepared for the worst possible situation, they inevitably will increase their odds for success. Those who fail to plan and fail to prepare are our greatest liabilities.

The most frightening and destructive phenomena's of nature (e.g. Hurricane, Tornado, Earthquake, Tsunami, Wild Fires, or Flooding) strike suddenly, violently, and many times in the event of an earthquake or tornado they occur without warning. If an earthquake or tornado occurs in a populated area, it may cause many deaths, injuries, and extensive property damage. There are no guarantees for safety following a disaster, identifying potential hazards ahead of time and advance planning can save lives and significantly reduce injuries and property damage. In the event of a disaster, EROs are required to do an assessment of the damage prior to allowing safety personnel and restoration groups into the incident area. Most likely, this would require communications in a scorched earth environment. FERPs would be required to setup and deploy the SoS in the disaster region and communicate to other reporting agencies to coordinate relief and aid.

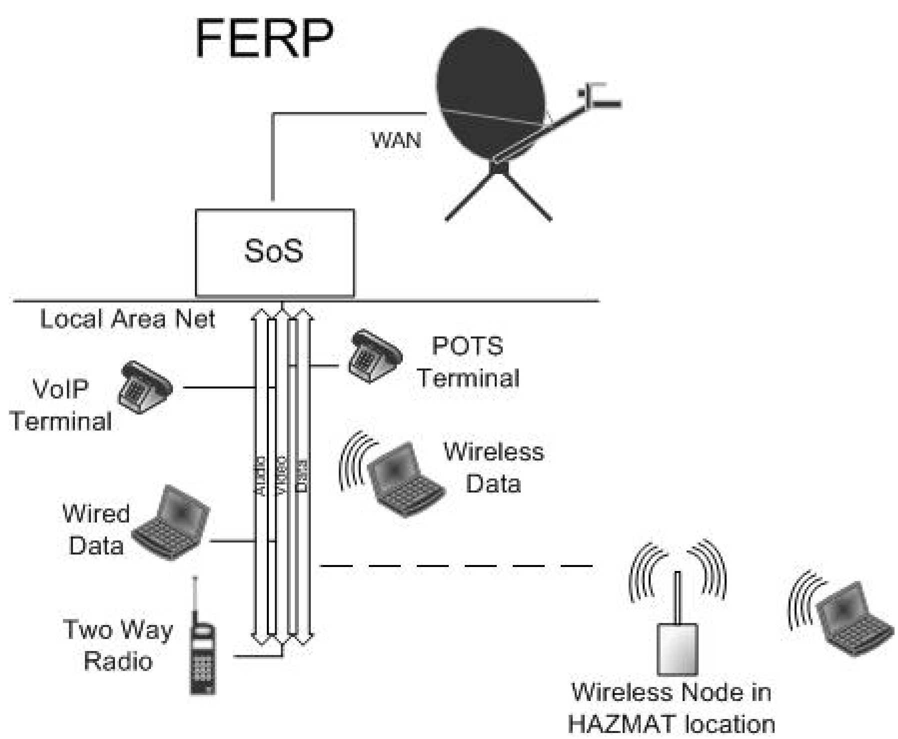


In the event of a Man-Made Disaster (e.g. Terrorist or Enemy-Nation Attack) the ERO would require a number of FERP teams respond and report. The needs now are to have interoperability with these team members to include establishing two-way radio communications, data transmissions to and from multiple agencies as well as establishing an Incident Area Command Center (IACC) with full voice telephony communications mandated. If the immediate responsibility of the ERO is to assess the damages by physically entering the disaster area providing an assessment to the IACC in order to organize and manage the critical next steps of the rescue, video transmission may be required to ascertain the damages and environmental impact.

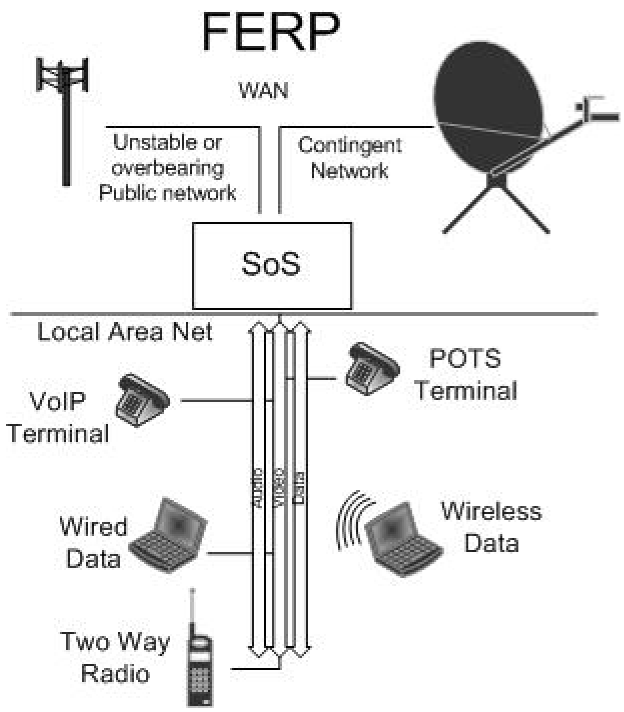


In all cases of the aforementioned disasters, all EROs need to asses the damage within the incident area, establishing communication to and from the incident site, enabling them to relay information of assessments to decision making authorities that enables them to conclude on the critical decisions for recovery. This would require the ERO to have minimal setup steps in deploying communications since the focus must be the disaster site. The SoS must be able to quickly deploy in different scenarios and adapt to different topologies of networks and environments seamlessly.

Example Only



Within 10 to 20 minutes of the FERPs' arrival at the incident area, IACC should be able to move into rescue operations. The system must now move to providing LAN and WAN capability, allowing responding personnel and agencies the ability to interoperate immediately.



Not all responses are for emergency operations, some exceptions are large-scale events (e.g. Republican or Democratic National Convention, Super Bowl, National Sports Events, Concerts, Demonstrations or Political Rallies). These types of events can often cripple existing communication layers with an influx of traffic generated at the event site. The ERO must have the ability to over come these obstacles easily and seamlessly. The FERP must have the ability to support two-way communications as well as telephony communications. In addition, the FERP must have the ability to send video data to and from the event site. Typically, in these types of situations, FERP members often work with civilian security and/or corporate personnel where interoperability is just a word in the dictionary. Many agencies are responsible for security at large scale events where tens of thousands of people attend. In many cases, multiple agencies, public and private are "working" the event in some manner. All require a system that establishes a LAN and WAN for all to utilize quickly and easily. In addition, this system must be able to utilize any current network infrastructure or establish its own infrastructure immediately.

4.3.2 System Performance Parameters

KPPs for the RPCKs

- Resilient communication established in 10 to 20 minutes.
- No technical support is required for any FERP to set up system.
- Portability, the common form factor should weigh less than 40lbs and be small enough to be carried on commercial airline and stored in an overhead compartment.
- Same functionality in different form factors.
- Very low power consumption, target 30 watts typical.

- Complies with Part 15 of the FCC Rules.
- Extended-temperature operation up to +54°C (130°F).

- The enclosure must meet or exceed:
  - FED-STD-101C, Method 5007.1, Paragraph 6.3, Procedure A, Level A Tests are superseded and concurrent with ASTM B 4169, DC-18, Assurance Level I, Schedule A.
  - MIL-STD-810F, method 506.4, Procedure II of 4.1.2. FED-STD-101C Method 5009.1, Sec 6.7.1Tests are superseded and concurrent with ASTM B 4169, DC-18, Assurance Level I, and Schedule H.
  - ATA 300, Category I, "General Requirements for Category I and II Reusable Containers".
  - Resilient to salt water spray: MIL-STD 810E Method 509.3.
  - Immersion MIL-STD-810F, method 512.4.
  - Qualified to MIL-STD-810 environmental standards.
  - Qualified to MIL-STD 810E Method 516.4. High shock/vibration exist.
  - Qualified to meet Ingress protection (IP67) while in use.
- Consist of at least 2-port WAN connections with fail over and load balancing.
- Provide an easy-to-use administration control GUI or HMI.
- Consist of at least a 4-port Fast Ethernet switch.
- Support auto-MDI-MDIX network installations, along with support for auto-crossover, auto-polarity, auto-negotiation, and bridge loop prevention.
- Allow for computing devices to be networked together using 10BaseT or 100BaseTX LAN connections.
- Field programmable, port-based VLAN functionality.
- Allow any combination of LAN ports to be connected together in subnets for use in a small secure or non-secure network.
- IEEE 802.3 and IEEE 802.3u compliant.
- Fully independent media access controllers (MACs).
- Embedded frame buffer memory.
- High-speed address look-up engine.
- Qualified to MIL-STD-810 environmental standards.
- Equipped with system status, warning, error indicators.
- Network cable complies with Category 6 standards, providing performance of up to 250 MHz.
- IEEE 802.11a/b/g/n standards (2412-2462MHz) (FCC), (5475-5725MHz) (CE), (5745-5825MHz) (FCC).
- Encryption standard must compile with 802.11i with AES-CCM & TKIP Encryption, 802.1x, 64/128/152bit WEP.
- Wireless data transfer speed up to target of 300Mbps.
- Wireless nodes peer-to-peer exceed a target of 1 km in range in line of sight environments.
- Port forwarding / tunneling allowing an external user to reach a port on a private IP address (inside the LAN) from the outside WAN connection.

- Administration of the system must support Hypertext Transfer Protocol over Secure Socket Layer (HTTPS) and an additional encryption/authentication layer between the HTTP and TCP.
- VoIP wired terminals support multi-line usage with up to 11 line indicators (expandable to 100 lines).
- VoIP wired terminals must support dual 10/100Mbps Ethernet ports.
- VoIP wired terminals must support basic enterprise call features (e.g. caller ID display or block, call waiting, hold, mute, speaker, transfer (blind or attended), forward, and 3-way conferencing.)
- Interconnection of Radio-over-IP (RoIP) interfaces allowing LMR radio to broadcast over SIP network.
- Connection of analog telephones or POTS terminals.
- Call types required in the RPCK or RCCS PBX.
- Activity Detection - Activity detect call feature, which provides an integrated voice terminal user a visual indication of voice activity of a particular terminal.
- Alternates / Fail-over Trunk - Automatic trunking fail-over if a primary voice trunk is determined busy, the system will switch to the next available trunk, this operation must be seamless to the terminal.
- Announcement on Hold (AoH) - Allow callers to listen to a recorded announcement\s to callers on hold or to a predefined extension. The system shall allow for one or more audio channels to be programmed to distribute audio information that is pertinent to the operation.
- Assigned Access - It shall be possible for selected dial terminals to have an assigned access (by class of service) to any combination of the following: individual nets, public address systems, radio trunks, and PSTN connections. Terminals assigned such access shall be able to obtain the desired connection by keying the appropriate number from the Address Numbering Plan, and terminals that attempt to complete a call to a destination to which access has not been assigned will receive an unavailable tone.
- Automated Attendant (AA) - The PBX shall allow callers to be automatically transferred to a user's extension without the intervention of a live receptionist. (e.g. select 1 for EOC, 2 for Field Director.)
- Blacklists - The PBX must have the capability of using a list of persons or organizations that have incurred disapproval or suspicion and therefore the call is rejected by the system.
- Call Details - The PBX shall make record and a log of all calls made including:
  - source number, destination number, call duration, date, and time.
- Call Forward - The PBX shall support a telephone call forward capability, for:
  - the user of a particular extension can chose to automatically forward calls to another desired extension or phone if their extension is busy.
  - the user of a particular extension can chose to automatically forward calls to another extension if not answered after a defined number of rings.
- Call Groups - The PBX shall support a telephone call groups' capability, for:
  - rotary hunting (where an incoming call is automatically rerouted to another terminal in a call group if the first terminal is busy, unavailable, or is not answered during the ring time out period.
  - call pickup within a call group (where any terminal in a call group can pick up a ringing call to a group member, by dialing a designated call pickup number).

- Call Monitoring - A call monitor capability shall be supported to allow supervisors or trusted users to listen or tap into an active call with out alerting the other parties of the monitoring.
- Call Queuing - Allows multiple calls to be placed in a queue and answered by the next available call group or extension.
- Call Recording - The PBX shall support recording audio of a phone conversation for later playback or retrieval.
- Call Transfer, Hold - Once a call is connected, it shall be possible to place the call on "Hold" "Transfer" by pressing the feature code.
- The PBX must have the ability to blind transfer a call to another extension without the need to wait for the other extension to pick up.
- The PBX must have the ability to transfer a call to another extension without the need for the other extension to pick up before the call is transferred.
- The PBX must allow a call to be placed on hold. A call hold capability shall be available to all PBX subscribers who are involved in a two party call.

- Caller ID:
    - The specific terminals will display the caller's phone number on the phones screen.
    - Remote phone must send caller's ID.
    - The specific terminal will display the phone number of a second caller whilst talking to the first caller.
    - The PBX must have the ability for an administrator to change or correct the outgoing caller ID information.
- Conference Bridging - It shall be possible to host a conference bridge or room that multiple parties at multiple locations using different phone types can access. All conference bridges will have the ability to be password protected by the administrator choice. (e.g. conference calls on a local extension, remote fixed line, mobile and VoIP connection all in one conference.)
- Extensions Numbering - The PBX shall have a true flexible numbering plan feature, whereby any number from "0" to "9999" may be assigned to stations or feature codes.
- Hot-line Trunk - The PBX shall have the ability to assign designated trunks to ring designated extensions.
- Interactive Directory Listing (IDL) - IDL allows the inbound callers to lookup a person's extension by their name.
- Paging - All terminals will have the ability to 'dial direct' to an overhead speaker and or capable terminal that can be grouped or zoned for announcement or an alert to be made.
- Protocol Conversion - This allows the interconnection of disparate phone networks: (e.g. connect a Telstra call to a VoIP call.)
- Standard protocols supported include: TDM, SIP, H.323, LAX, SCCP.
- Radio Device Connection:
    - The PBX must allow the interconnection of analog terminals (e.g. Two Way Radio, Land Mobile Radio, and other like devices)
- Remote Call Pickup - This allows a call to be picked up at a remote terminal location.

- Remote Office Support - Ability to connect phones located in a remote office to the office system as local extensions.
- Speed Dialing - Speed dial numbers shall be programmable at both the local level (speed dialing numbers that are applied to a unique terminal) and at the global level (speed dialing numbers that are applied to all terminals). Each local level speed calling list is unique to a specific terminal while the global level is available to all configured terminals.
- Three-Way Calling - Connect three people into a mini conference call.
- Voice-Mail - The PBX must have the ability to record a message from a caller when you are away from your desk. This includes ability to deliver the voice-mail message via email as well as the standard flashing light on your terminal (this feature is terminal specific).
- Satellite services when they are needed.

KPPs for Satellite Services for the RPCK

- VSAT data terminal must have the capability for Star and SCPC configurations.
- VSAT data terminal shall support at least 4 public IP addresses.
- VSAT data terminal shall support an 8 Port 10/100 Ethernet Switch.
- VSAT data terminal shall support Ku-band.
- VSAT data terminal shall support auto antenna acquisition with one button push operation.
- VSAT data terminal shall support TCP/IP throughput of transmit of 18 Mbps and receive 4.2 Mbps.
- BGAN data terminal shall support TCP/IP throughput of transmit of 464 kbps and receive 448 kbps.
- BGAN data terminal shall support audible tone signal strength for manual acquisition.
- BGAN data terminal must meet IP-54 rating (dust and spray proof in all directions).

KPPs for SoS Framework and Software

- Provide for modular system development and composition.
- Provide a method for brokering transactions amongst the composed subsystems.
- Provide translators that act as proxies for services, translating requests/responses into and out of a common, shared format (our XML-based language).
- Provide a method for definition of composition of services.
- Provide for communications among/between asymmetric clients.
- Respond to other well-known communications protocols for discrete info (including, for example, Jabber, et. al)
- Be able to render audio and video supplied in various formats.
- Be able to capture audio and video in some number of oft-supported formats.
- Provide a method for publishing availability/capabilities to other possible clients.
- Provide for authentication of credentials and access to identity information.
- Provide for transport of content in cases where peer-to-peer is not possible due to underlying network configuration.
- Provide for ad hoc network creation where indicated.
- Provide for store and forward of data where required (in, for example, cases where a client is not available at the time of original sending).

- Provide a method of finding clients with known characteristics.
- Provide a method for decoupling content itself from the method for transporting said content to other clients.
- Provide for data transport.
- Provide for control/throttling of data transfer (particularly streamed data transfer) to ensure the viability of the local network as a whole.
- Support the Federal efforts to provide extended alerting:
  - Commercial Mobile Alert System (CMAS).
  - Common Alerting Protocol (CAP).
  - existing broadcast alert services.
- Provide a mechanism for Trusted Identity Management.
  - National Incident Management System (NIMS) requirements (SP 800-73, SP 800-78, SP 800-79, IR 6887).
  - Homeland Security Presidential Directive 12 (HSPD-12) and Federal Information Processing Standard (FIPS) 201 compliance and support.
  - First Responder Identification Credential (FRAC) support.
    - Public Law 110-53 compliance.
    -

4.3.3 Interoperability

Interoperability provided by software that creates a communication framework enables any IP device or system to create a system of systems allowing interconnectivity between any IPv4 or IPv6 user device and multiple IPv4 or IPv6 networks. Any FERP can communicate using voice, video or share data with any other FERP; limited only by the capability of their device (i.e. a LMR would be limited to voice communications). The FERP can communicate with their ERO and can collaborate with other agencies and FROs, NGO, military response teams or private sector security that may be responding to the incident. If responding organizations do not have the software prior to the incident, the SoS software that is included with every RPCK can be freely distributed from any FERP to anyone who needs it. This allows interoperability to be dynamic, changing to meet the communication needs as the response grows and evolves.

The only requirement for interoperability is that the FERPs terminal or device has an IP or MAC address. If the use of analog devices are part of the EROs response plan the analog network can be given an IP or MAC address by connecting one of the analog terminals using the analog network be connected to a patchwork interoperability switch that in turn is a part of the SoS.

4.3.4 Human Interface Requirements

Based on a communications framework required by this ORD, the strength of a system of systems is based software that will run on any operating system, which will run on an IPv4 or IPv6 networks. There are no special human interface requirements other than knowing how to use a common phone, a LMR or computer. If the FERP can access and use day-to-day computer applications used by the ERO, then they will be able to run the SoS software. It is easier than sending an email. The FERP can use devices and terminals they already use.

The RPCK standard form factor will weigh less than 40lbs, allowing any FERP to hand carry the kit if necessary. The SoS and RPCK should require no specialized personnel at the incident site. Any FERP should be able to set up a RPCK in 10 to 20 minutes even if they have no experience or training. No matter how well designed the system is, systems do require support due to user, hardware or software malfunction. If for any reason support should be required due to equipment failure, the user must be able to use the troubleshooting guide included with the system. Around-the-clock telephone and online support will be available from the RPCK provider. The human interface requirement for this system requires the FERP to be able to read simple instructions.

4.3.5 Logistics and Readiness

The SoS will be up and utilized constantly by EROs. It can provide inter-agency interoperability on a daily basis and be in operation when an incident occurs. As the FERP arrives at the incident site, interoperability and collaboration are immediate just by the FERP turning on the devices they are using; the FERP connects automatically to the SoS.

In order to facilitate interoperability with EROs and FERPs that do not have the SoS software, the software must be available to every FERP on a USB thumb-drive that can be used to freely install on any computer required to join the SoS. The installation software should also be available to load on ERO servers so that the software can be freely downloaded if necessary. The SoS software should also be downloadable from approved websites with proper security clearance. Installation of the software must be quick, simple and intuitive. No training should be necessary for any FERP to install the software and connect to the SoS.

If the device is only able to run on an IPv4 network, free VPN software must be available for installation. Installing and using the VPN should require no configuration. If a VPN is needed it should be as simple as clicking on ‘install VPN” and the VPN must automatically install, configure and connect the FERP to the SoS via the VPN.

If software updates are released for the SoS or RPCK, a release method of freely upgrading will be implemented.

At least one RPCK should be available to every ERO in the country. Because a requirement for the RPCK is that it be a self-contained kit, distribution of new kits, additional kits, accessories such as additional VoIP handsets, cameras, headsets, cables, satellite systems should be managed under a contract with a national technology logistics company. Logistics must be handled by an organization, which specializes in delivering network technology efficiently to the public/private sector. Efficient distribution and parts should be stored in strategically located sites in order to guarantee delivery to the ERO in less than 8 hours. A just-in-time inventory method should be used to avoid using public funds to stockpile systems. A purchasing system should be instituted to guarantee EROs the ability, once a state of emergency is declared, to order additional systems, parts and accessories immediately.

4.3.6 Other System Characteristics

The SoS and RPCK will be simple to use and affordable. VoIP services will be provided with a flat rate annual contract for unlimited calls. Every RPCK will have an available satellite option for resiliency; the cost of constant satellite services will be affordable. DHS should negotiate flat rate contracts with providers for on-demand satellite service when the RPCK is deployed. Every system should always be on and able to support a phone call to the national support center requesting that additional bandwidth be provided for the duration of the incident. Without a national plan, the cost of satellite services may be more than the cost and maintenance of the kit.

5 System Support

5.1 Maintenance

A maintenance agreement should be in place on every SoS system and RPCK.

The SoS will run around the clock, if issues arise, users should contact the support desk. The support will be available unceasingly for SoS. If updates to the SoS software are needed, the update will be sent directly to the user by the support desk and will be downloadable from a support website.

The RPCK must be used regularly in everyday operations or be required to be tested twice a month to be confident that there are no problems with the kit's performance. The day-and-night support center must have the ability to run remote diagnostics on any kit and if possible repair the system remotely. If a kit has a component failure that cannot be immediately fixed at the users' location with the assistance of the support desk, a loaner will be shipped to the ERO immediately. The ERO will ship the "down" system to the repair depot. Under the support maintenance agreement the loaner system is provided at no charge until their repair kit is returned and tested by the ERO. A ratio of loaners available to kits in service will be 1 to 30.

5.2 Supply

The installation software will also be available on ERO servers so that the software can be downloaded from the ERO server if necessary. The SoS software should also be downloadable from approved, secure websites with proper authorization. Installation of the software must be quick, simple and intuitive. No training should be necessary for any FERP to install the software and connect to the SoS.

Because a requirement of the RPCK is self-containment, distribution of new kits, additional kits, loaner kits should be available if a RPCK fails. Accessories such as additional VoIP handsets, cameras, headsets, cables, satellite systems should be managed under a contract with a national technology logistics company that specializes in delivering network technology efficiently to the private/public sector. Efficient distribution requires parts be stored in strategically located depots in order guarantee delivery to the ERO in less than 8 hours. A just-in-time inventory method is required to avoid using public funds to stockpile systems. A purchasing system is required to guarantee EROs the ability, once a state of emergency is declared, to order additional systems, parts and accessories immediately.

5.3 Support Equipment

The RPCK will include any equipment necessary for testing and the system must be available to be tested remotely by support if need. The remote diagnostics will require nothing more than the customer's approval.

5.4 Training

The SoS and RPCK will be simple enough that user training is not required. However, in order to maximize the power of the SoS and to fully understand what the RPCK is capable of, webinars will be held everyday on a regional basis covering topics that will improve the effective use of the SoS and RPCK. An online group forum will be available for FERPs to share ideas and ask questions of other FERPs. This service will be a feature of the SoS software.

5.5 Transportation and Facilities

The SoS is software and does not require transportation or storage. The RPCK by design must be small enough to store in the trunk of a car or in a closet in the FERPs office or duty station. It will be able to be stored anywhere with a temperature between minus ten degrees Celsius and fifty degrees Celsius. The RPCK will require no special transportation; however, it must be available in a form factor that can be mounted in any vehicle, making that vehicle a mobile resilient communication center. It also will be able to be used anywhere at anytime without any special installation being required and easily be transportable as carry-on luggage on any commercial airline.

6 Force Structure

Many homeland security applications rely on resilient communications; there can be no SoS without communications systems to connect to. In order to implement a national SoS providing national interoperability, enough RPCKs must be distributed across the country to provide resilient communication in enough locations to guarantee a national emergency communication network can be created from a system of systems. It would take 200,000 RPCKs to provide at least one system to each of the following:

Example Only

Potential system users	Approximate Number
Law enforcement agencies in the United States	**17,000**
Fire departments in the United States	**30,000**
Incorporated cities in the United States	**80,000**
Counties and or Parish Governments in the United States	**3,000**
School Districts and Colleges in the United States	**20,000**
Emergency Operation Centers in the United States	**15,000**
Ports of entry in the United States	**240**
Critical Infrastructure and Key Assets in the United States	**33,000**
Hospitals in the United States	**5,500**

These numbers do not reflect the number of court houses whether Federal, State, District or Local, the number of jails and or prisons, total number of Federal Government agencies buildings or personnel in the United States, the number High Schools, Middle Schools or Elementary Schools in the United States. The numbers also do not reflect the number of substations and offices within a particular category. If a RPCK was distributed to each of the 53,000 fire stations alone, the infrastructure for a national resilient communications network would be in place.

The SoS will be distributed to every FERP (as many as one million copies in the first six months) in the country as soon as possible, even without a kit the SoS can be created and as long as communication infrastructure is sound, a local, regional, state and national interoperability network will be created enabling collaboration and cooperation.

7 Schedule

The SoS should be rolled out in phases. Year one should establish SoS groups in the most vital areas creating a national framework of senior FERPs, EROs and supporting agencies with a nation-wide roll-out completed in less than four years.

8 System Affordability

The total price for core components to meet the mission described in the ORD shall be less than $20,000 (in high volume production).

9 Signatures

____

Sponsor's Acquisition Program Manager [print and sign] Date

____

Sponsor's Representative [print and sign] Date

____

S&T Project Manager [print and sign] Date

____

S&T Division Head [print and sign] Date

10 Appendixes

1. In this document, the terms "product" and "system" are synonymous. The word "system" is used to refer to either.

2. The word expensive as it relates to emergency response communications not only means the acquisition costs of expensive hardware and software, but the costs of ongoing maintenance, training and support costs that many times exceed the cost of the actual hardware and software.

3. The term "scorched earth" here means and incident scene where normal communication infrastructure need for voice, date and/or video communication has been severely compromised destroyed or does not exist.

4. Stennis Space Center was without communication infrastructure for over 2 weeks after Hurricane Katrina made land fall.

5. An example of what is meant by 'pony express", In responding to the disaster created by Hurricane Charley in August of 2004, 17 FROs responding to provide mutual aid to a devastated Hardee County Florida, for days had to rely on passing notes between command posts and having responders drive 45 miles to relay communications to areas not affected by the destruction of the communication infrastructure in southwestern and central Florida.

11 Glossary

Resilient	Recovering readily from injury, adversity, or the like while returning to the original form.
System of Systems	A collection of task-oriented or dedicated systems that pool their resources and capabilities together to obtain a new, more complex, 'meta-system' which offers more functionality and performance than simply the sum of the constituent systems.
Dynamic Interoperability	A property referring to the ability of diverse systems and organizations to work together (inter-operate) characterized by continuous change, activity, or progress.
IPv4	Internet Protocol version 4 (IPv4) is the fourth iteration of the Internet Protocol (IP) and it is the first version of the protocol to be widely deployed. IPv4 is the dominant network layer protocol on the Internet and apart from IPv6 it is the only standard internetwork-layer protocol used on the Internet. IPv4 is a data-oriented protocol to be used on a packet switched internetwork (e.g., Ethernet). It is a best effort protocol in that it does not guarantee delivery. It does not make any guarantees on the

	correctness of the data; this may result in duplicated packets or packets delivered out of order. These aspects are addressed by an upper layer protocol (e.g. TCP, and partly by UDP).
IPv6	Internet Protocol version 6 (IPv6) is a network layer for packet-switched internetworks. It is designated as the successor of IPv4, the current version of the Internet Protocol, for general use on the Internet. The main change brought by IPv6 is a much larger address space that allows greater flexibility in assigning addresses. The large number of addresses allows a hierarchical allocation of addresses that make routing and renumbering simpler. With IPv4, complex CIDR techniques were developed to make the best possible use of a restricted address space. Renumbering, when changing providers, can be a major effort with IPv4. With IPv6, however, renumbering becomes largely automatic, because the host identifiers are decoupled from the network provider identifier.
COTS	Commercial off the Shelf
ERO	Emergency Response Organization
FERP	First Emergency Response Provider
RPCK	Resilient Portable Communications Kit
RCCS	Resilient Communication Command System
NCRN	National Communication Resiliency Network
GUI	Graphical User Interface
QoS	Quality of Service
IACC	Incident Area Command Center

OPERATIONAL REQUIREMENTS DOCUMENT

Persistent Intelligence, Surveillance and Reconnaissance Family of Systems Services

Contents

1 General Description of Operational Capability

The Department of Homeland Security (DHS) requires the capability to commercially lease reusable, medium altitude Intelligence, Surveillance, and Reconnaissance family of systems to augment Customs and Border Patrol (CBP), United States Coast Guard (USCG), Immigration and Customs Enforcement (ICE), and the Federal Emergency Management Agency (FEMA) in support of their mission areas. The leasing of this family of systems should be low cost compared to DHS acquisition, operations and maintenance of MQ-9 Predator B unmanned aircraft, have high reliability, maintainability and availability, be easily transportable, and provide full connectivity at all levels of command and control. This family of systems lease includes tactical unmanned aircraft systems (UAS), medium altitude long endurance (MALE) UAS, and the command and control connectivity to provide all appropriate DHS nodes full motion video, voice, and data transmission and reception at all echelons. Each UAS is packaged as a "fly away kit" which can be transported to any required border region in support of CBP, and moved as necessary in support of USCG, ICE, and FEMA. The required C2 connectivity is also self-contained and can be transported to the appropriate location as required to support the missions. These "kits" are designed to be scalable, and tailorable to support DHS needs.

1.1 Capability Gap

CBP is actively engaged in the Secure Border Initiative to attain the ability to gain operational control of our nation's borders by providing 24-hour, year-round surveillance capabilities that will help deter illegal entry attempts into the United States, and enable USBP agents to detect, analyze, and rapidly respond to illegal cross border activity. The MQ-9 Predator B Unmanned Aircraft System (UAS) augments Customs and Border Protection Air and Marine (CBP A&M) assets supporting ground interdiction agents on the Southwest Border. CBP A&M is engaged in the Department of Homeland Security's (DHS) mission to prevent terrorist attacks within the United States, reduce its vulnerability to terrorism, minimize damage from attacks that might occur, and streamline recovery efforts. CBP A&M accomplishes this mission through an integrated and coordinated air and marine force engaged in the detection, interdiction, and prevention of acts of terrorism arising from unlawful movement of people or illegal drugs and other contraband. However, this capability is resource constrained and is assumed to be so for the foreseeable future. Currently, CBP A&M operates 4 MQ-9 UAS in support of southwest, southeast, and northern border regions, in addition to over 260 manned aircraft throughout these three border regions. A persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems can readily augment CBP A&M and provide both enhanced capability and improved persistence at a lower cost per flight hour. The family of systems immediately provides a turnkey, "power by the hour" ability to apply additional UAS into an area of interest, increasing sensor dwell time, reducing revisit rates, and accomplishes this at a much lower cost compared to using manned aircraft.

The capabilities described in this ORD also support the DHS objective of Maritime Domain Awareness (MDA) which is the effective understanding of anything associated with the global maritime domain that could impact the security, safety, economy, or environment of the United States. MDA is the integration of Global Maritime Intelligence and Global Maritime Situational Awareness. Global Maritime Intelligence is the product of legacy, as well as changing intelligence capabilities, policies and operational relationships used to integrate all available data, information, and intelligence in order to identify, locate, and track potential maritime threats. A persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems enhances MDA by providing increased numbers of sensors, superior persistence, at a lower cost than manned alternatives.

The United States Coast Guard is a military, multi-mission, maritime service within the Department of Homeland Security and one of the nation's five armed services. Its core roles are to protect the public, the environment, and U.S. economic and security interests in any maritime region in which those interests may be at risk, including international waters and America's coasts, ports, and inland waterways. USCG protects America's maritime borders from all intrusions by: (a) halting the flow of illegal drugs, aliens, and contraband into the United States through maritime routes; (b) preventing illegal fishing; and (c) suppressing violations of federal law in the maritime arena.

USCG Unmanned Aerial Vehicles (UAVs) can provide persistent wide area surveillance at both strategic and tactical levels. Access to sensor coverage and data provided by UAVs may reduce some operational requirements for conventional aircraft, by extending the mission reach of Coast Guard operational units. UAVs will contribute to a range of missions, including maritime border protection; law and treaty enforcement; and search & rescue. To date, the USCG has not acquired any UAV systems, but instead is collaborating with CBP to provide an interim unmanned capability using a portion of their MQ-9 assets, stretching thinner a four vehicle fleet. A persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems can fill this critical gap, by providing dedicated systems to support USCG that can ensure dedicated capacity to support USCG missions.

The primary mission of the **Federal Emergency Management Agency** is to reduce the loss of life and property and protect the Nation from all hazards, including natural disasters, acts of terrorism, and other man-made disasters, by leading and supporting the Nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation. A persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems could provide dedicated UAS assets to assist FEMA in damage assessment, search and rescue, and Chemical-Biological-Nuclear-Radiological and Explosive (CBRNE) consequence management.

U.S. Immigration and Customs Enforcement (ICE), the largest investigative arm of the Department of Homeland Security (DHS), is responsible for eliminating vulnerabilities in the nation's border, and with economic, transportation and infrastructure security. ICE intelligence professionals process information from a variety of sources to provide assessments of patterns, trends and new developments in a wide range of law enforcement areas. Intelligence focuses on data and information related to the movement of people, money and materials into, within and out of the United States, to provide accurate and timely reporting to ICE leadership and field agents in support of enforcement operations. A persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems could provide dedicated UAS assets to assist ICE in support of their mission.

1.2 Overall Mission Area Description

This ORD supports the following Office of the Secretary of Homeland Security Mission Areas: Land Surveillance and Reconnaissance, Maritime Surveillance and Reconnaissance, information sharing, and command and control.

1.3 Description of the Proposed Product or System

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems will build on the capabilities existing in the CBP, USCG, FEMA and ICE and provide significant, additive capability to DHS. It provides a loitering and persistent capability not previously available to personnel at all echelons, from the border patrol agent monitoring the southern US border, first responders, Coast Guardsmen, all the way up to the President of the United States. Each persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems will have a baseline payload of sensors that offer multi-spectral acquisition capability. The system will be flexible enough to add additional combinations of payloads and the capability to carry interchangeable, but compatible, payloads for flexibility. The ISR family of systems aircraft and mission payloads will be remotely operated throughout the range of DHS operations. The system will collect and process information that can then be reported or further exploited to accomplish the intelligence functions of indications and warning, support to appropriate DHS agencies and departments requiring surveillance and reconnaissance services. The ISR family of systems includes a variety of commercial off the shelf (COTS) remotely piloted aircraft (RPA) systems, associated payload(s), data link(s), ground station(s), communications and dissemination systems, logistics support packages, and an ability to accomplish the following functions: Command and Control (C2) of multiple air vehicles and payloads; compliance with all appropriate communications architectures that permit interoperability with any other system that complies with standard formats for data and direct dissemination via the data link. Additional exploitation system capability can also be added, at the discretion of DHS.

1.4 Supporting Analysis

This ORD supports Homeland Security Presidential Directive (HSPD):

HSPD – 2: Combating Terrorism through Immigration Policies to prevent aliens who engage in or support terrorist activity from entering the United States

HSPD – 4: National Strategy to Combat Weapons of Mass Destruction which applies new technologies, increased emphasis on intelligence collection and analysis, strengthens alliance relationships, and establishes new partnerships with former adversaries to counter this threat in all of its dimensions

HSPD – 5: Management of Domestic Incidents. The ability of the United States to manage domestic incidents by establishing a single, comprehensive national incident management system

HSPD – 13: Maritime Security Policy. Establishes policy guidelines to enhance national and homeland security by protecting U.S. maritime interests

HSPD – 19: Combating Terrorist Use of Explosives in the United States. The prevention and detection of, protection against, and response to terrorist use of explosives in the United States.

This ORD supports DHS S&T continuing need to develop the means for greater first responder participation in the definition of capability gaps in order to ensure their high priority needs are met. DHS customers' critical needs take the form of Enabling Homeland Capabilities (EHCs), consisting of technologies that can be developed, matured, delivered, and commercialized or validated as a standard within a 3-year period. This ORD directly addresses the following EHCs:

Border Security

DHS S&T Leads: Customs & Border Protection and Immigration & Custom Enforcement

- Detection, tracking, and classifying of all threats along the terrestrial and maritime border including numerous topographies such as rugged terrain, concealing foliage, water obstacles, mountains, and other environmental constraints

Infrastructure Protection

DHS S&T Lead: Office of Infrastructure Protection

- Advanced, automated, and affordable monitoring and surveillance technologies

Interoperability

DHS S&T Leads: Federal Emergency Management Agency and Office of Emergency Communications

- Standardize, pilot, and evaluate emergent wireless broadband data technologies and applications
- Provide seamless access to voice and data networks, using a unified communications device

1.5 Mission the Proposed System Will Accomplish

The missions that the persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems will accomplish include, but are not limited to:

- Border Security
- Port Security
- Natural Disaster Response

- Search and Rescue
- Man-Made Disaster Response
- Special Security Event Support

1.6 Operational and Support Concept

1.6.1 Concept of Operations

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems will function as a stable of dynamically re-taskable assets, able to combine all elements of the ISR process. It will leverage existing COTS capabilities to increase mission effectiveness and create synergies for DHS. The family of systems will rapidly flex between Intelligence, Surveillance, Reconnaissance, search and rescue, and disaster response where appropriate.

The family of systems will operate primarily at medium altitudes, but will also contain capability for short range, low altitude operations in supporting DHS. It will seamlessly integrate with existing DHS assets from CBP, USCG, FEMA, and ICE as well as other government agencies as DHS shall direct. The family of systems will extend the department's eyes in the area of operations and provide the ability to immediately transition to a different role when appropriate. Command and control (C2) through all echelons will enable the family of systems to rapidly transition within the ISR collector, communications relay, and search and rescue roles.

The family of systems will integrate with existing DHS agency C2 concepts and organizations and existing tactics, techniques, and procedures: operational control will be exercised through the appropriate DHS agency, and the platforms will deconflict using normal air traffic control and airspace control measures, such as a temporary flight restriction (TFR). Its persistence and ability to communicate with C2 nodes and other DHS assets render the ability to accomplish critical DHS missions under adverse surface weather conditions. The family of systems will use off-board data, robust sensors, and automatic cueing to detect persons in areas of interest. Immediate, automated processing of data will derive actionable coordinates to assist other DHS assets to accomplish their respective missions. Improved communications/data links and situational awareness displays will ensure full area of interest integration at all DHS command and control echelons. A modular architecture permits tailored mission flexibility, where the family of systems acts as the platform to employ specialized sensor payloads, such as communication relay.

The family of systems will offer DHS personnel and planners a low-cost, persistent capability to perform a wide variety of DHS missions augmenting existing assets in achieving desired outcomes. It will seamlessly integrate with manned and unmanned platforms on the ground, in the air, and in space. Digital, open-ended, machine-level interfaces will leverage information technology to rapidly and accurately locate, identify, and act on critical emerging items of interest and facilitate the timely flow of actionable information to all echelons of command. The family of systems is scalable, and tailorable to meet DHS means. The family of systems will be available to DHS as a leased service using a "power by the hour" concept.

1.6.2 Support Concept

Logistics support will be managed by the family of systems service provider and shall be integrated into the existing commercial support structure. The family of systems must have a maintenance concept that provides for high reliability, maintainability, and availability at the minimum cost. The service provider will perform all maintenance with a focus on maximizing rapid transportation, minimizing repair turnaround times, and minimizing payload reconfiguration times. Standard test and ground support equipment, petroleum, oil, lubricants, line replaceable units (LRU), and repair parts will be used. Peculiar support equipment, manning, training, unique aviation fuel and facility requirements will be minimized. The service provider will be responsible for technical data, training, and procedures. The logistics support concept should maximize system availability, flexibility and self-sufficiency. Stages of various levels of contractor support may be required prior to Initial Operational Capability for each increment to provide supply and maintenance technical support during the build up phase. For operations in sensitive environments, DHS users must have easy and reliable sustainment capability for both austere operations and airfield operations.

Supply support will be accomplished by the service provider (Threshold). Contractor supply data systems must provide DHS users total asset visibility throughout the supply chain and meet the protocols for, and interface with any DHS or other government agency supply data system (Threshold). The service provider will provide personnel to support operations from existing DHS facilities, and deployable contractor manpower positions, if required. Supply/resupply methods will not require additional reporting procedures. To the extent possible, parts should be properly configured with current software and delivered with all proper seals, gaskets, pneumatic, and electronic interface connections installed so they may be directly connected in accordance with the appropriate technical orders. The service provider is responsible for shipping mission critical parts originating from the contractor facility to any location supporting DHS operations. Required parameters for United States deliveries: 48 hours (Threshold) from supply system requisition to delivery of parts to aircraft, 24 hours desired (Objective).

2 Threat

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems will face a wide array of threats during operations ranging from humanitarian operations like disaster relief, to low-intensity operations like supporting CBP, to high-intensity operations like response to a terrorist attack. As an attritable asset, the family of systems may execute missions in higher risk scenarios (e.g., CBRNE exposure) than a corresponding manned platform. Possible threats to the family of systems range from small arms (e.g., looters/rioters) to surface-to-air missiles (SAM) including man portable air defenses (e.g., terrorists), fixed-wing and rotary-wing aircraft, directed energy weapons (to include lasers and radio frequency weapons), nuclear, biological, and chemical (NBC) weapons, and information warfare. The most severe threat to the proposed family of systems will be a combination of these diverse systems, with the degree of severity being mission scenario dependent. In addition, terrorism and sabotage are also threats at all operating locations. Ground control stations are subject to the same threats as other assets at the location they are operating from but could be a higher priority for a surgical attack depending upon other collocated assets.

3 Existing System Shortfalls

Of all of the DHS agencies addressed by this ORD, CBP is the most advanced with four MQ-9 UAVs, building to an eventual fleet of 20 aircraft supporting both the southern and northern border. However, in the event horizon for this ORD, there remain critical gaps in ISR coverage that could be filled by utilizing the persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems capability.

The USCG is now partnering with CBP to investigate using MQ-9 UAVs in support of maritime ISR in the southeast region of the United States. Even with this assist from CBP, USCG currently has no deployable ISR assets for their fleet. The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems can close this critical gap.

Likewise, FEMA must rely on other government agencies to supply ISR support in response to natural or man-made disasters. The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems would provide FEMA an in-house disaster response capability.

Finally, ICE would benefit from the use of the persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems supporting intelligence collection on high profile criminals and terrorists in support of their mission.

4 Capabilities Required

4.1 Operational Performance Parameters

The system must support flexible employment options and must support DHS operations basing (Threshold).

4.1.1 Deployed Ground Control Station (GCS) Employment:

A complete persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems consists of a GCS and/or Launch and Recovery GCS (LRGCS), four aircraft, data link, and support equipment (SE) collocated at a DHS operating location (Threshold).

4.1.2 Remote Split Operations Employment:

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems uses a GCS or a LRGCS deployed at a DHS operating location, launches an aircraft and hands it off to a GCS located in or outside the area of interest Beyond Line Of Sight from the launching GCS/LRGCS (Threshold).

4.1.3 Ground Control Stations

The GCS is either mobile to support forward operating locations or at a fixed facility to support remote split operations. A mobile GCS is containerized for deployability. A fixed facility GCS consists of identical capability in a permanent facility. For the persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems it must

(1) have the capability to perform mission planning, (2) provide a means for manual and/or autonomous control of aircraft and payloads, (3) allow personnel to launch, recover, and monitor aircraft, payloads, system communications status, and current and forecast weather along entire route and vicinity for duration of flight, (4) receive payload sensor data, (5) display all-source threats to the aircraft, (6) display Common Operational Picture, and (7) provide support functions. The ground station must perform these functions as required, prior to, and during, each family of systems mission.

A deployed system must support 24 hours per day, seven days per week operations for 30 days (Threshold). Ground stations, except LRGCS, must be able to control two aircraft simultaneously (one full mission and one ground operations, takeoff, enroute navigation and landing) to support continuous area of interest coverage (Threshold). Multiple full air vehicle control of at least four aircraft is desired (Objective). The GCS must provide redundancy for vehicle control (Threshold). Workstations for all other functions listed above must be reconfigurable (Objective).
The GCS will receive, process, format and perform quality control of sensor data, sensor auxiliary data, and platform navigation data from at least one (Threshold), four (Objective) aircraft for dissemination/exploitation. The mobile ground stations and associated equipment must be operable and supportable from forward deployed and austere locations (Threshold). The ground station must be able to record and store collected data (Threshold), in a commercial off-the-shelf (COTS) digital random-access format/media (Objective).

To support system miniaturization and maximize operational flexibility/deploy-ability, the GCS shall be designed with modular/reconfigurable systems (Threshold), using open-architecture operating systems (Threshold). Full air vehicle and/or sensor command and control capability shall be incorporated into a ruggedized, briefcase-sized computer (Objective), and designed to work in a distributed command and control environment (Objective).

4.1.4 Secure GCS

GCS equipment and interfaces must be certified for DHS secure operations and data transmissions. System and interfaces will be certified for collateral level (SECRET (Threshold) and TS (Objective)).

4.1.5 Displays

Information required to safely perform ground and flight/mission operations will be displayed in a heads-up display (HUD) (Threshold). Information required to operate equipment/ system shall be displayed in logical menus with minimal layers and capability for single action return to the top-level menu (Threshold). Any single menu action which could result in the probability of causing harm to ground personnel or loss of the aircraft will require a warning display and a confirmatory step before execution (Threshold)

4.1.6 Aircrew/DHS Situational Awareness

The aircrew requires near-real-time situational awareness displays in the GCS that fuse mapping, charting, geodetic information, aircraft position, sensor pointing information, and weather. Situational awareness data must be fused into a common display (Threshold). In addition, aircrew situational awareness should be maximized by providing flight indicators and warnings using multiple sensory cues (e.g., visual, aural and tactile) (Objective). The system shall provide an aural warning when the aircraft is nearing flight conditions that exceed normal operating parameters (Objective).

4.1.7 Digital Video Interfaces

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems should use standard digital interfaces and National Geospatial-Intelligence Agency (NGA)-compliant digital video formats (News Industry Text Format and Joint Photographic Experts Group) to maximize interoperability and imagery quality. Use GCS-based encoder and Key Length Variable (KLV) system to convert analog video outputs to Moving Picture Experts Group (MPEG)-2 and KLV private data stream (PDS) prior to disseminating to users (Threshold). Eliminate all analog-to-digital conversions by compressing digital video directly from sensors into MPEG-2 data stream, add KLV PDS to stream prior to dissemination (Objective). All of the system's data that will be exchanged or has the potential to be exchanged, shall be tagged, as required, in accordance with the standard for tagged data items (e.g. Extensible Markup Language (XML), the current JTA standard), and tags shall be registered.

4.2 Key Performance Parameters (KPPs)

4.2.1 LRGCS

The LRGCS will be capable of servicing, systems checks, maintaining, launching, and recovering aircraft under LOS control for handoff to a mobile or fixed GCS. (Threshold) It will be designed for minimal physical and logistics footprint and reduced support requirements (Threshold) and provide the ability to perform functional system checks on aircraft satellite communications systems. (Objective)
The GCS and LRGCS will provide sufficient cues to allow the pilot to safely takeoff, navigate under Instrument Flight Rule conditions to published weather minimums, and land (Threshold).

4.2.2 BLOS Communications for Multiple Aircraft Control

The ground communications terminal supporting BLOS operations shall allow one (1) to four (4) GCS connections and support for four (4) simultaneous aircraft orbits with appropriate number of hot spares (Threshold) and one (1) to eight (8) GCS connections and eight (8) simultaneous orbits with appropriate number of hot spares (Objective).

4.2.3 Computer Resources

Computer resources will consist of all hardware and software necessary to fulfill mission requirements including that associated with aircraft avionics systems, mission planning systems, weapon planning, support equipment, and data collection equipment. Software shall use a structured programming language and open-system approach (Threshold). All software shall provide enhanced system performance, maintainability, interoperability, portability, reliability, and user friendly operation. Computer hardware resources (storage, interconnecting data bus, memory, and processor) must have a 100%

reserve over that used or experienced during the most demanding processing and storage operations (Threshold) with a goal of 200% (Objective). Storage requirement includes the entire worldwide navigation database (Threshold). Reserve resource capability shall be computed by sub-system and shall not be a system-wide average. Hardware and software must ensure data integrity is maintained (Threshold).

4.2.4 Computer Software

The software will be developed in a modular manner to promote rapid and low-risk system upgrades (Objective). Software will be releasable to other DHS contractors for under government purpose rights or restricted use in the development of associated training, planning or data exploitation systems (Threshold). All software maintenance shall be compatible with the existing DHS computer software support structure, including maintenance data collection and other information systems planned for use (Objective). Software shall be designed for reusability in the training devices, by incorporating "hooks" to support trainer-unique functionality (Objective).

4.2.5 Interfaces

External/internal system interfaces must be fully documented and defined to facilitate evolutionary growth through modular replacement of hardware and/or software (Threshold), and to satisfy requirements for interoperability with existing or projected capabilities (Objective).

4.2.6 Operational Flight Program (OFP)

OFP software changes shall be loaded and verified by service provider maintenance using standard PC based laptop computers (Threshold). Aircraft software loading/verifying will be accomplished via a standard interface (Threshold). Loading and verifying of OFP must be accomplished within 30 minutes (Threshold) 15 minutes (Objective). Operational software version information for all Computer Software Components shall be displayed upon operator request (Threshold).

4.2.7 Mission Planning

The system will support the use of a DHS approved Mission Planning System architecture, standards and interfaces (Threshold). The capability shall consist of an automated system to provide responsive, flexible, user-friendly and accurate integration of payload and platform mission planning, including threat avoidance along the route for the flight duration (Threshold). The system must allow for pre-flight loading and in-flight updates of mission data (Threshold). System will display digital, geo-referenced current and forecast weather overlaid on GCS situational displays (Objective). The capability for sensor collection planning requirements and display of collection points on sensor operator display is required (Threshold). The ability to designate a collection objective on sensor operator display and automatically slave a designated sensor to that point in wide field-of-view is required (Threshold), in narrow field-of-view (Objective).

4.2.8 Mission Data

Personnel must be able to load and verify mission/navigation data via a data transfer system (Threshold). Aircraft and fixed/mobile GCSs data systems must be certified to store classified data at DHS direction (Threshold). If required by DHS, the aircrew shall have the ability to selectively zeroize data with/without power on the equipment (Threshold). The aircrew shall have the capability to zeroize all classified data (with the exception of the flight data recorder) with a single safeguarded action (Objective).

4.2.9 Certification

The aircraft system requires certifications to allow United States-wide system employment.

4.2.10 Airworthiness Certification

The aircraft system must be certified as airworthy when operated in accordance with its technical order (Threshold, KPP).

4.2.11 Airspace Access

The aircraft system must be able to operate in appropriate Federal Aviation Administration (FAA) airspace (Threshold). The aircraft system must be able to operate in appropriate classes of airspace worldwide with no additional coordination requirements than inhabited aircraft (i.e., file-and-fly) (Objective).

4.2.12 Sense-and-Avoid Requirement General

The overall performance of the sense-and-avoid system shall be such that the probability of colliding with another aircraft is comparable to that for other aircraft of similar size, weight, and performance. The measure of total system performance shall depend on, but not be limited to, such aspects as onboard sensors, air traffic control, concept of operations, and reliability. Furthermore, the system shall possess the capability to detect both participating and non-participating aircraft day and night (weather permitting), determine if a potential collision hazard exists, notify the operator of the hazard, and either provide a suggested conflict resolution for pilot action or maneuver autonomously to avoid the other aircraft (Objective).

4.2.13 Aircrew Warning and Collision Avoidance

The sense-and-avoid system shall notify the operator through some combination of visual and audible warnings when an aircraft is projected to pass within 500 feet (Threshold). The warnings shall allow sufficient time for the operator or onboard autonomous system to maneuver the aircraft to avoid conflicting traffic by 500 feet (Threshold). If the aircraft does not receive a pilot/operator command input to resolve an imminent collision hazard (defined as aircraft projected to pass within 500 feet of one another), it shall maneuver autonomously to avoid the conflicting traffic by at least 500 feet (Objective). The autonomous maneuver capability will warn the pilot/operator about the pending maneuver and incorporate an override capability, time and conditions permitting (Objective).

4.2.14 Field of Regard

The field of regard of the onboard sensor system shall be at least 110 degrees horizontal from the nose, 15 degrees vertical with respect to the flight path angle, and be able to detect conflicting air traffic during all expected maneuvers (Threshold).

4.2.15 Lost Link Procedures

If the aircraft loses its command and control (C2) link(s), it shall have the capability to maneuver autonomously to avoid traffic and then return to its previous altitude and course once the avoidance maneuver is complete (Threshold). If the aircraft maneuvers to avoid traffic while lost link, it shall notify the aircrew of this fact upon re-establishment of the link (Threshold).

4.2.16 Emergency Situations

A reliable sense and avoid system will operate under emergency power situations (e.g., engine-out glide, battery only, etc.) (Objective).

4.2.17 Ground Operations

The system must be able to operate from airfields with other aircraft (Threshold). The aircraft must be able to operate at up to 8,000 ft density altitude with a 50-ft obstacle from prepared airfields with runways 5,000 ft by 75 ft (Threshold), 3,000 feet by 75 feet (Objective) and taxiway widths of 50 feet (Threshold). The system must also be capable of launching and recovering on unimproved areas. (Threshold)

4.2.18 Takeoff and Landing

The air vehicle must be able to takeoff and land using pilot control via the LOS link (Threshold) and allow for automated takeoffs and landings via BLOS datalink (Objective). Crosswind limitation for takeoff and landing not less than 16 knots (Threshold) to 20 knots (Objective) on a dry runway. The aircraft must be capable of takeoff and landing on wet runways (Threshold).

4.2.19 In-flight Operations

The system must operate at flight altitudes of 10,000 (Threshold), 30,000 (Objective) feet Mean Sea Level. The aircraft must be able to operate in Visual Meteorological Conditions (Threshold). The aircraft should have the capability to be equipped with a system to track vehicle position to aid in locating a downed vehicle (Objective).

4.2.20 Cautions and Warnings

Methodology for displaying system warnings, cautions, and alarms must be appropriate to the gravity of the situation (Threshold). Screen displays of system warnings, cautions, and alarms must be consistent between workstations (Threshold).

4.2.21 Data links

Software Communications Architecture (SCA) is desired for all data links (Objective).

4.2.22 Multi-band LOS Datalink

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems requires multi-band capability to effectively support DHS operations. Field-installable, modular kits are required to allow swapping out existing LOS transceivers and antennas for data link-compliant terminals (Threshold). Integrated multi-band ground and aircraft transceivers and antennas are required (Objective).

4.2.23 Tactical Video Streaming and Imagery Data link

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems requires the capability to simultaneously broadcast sensor video to multiple aircraft or ground users within LOS of the aircraft (Threshold). The system shall simultaneously broadcast to multiple users over data link or other appropriate standard interface (Objective).

4.2.24 Single Frame Imagery Dissemination

Capability to allow aircrew to create a still frame image of the current sensor video frame and transmit it over LOS link to aircraft and ground users via a data single format is required (Threshold).

4.2.25 Voice Communications

SCA is required for all radios (Objective).
All aircraft and ground radios must be compatible with VHF Air Traffic Control (ATC) 8.33 kHz and 25 kHz Channel Spacing (Threshold).

4.2.26 Aircraft Radio Communications

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems aircrew must be able to simultaneously monitor and communicate with multiple C2 nodes, aircraft, and appropriate DHS personnel using voice communications during all missions. Radios must be compatible with existing nets (FM, VHF, UHF, Maritime, and/or SATCOM) and transmission security techniques. Radios must be able to monitor the appropriate guard band.

4.2.27 GCS Radio Communications

Aircrew requires access to VHF/UHF networks within GCS LOS and:
Aircrew shall be able to transmit and receive audio for all radio channels/networks through the GCS intercom system (Threshold).
Aircrew shall be able to control the radio channel and mode from the existing operator seats (Threshold), with control integrated in the pull down menu system (Objective).

4.2.28 GCS Intercom

The system requires an integrated intercom system.

Aircrew shall be able to access all radio and telephone communications systems through a single headset/intercom system (Threshold).

The intercom system shall allow extending the intercom stations to co-located fixed or deployable ops cells (Threshold).

Intercom shall be extendable to up to 300 feet (Threshold) or 2 km (Objective).

Crew chiefs should connect on intercom nets using wireless headsets (Objective).

The aircrew shall have the ability to define access rights for each intercom station to include radio transmit, receive/monitor only, and membership in private nets (Threshold).

4.2.29 Navigation

Basic Area Navigation shall be compliant with FAA Advisory Circular AC 90-96 (Threshold). Required Navigation Performance (RNP-l) (Threshold), RNP-0.3 (Objective).

4.2.30 Surveillance

Automatic Dependent Surveillance-Broadcast (Objective). Reduced Vertical Separation Minimum compliant avionics (Threshold). Mode S Level 2 (Threshold).

4.2.31 Global Air Traffic Management (GATM) Requirements

The persistent Intelligence, Surveillance, and Reconnaissance (ISR) family of systems must be certified to applicable civil communication, navigation, surveillance, and air traffic management performance standards to ensure access to controlled airspace (Threshold).

4.2.32 Propulsion system

The engine design must be compatible with airframe design to maximize access for on-equipment maintenance and inspections (Threshold). Unassisted ground start capability and in-flight restart capability is required (Threshold). A heavy fuel compatible engine is required (Objective).

4.2.33 Weather Hazards

The system must be equipped to detect and avoid weather hazards (e.g., thunderstorms, lightning, etc.) and the data must be provided to the ground station so operators may take action as required (Threshold). The ground station must have a terminal area weather radar display (Objective). Operators require real-time measurements from the aircraft of ambient temperature, wind speed/direction (Threshold). The system must be able to support ground, launch and recovery operations in extreme temperature conditions (-40 F to +110F) (Threshold) (-40 F to +150 F) (Objective). While sustained aircraft operations in icing or turbulence are not envisioned, the aircraft must have the capability to detect and transition through a 5,000 ft layer of light icing and/or moderate turbulence (Threshold); and transition through a 5,000 ft layer of moderate icing and sustained moderate turbulence (Objective). The aircraft and payloads design should mitigate performance degradation caused by extended, moderate exposure to environments containing sand, dust or rain (Objective).

4.2.34 Flight Data Recorder

The system must provide the capability to continuously record flight data with an operable data link (Threshold). The aircraft must incorporate a crash-survivable data recorder to continuously record the last 30 minutes of flight data during lost link conditions (Objective).

4.2.35 Lost-link Performance

In the event of loss of data link, the aircraft must execute a preplanned, user-programmable mission profile to facilitate restoration of the data link and minimize collateral damage if link cannot be reestablished. (Threshold). The aircraft must have the capability to support automatic landing if link cannot be reestablished (Threshold).

4.3 Payload Characteristics.

4.3.1 Mission Kits

Mission kits will consist of defined equipment, sensors, and personnel required to meet specific DHS requirements and will be identified as such.

4.3.2 Sensor/Payload Capabilities

System shall be designed to allow rapid payload reconfiguration (Objective). Payloads should be hardened against laser attack (Objective).

4.3.3 Electro Optical/Infrared Sensor(s)

The sensors will have full-motion video and be capable of:
In daylight conditions, providing color, motion video with a National Imagery Interpretability Rating Scale (NIIRS) rating of 5.0 at 30,000 feet slant range (Threshold, KPP) and 8.2 at 60,000 feet slant range (Objective).

Multiple focal lengths to provide wider area surveillance at a reduced NIIRS (Threshold).

In low-light/night conditions, producing video images at a NIIRS rating of 4.0 at 30,000 feet slant range (Threshold, KPP) and NIIRS 8.2 at 45,000 feet slant range (Objective).

The sensor(s) shall be able to detect and display the location of laser target markers and Search and Rescue signaling devices (Threshold).

The system must have an eye-safe, near-infrared, multimode target marker (Threshold).

The sensor(s) will maintain an auto-track on a designated object within the design gimbal tracking limits for minimum of 60 seconds (Threshold) for 60 seconds on a moving target (Objective); on a designated object for as long as the aircraft position allows the sensor to maintain the object/target in its field of view (Objective).

Sensor operator shall be able to discontinue auto-track at will (Threshold).

4.3.4 Sensor Bore-sighting

Sensors providing three-dimensional geolocation information will be capable of manual bore-sighting (Threshold); auto-bore-sight (Objective).

4.3.5 Automatic Search Pattern/Automatic Cuing

The sensor must be able to automatically search an area with an operator selectable pattern appropriate to the item of interest type and location (raster, star, spiral, etc.) and cue potential items of interest (Objective). The operator should be able to manually designate displayed returns as items of interest (Objective). The operator should be able to manually break the lock on a particular item of interest; the sensor should then resume the search, locking on the next available item of interest (Objective). The system should be selectively capable of automatically cross-cueing all sensors to an item of interest within the sensor's field-of-view, provide resolution of 5 meters or less. The system should have a capability to overlay/integrate/ fuse data over other sensor data (Objective). The system will be capable of item of interest classification, recognition, and identification (Objective).

4.4 System Performance.

4.4.1 Mission Scenarios

4.4.2 System Performance Parameters

Key Performance Parameter	Development Threshold	Development Objective
The aircraft system must be certified as airworthy	Certification complete	
Datalinks for all command, control, and dissemination networks	Compliant Datalinks	NSA Compliant, DISA Certified
The aircraft must have a minimum total endurance of 10 hours plus appropriate fuel reserves	10 hours	24 hours
Provide full motion video with a NIIRS rating at 30,000 feet slant range of:	Daylight color video 5.0 NIIRS, low light/night 4.0 NIIRS	Daylight color 5.5 at 60,000 feet slant range, low light/night 5.5 at 45,000 feet slant range
Employment of EO/IR Sensor Suite	Successful	
The system must be capable of being transported by C-130 (Military) or civilian aircraft (e.g., FED EX) by either palletized or roll-on/roll-off capability	Demonstrated capability	
All activity interfaces, services, policy-enforcement controls, and data- sharing of the appropriate interoperability profiles will be satisfied to the requirements of the specific integrated architecture products (including data correctness, data	100 percent of interfaces; services; policy-enforcement controls; and data correctness, availability and processing* requirements	100 percent of interfaces; services; policy-enforcement controls; and data correctness, availability and processing*

availability and data processing), and information assurance accreditation, specified in the threshold (T) and objective (O) values.	designated as enterprise-level or critical in the integrated architecture.	requirements in the integrated architecture.

System Performance Parameter Attributes:

Attribute	Development Threshold	Development Objective
System must support 24/7 operations for 30 days	24/7 operations for 30 days	
Heads-up display	Approved	
Situational awareness data	Fused into a common display	Bi-directional into the network
LOS Communications for Multiple Aircraft Control	4 simultaneous aircraft	8 simultaneous aircraft
Loading and verifying of OFP	30 minutes	15 minutes
Operational altitude MSL	10,000	30,000
Daylight video NIIRS rating	5.0 @ 30,000 ft slant range	5.5 @ 60,000 ft slant range
Low-light/night video NIIRS rating	4.0 @ 30,000 ft slant range	5.5 @ 45,000 ft slant range

4.4.3 Interoperability

The system requires an ISR Interoperability Architecture certified standard interfaces to applicable C4ISR architectures as required by DHS. Using the Joint Interoperability Test Command (JITC) Interoperability System Certification ensures that the persistent ISR family of systems contains interfaces, protocols and data standards that conform to information technology standards found in other government agencies to maximize interoperability. Critical components such as routers and switches internal to the system will be capable of providing their status to appropriate external networks (Threshold).

4.4.4 Human Interface Requirements

All system components must be ergonomic in design to eliminate personal injury of individuals operating and maintaining the system. In addition, it must be user friendly to allow ease of operation and maintenance, and must be designed to eliminate all family of systems component damage during operation, disassembly, repair, and assembly.

4.4.5 Logistics and Readiness

High reliability, ease of maintenance and supportability are the persistent ISR family of systems requirements.

Overall	Threshold	Objective
Full Mission Capability	80%	90%
Mission Capability	90%	95%
Not Mission Capable for Maintenance	≤8%	≤5%
Not Mission Capable for Supply – Overall	≤ 10%	≤ 5%
Abort Rate	<10%	<5%
Mean Time Between Maintenance Planned	Hourly- 50 hours Calendar-30 days	Hourly- 100 hours Calendar-60 days
Mean Time Between Critical Failure	500 hours	1000 hours
Mean Repair Time	<90 min	<60 min
Effective Time On Station	85%	>95%

5 System Support

Initial Operational Capability (IOC) Definition. IOC declaration is based on the system meeting the required assets available date and the service provider successfully completing a realistic trial period that demonstrates it can perform its assigned DHS mission(s). IOC declaration is meant to be event-driven and not schedule-driven. IOC is declared when the service provider demonstrates its ability to perform its assigned DHS mission(s) with the new or upgraded systems. The service provider must be sufficiently satisfied with system performance, quantities received, level of proficiency, and support capability to declare the assets initially operational and capable of performing the assigned DHS mission. IOC is declared six months after DHS leases at least one persistent ISR family of systems kit in support of one DHS agency. FOC declaration is based on all family of systems kits required by DHS to support all agencies identified by this ORD.

5.1 Maintenance

A maintenance training system will be comprised of, but not limited to, training devices, courseware, hardware, software, facilities, and personnel. The Training System will support the organizational maintenance structures and the following training categories: Initial Skills, Continuation, and Conversion/Activation Training (Threshold). Maintenance personnel will require initial skills training and continuous career field training to support mission roles. Familiarization training may be developed in the Computer Based Training (CBT) format. Training devices shall replicate the functionality of the aircraft, GCS, beyond line-of-sight communications, and associated equipment and be designed for concurrent upgrades to accurately simulate current fielded systems (Threshold). Devices shall support a continuous upgrade knowledge level training with troubleshooting, fault isolation, repair, and remove/replace type tasks that extend beyond the initial skills level (Threshold).

5.2 Supply

Spares Support Packages. Deployed operations will be supported through the use of spare support packages. Spare support packages will include sufficient quantities to support a full family of systems deployment in support of DHS missions for 30-days (24/7 operations) without re-supply (Threshold).

Provisioning Strategy. Sufficient spare parts must be planned, budgeted, and procured to minimize down time. Provisioning will ensure all parts upgrades and/or replacements are properly documented for installation and training prior to operational employment. Each system will require initial spares at system delivery as determined by DHS (Threshold) and a 30-day spares support package for deployed operations (Threshold).

5.3 Support Equipment

SE maintenance and calibration will be minimized. Appropriate technical documentation will be required for procured SE. The system and its SE must use standard fittings and connections (Threshold). All required SE must be operated in the same ground environment, as the system (Threshold). The quantities, characteristics, and functions of this SE will not restrict operational employment of the system in support of DHS missions. All required peculiar SE will be fielded with the delivered system for all levels of maintenance and in sufficient quantities to support the operational mission (Threshold).

Requirements for flight-line test equipment will be held to an absolute minimum and will be of minimum size, weight, and complexity needed to verify system operational status and fault isolation. The calibration of peculiar SE must be accomplished at required calibration intervals of not less than 180 days (Threshold). SE shall be selected using the following preference hierarchy (most desirable first); existing government furnished equipment, COTS, modified COTS, and newly designed SE to satisfy multiple system requirements. Any SE new to the family of systems inventory shall be delivered with complete logistics support (Threshold).

5.4 Training

The training system (e.g., syllabi, unit training devices, and training devices) must provide qualified mission operators and task certified maintainers across the training continuum. The syllabi, part task trainers, and training devices will be defined to reflect operator, maintenance, and communications personnel training needs. Training devices and part task trainers will replicate the operational equipment, controls, and displays as necessary for DHS mission accomplishment. For operations, aircrew training devices will be considered a prime source of initial, mission, and continuation follow-on training in lieu of actual aircraft flights. Training devices should integrate the effects of threats and weather on the systems. The training plan must ensure service provider personnel are trained and available to operate and maintain the system prior to IOC. Operations and maintenance will use an agreed to portion of the family of systems fleet to support formal training. Maintenance training shall focus on producing qualified technicians to maintain new systems, and shall include system operation and familiarization, system and subsystem theory of operation, interfaces with existing aircraft systems, troubleshooting, and task accomplishment required to support all organizational-level maintenance. Initial training and any required materials (courseware, lesson plans, charts, and diagrams) shall be procured by the service provider at least 30 days prior to accepting delivery of each new system component (Threshold). In order to allow competitive procurement of training systems, relevant interface, flight, mission, and maintenance data shall be available completely (Threshold).

5.5 Transportation and Facilities

The system design must minimize deployment footprint, be mobile, deployable, and transportable by standard means to include road, and air transportable by military, Civil Reserve Air Fleet (CRAF) or civilian aircraft. The system must be capable of being transported by C-130 (or equivalent) aircraft by either palletized or roll-on/roll-off capability (Threshold, KPP). Aircraft, GCS/LRGCS, data link and support equipment stowed for transport must suffer no internal or external damage or degradation of performance as a result of being transported by or as a result of being loaded or unloaded onto trucks or aircraft by forklift, crane, hoist, or winch, (Threshold). The design should minimize the system's deployment footprint, including basic equipment, training, operations, maintenance, and support equipment. If any portion of the system will not be used for daily flying operations, provisions should be made for long-term storage of components. The system must have the capability, under normal conditions, to tear down and prepare for movement in less than 24 hours by service provider personnel (Threshold). The system must be capable of set-up by service provider personnel and operation (one aircraft prepared for launch and one as a ready spare) within 24 hours after arrival at a deployed location (Threshold). The system must be capable of full-up operations within 36 hours after arrival (Threshold).

6 Force Structure

The solution should be usable by CBP, TSA, USSS, USCG and FEMA, as well as first responders and critical infrastructure/key resources potential users.

7 Schedule

The solution shall be available for lease within one year of the completion of this ORD.

8 System Affordability

Total lease price shall be less than $25/square mile/day with all maintenance, spares, etc. borne by the supplier.

9 Signatures

____
Sponsor’s Acquisition Program Manager [print and sign] Date

____
Sponsor’s Representative [print and sign] Date

____
S&T Project Manager [print and sign] Date

____
S&T Division Head [print and sign] Date

Operational Requirements Document (ORD)

Interoperable Communications Switch

Example Only

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Example Only

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1 General Description of Operational Capability

As a goal, first responders would like to be able to speak to anyone at any time in any place. With the ubiquitous cell phone, that vision seems to be nearly a reality. There is a natural desire to extend this near reality to the far more complex environments of mobile platforms , remote locations (middle of the ocean, out in the desert, atop mountains), and scenes of destruction (earthquakes, explosions, fires).

While the inability to complete a cell phone call successfully may be an annoyance in a personal situation, the inability to communicate can have deadly consequences in a public safety situation. It is therefore critical that those responsible for communications in these organizations plan ahead for contingencies, set realistic expectations, acquire necessary equipment, and conduct training on a periodic basis.

Regarding expectations, it is realistic to pre-engineer multiple solutions to specific interoperability challenges that can be relied upon in an emergency. It is not realistic to think that on-the-fly personnel can expect to successfully interoperate between communications media that have not been previously analyzed and engineered for interoperability. There are numerous challenges to successful interoperability. The right combination of equipment, knowledge, and training will lead to mission critical interoperability when it's needed most. Wishful thinking and ignoring the complexities will, in contrast, provide a false sense of security and lead to failure.

The problems and issues associated with different radio systems not being able to communicate with each other have been known to first responders for many years. The communications problems surrounding the terrorist attacks on September 11, 2001 significantly raised the visibility of this issue and have led to numerous and varied attempts to improve communications interoperability amongst first responders.

1.1 Capability Gap

One primary method of resolving communications interoperability is having all involved parties using the same, or at least interoperable, radios, whether they are cellular, portable, fixed or mounted. Since many first responders have already invested significantly in their current radio systems, acquiring new radios is often not a practical solution. This leads to the second means of resolving interoperability issues, the use of a gateway or switching type of device or system that can quickly and easily connect two or more otherwise non-interoperable radio systems. This system would allow multiple first responders to talk to each other either directly or via radio nets, all while using their existing radios, cell phones, or telephones.

1.2 Overall Mission Area Description

The mission area covered by this ORD is all public safety related events where first responders must communicate with other first responders using communications media such as radios and telephones that are not normally interoperable. This includes different agencies and types of first responders (police, fire, EMTs, etc.) and first responders from different jurisdictions and/or locations (city, county, state, federal, etc.)

1.3 Description of the Proposed System

Responders in the field need access to a switching system with the capability to integrate voice communications of all types in a special evolution or command and control type environment such as an Emergency Operations Center. The proposed interoperability switching system will provide the user the ability to provide advanced Private branch Exchange like capabilities between handsets connected through PSTN, IP, local radio systems (e.g. Land Mobile Radio (UHF or VHF)), commercial wireless (cellular/PCS and satellite) and other standard interface systems. The switching system shall include a full range of switching functions for telephony, radio circuits, simultaneous plain and P-25 encrypted circuits, progressive radio and telephone conferencing and netting, extensive administrative support for configuration planning and event and call logging, and a wide variety of system interfaces. It will support a wide range of commercial voice terminals (analog and digital), radios, wireless systems (such as IP-DECT), integrated voice communication terminals, assignable loudspeakers, and virtually any other analog or digital voice source. The switching system will be able to provide interoperability on a much broader scale than simply tying together radio nets. The switching infrastructure must able to bring all the types of voice communications needed by each user together in a single voice terminal. For some, a telephone is sufficient; for others, a multi-purpose integrated terminal that can handle both radio and telephone calls is appropriate.

The switching system shall be capable of connecting to all types, brands and styles of first responder land-mobile radios in a fixed or mobile communications center. The system will be the hub that connects or networks different types of radios (even radios on different frequency bands) and at the same time allows the local users at the communications center to join multiple radio networks and communicate over telephones, intercom and landlines, all at the same time. Figure 1.3-1 shows the critical functions and interfaces of such a system that will allow first responders, and anyone else associated with a particular emergency operations or communications center, to communicate with one another while using different systems.

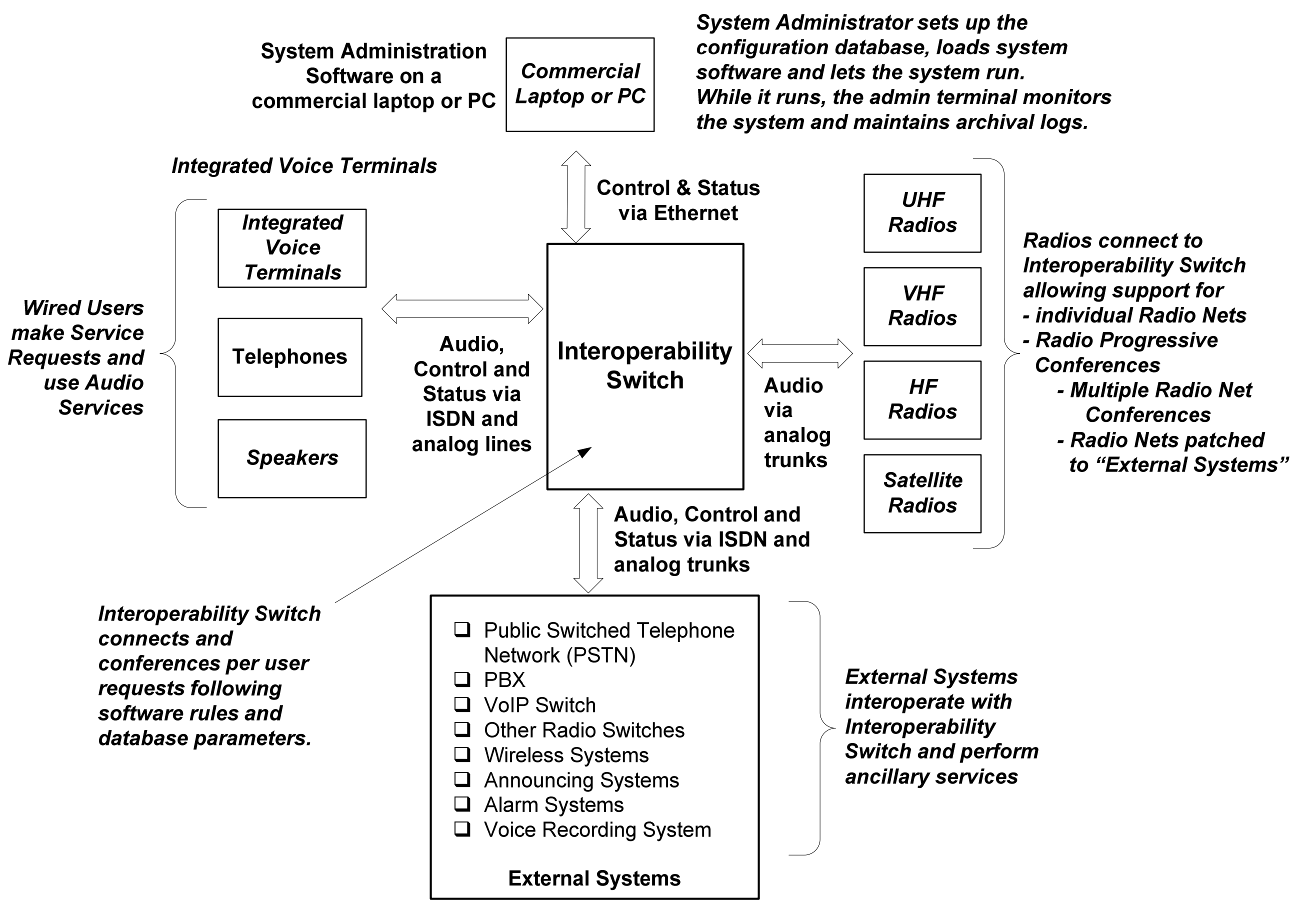

Figure 1.3-1 The critical functions and interfaces of an interoperability switching system to provide first responders interoperability with each other and the rest of the world

1.4 Supporting Analysis

This ORD is supported by analysis done by DHS S&T.

1.5 Mission the Proposed System Will Accomplish

The proposed system will be able to connect and network different and various types of radios, wireless systems, integrated voice terminals, telephones and other communications media such as PBXs, VoIP Switches and the Public Switched Telephone Network (PSTN). Integrated voice terminals are defined as devices that can handle several functions, such as radio calls, telephony, and intercom simultaneously. The proposed system will provide a means for users (first responders and those that need to talk to them) with different communications devices and media to seamlessly communicate and interoperate with one another.

1.6 Operational and Support Concept.

1.6.1 Concept of Operations

The Interoperability Switch will enable first responders to communicate with each other and with communications center personnel using different types of radios, cell phones, telephones and other communications means. This system will integrate voice communications so that police, fire, EMT personnel of all types and from all jurisdictions will be able to easily talk to each other using whatever means of communications they have. Figure 1.6-1 shows the concept of first responders using various devices all connected to the Interoperability Switch by either wire or wireless, being able to communicate with one another. This communications can be either conferenced, networked (netted) or point to point. The proposed system will typically be located in a fixed communications or command center such as an Emergency Operations Center (EOC) but will also be sized to be able to be located in a mobile station if needed.

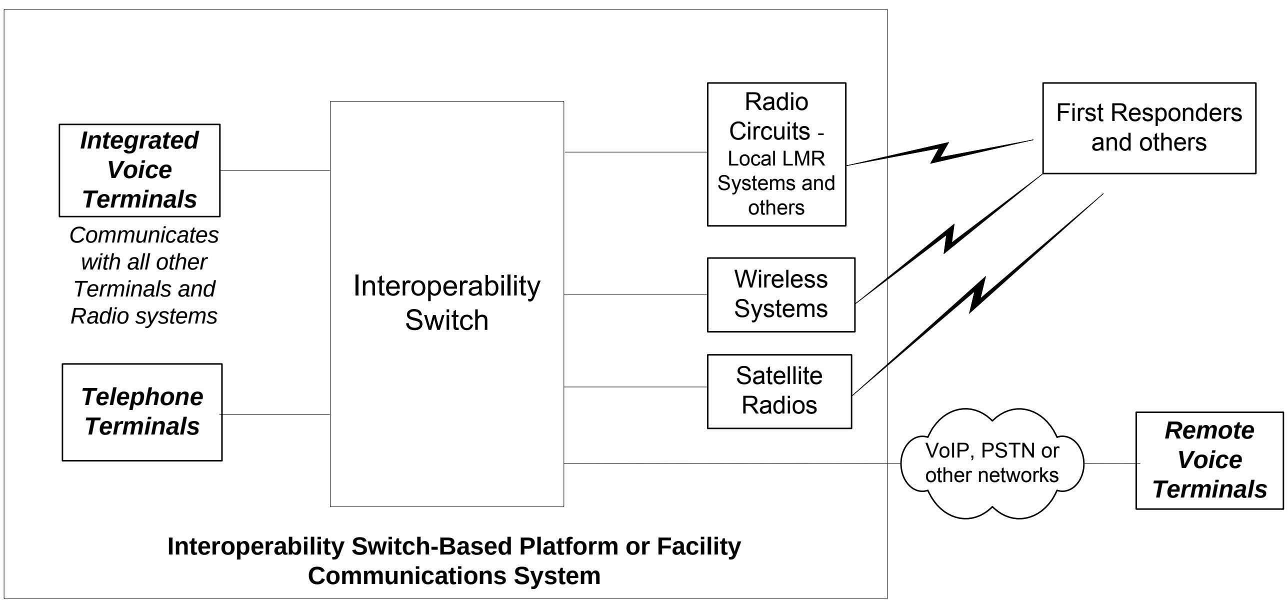

Figure 1.6-1 An Interoperability Switch-Based Facility Communications System Provides Networked Communications Between any Number of Agencies and Personnel

The proposed system will provide the following operational capabilities:

1. Enable all agencies and entities to keep their existing radios and other voice terminals, yet integrate them together in a System-of-Systems.
2. Provide the ability for communications operators to quickly and seamlessly connect or disconnect any number of First Responders with a few button pushes (no laptop needed).
3. Deliver calls without blocking.

4. Enable managers, and other authorized users, to monitor as many communication channels or circuits as they require (or can personally handle) to achieve maximum situational awareness.
5. Interface with security and encryption, if required, to provide transmission security, and easily control who can hear which conversations.

1.6.2 Support Concept

The proposed system shall be maintainable either by the equipment provider or by personnel trained to maintain the system.

The design of the proposed system shall support easy installation by the equipment provider or other trained personnel. Some knowledge of the (fixed or mobile) emergency operation center's interfaces (such as radios, telephones and power) will be required in order to plan and do the installation.

Maintenance requirements for the system shall be minimal. Each unit shall include basic self-test mechanisms to indicate proper operation. System design shall allow for easy replacement of a defective Line Replaceable Unit (LRU) by a new unit with no need for user level repair maintenance. Defective LRUs will be returned to the manufacturer for disposition.

Spare parts will be made available by the equipment provider if not available as a commercial off the shelf (COTS) item.

Training shall be provided by the equipment provider to either a system trainer (via a train-the-trainers session) or to the users and operators at the installed site at a time convenient to the users and operators.

2 Threat

The proposed system counters any threat potentially caused or exacerbated by first responders not being able to communicate with one another. In critical situations, the inability of responders to be able to communicate with one another or with command and control authorities could cause loss of life. The interoperability provided by this system will eliminate communications breakdown or failure as a source of issues when dealing with the threat or situation.

3 Existing System Shortfalls

Existing systems that provide interoperability have the following weaknesses:

The number of devices and nets supported is inadequate to serve as a radio switch for all but the very smallest of applications.

No support is provided for integrated voice terminals. Integrated voice terminals greatly improve the mission effectiveness of users through:

Allowing multiple circuits (radio or telephony) to be monitored simultaneously while supporting one channel in active mode.

Provision of dynamic key text and color to make communications intuitive and responsive to the specific needs of the user.

Supporting advanced interaction with remotely controllable radio terminals. Such interaction requires an intelligent switch.

Allowing a member of a conference (using an integrated voice terminal - IVT) to monitor the terminal traffic and dynamically manage the conference by adding members or dropping others out of the conference as circumstances warrant.

No support is provided for secure voice circuits. Even if secure conferences are not attempted (with multiple radios and encryption devices), these applications do require the switching system to support secure radio circuits at the same time that plain radio circuits are operating. This imposes requirements on the switching equipment that the current systems do not support.

While the Human-Machine Interface (HMI) for current systems may be adequate for the duration of a specific interoperability net, it is not acceptable for a general radio switch.

The HMI for a current system is accomplished using a laptop. Thus, the management of any conference requires someone to use a central gateway laptop for conference setup and management. This requires personnel resources that will not be necessary when each conference can be managed at the voice terminal of the leader of the conference.

The ideal managers of specific conferences are likely to be different individuals depending upon the mission served by the conference. Thus, a central laptop is much less effective for HMI than allowing integrated voice terminals to serve the conference managers as needed operationally.

4 Capabilities Required

4.1 Operational Performance Parameters

The proposed system shall provide required voice and control signal connections to support terminal-to-terminal calls, terminal to net calls, external system calls to terminals and nets, and combinations of these.

The proposed system shall provide a “non-blocking” architecture such that calls cannot be blocked because of switch limitations.

The proposed system shall support ISDN and POTS lines and trunks, and provide for non-blocking traffic flow among all switch port connections, for up to 2000 subscribers (configuration dependent).

The proposed system shall be able to provide connections for three classes of terminal devices:

- Direct BRI S/T line connections for user terminals such as integrated voice terminals and ISDN phones;
- Direct POTS connections for POTS and Analog phones and connections;
- Network Termination (NT) adapters for converting between the BRI S/T lines and special analog interface connections such as Radios and PA systems.

The proposed system shall provide a Primary Rate Interface (PRI) trunk connection for interfacing to Private Branch Exchange (PBX) systems and Radio Communication Systems (RCS).

The proposed system shall be capable of providing redundancies to ensure protection against single-point failures.

The proposed system shall support full-duplex connections, conferencing, self-test operations, and both Plain (unencrypted) and secure modes of operation between designated terminals and systems.

The proposed system shall be created such that users from outside the EOC's area of responsibility are able to communicate with local first responders.

Digital Terminals

The proposed system shall support digital/ISDN terminal direct dial service to other dial terminals and direct dial access (when properly class marked) to nets and external systems that interface with the Interoperability Switch.

Specific Interoperability Switch features available for use by digital terminals will be limited only by the physical configuration of the terminal and the accesses or class marks available to it.

Digital/ISDN terminals shall provide an interface to an associated Interoperability Switch in accordance with industry standard digital BRI S/T characteristics and requirements, and to standard accessory connections associated with the terminal (e.g., handsets, headsets, speaker extensions).

Integrated voice terminals (IVT) are multi-functional ISDN terminals that will have Push-to-Talk capability and can therefore make radio calls in addition to making standard telephone and intercom calls.

The Interoperability Switch shall provide the power for the ISDN terminals.

Analog Terminals

The Interoperability Switch shall support analog POTS (Plain Old Telephone Service) services that operate with a standard Loop Start signaling interface, for connections to

POTS terminals, associated FAX machines and external connections that appear to the POTS interface as a terminal.

Analog POTS terminals shall provide an interface to an associated Interoperability Switch in accordance with the requirements of industry standard EIA/TIA-464B, and to standard accessory connections for the terminal (e.g., handsets).

The Interoperability Switch shall provide the power for the analog terminals.

System Features

The proposed switching system shall provide the connection paths for the voice and control signals transmitted and received by dial terminals and net terminals. The types of call connections that shall be provided are as follows:

- Dial terminal to dial terminal calls: The calling party activates the dial terminal, receives a dial tone or indication and presses or selects (keys) the appropriate buttons on the terminal for the desired service
- Dial terminal to Net terminal calls: The calling party initiates the call and keys the terminal for the desired service. If the dialed number or single button access represents a net, the calling party will be connected to the net.
- Designated terminal to External System interface connections (such as PBXs, VoIP Switches or the PSTN)

The proposed system shall provide and support the services and features shown in Table 4.1-1. The paragraphs that follow the table define the service requirements in additional detail.

Example Only

Table 4.1-1 Matrix for Required Types of Terminal Calls Operations and Services

	CALL OPERATION OR SERVICE	TERMINAL APPLICABILITY		
		Integrated Voice Terminal	ISDN COTS Terminal	POTS or Analog Terminal
1	Call Hold	X	X	X
2	Call Transfer	X	X	X
3	Abbreviated Addressing	X	X	X
4	Progressive Conference	X	X	X
5	Preset Conferencing	X	X	X
6	Meet-me Net	X	X	X
7	Privacy/Auto Override	X	X	X
8	Call Forwarding	X	X	X
9	Call Waiting	X	X	X
10	Assigned Access	X	X	X
11	Access Restriction	X	X	X
12	Alternates	X	X	X
13	Plain or Secure Calls	Either	Plain	Plain
14	Call Monitor (Simultaneous)	X	-	-
15	Push To Talk	X	X	X
16	Intercom Announcing	X	-	-
17	Intercom Hotline	X	-	-
18	Emergency Reporting	X	X	X
19	Speed Calling Lists	X	X	X
20	Call Groups	X	X	X
21	Discriminating Ringing	X	X	X
22	Caller ID	-	X	
23	Activity Detection	X	-	-
24	Analog connection	X	X	X
25	PA Announcing System connection	X	X	X
26	Alarm System Connection	X	-	-
27	Radio Net access	X	X	X
28	Radio Progressive Conferencing	X	X*	X*
29	Assignable Speaker	X	-	-
30	Voice Recorder – Record	X	-	-
31	Voice Recorder – Playback	X	-	-

X Required
- Not Required
* Does not need to initiate a Radio Progressive Conference, but can be added by an Integrated Voice Terminal

System Call Processing Requirements

The following subparagraphs of this section provide a brief description of Call Processing types and services for the Interoperability Switch (shown in Table 4.1-1).

Call Types

Call Hold

Call Hold places an engaged call on hold to allow a subscriber to consult a third party. A Call Hold capability shall be available to all Interoperability Switch subscribers who are involved in a two party call.

Call Transfer

Call Transfer provides a capability to transfer a received call to another terminal, and also permit three-party calls.

A Call Transfer capability shall be available to all Interoperability Switch subscribers who are involved in a two party call.

Call Transfer shall refer to both a "Blind Transfer" (transferring party hangs up before the transfer is answered) and an "Active Transfer" (transferring party waits for the transfer to be answered before completing the transfer). Active Transfer is also known as a transfer with introduction.

Call Transfers to PSTN Lines, Nets, Conferences, and Multi-party calls shall not be allowed.
Additionally, Call Transfers from Nets and Conferences shall not be allowed.

Subscribers currently connected to nets or in conferences shall not have the capability of call transfer.

Abbreviated Addressing (Speed Dialing)

Abbreviated Addressing / Speed Dialing permits designated dial terminals the capability to use abbreviated addresses for dialing. Entering a designated abbreviated addressing code into a terminal keyboard (typically two digits preceded by an "asterisk") shall initiate a call from the dial terminal.

Speed Dial Numbers shall be programmable at both the Local level (Speed Dialing numbers that are applied to a unique terminal) and at the Global level (Speed Dialing numbers that are applied to all terminals). Each Local Level Speed Calling List is unique to a specific terminal while the Global Level is available to all configured terminals.

The system administration terminal software (SAT) shall allow for the configuration of up to 10 Local Level Speed dial numbers per terminal, and the SAT shall allow for the configuration of up to 80 (T) Global Level Speed dial numbers.

Each integrated voice terminal shall provide the ability to program up to 20 (T)/25 (0) pre-programmable dial keys or buttons, local to the integrated voice terminal, that are to be used for speed dial. Additionally most ISDN telephone terminals provide the ability to program speed dial keys available on the terminals.

Privacy/Automatic Override

It shall be possible to assign a Privacy Override capability so that the “busy” condition of a called dial terminal, and Call Waiting if applicable, can be overridden by someone with the proper authority. This feature will allow selected users to exercise preemption capabilities to cut into or override terminals being used for calls with lower precedence levels. Two methods shall be available for initiating Privacy Override in designated terminals:

a. After receiving dial tone, the subscriber depresses the # key and then keys in the called terminal directory number; or
b. After keying the called terminal directory number and receiving busy, the subscriber depresses the # key within three seconds after receiving busy tone.

A one-second override tone shall be placed on the existing connection, such that all members of the connection hear the tone, before connecting the override call.

An Overridden terminal with the Call Waiting capability that is active on one call appearance shall have the previously active call placed on hold.

Call Forwarding

Dial Terminals designated or class marked for Call Forwarding shall be able to have all incoming calls routed to another dial terminal, through subscriber implementation.

Three types of Call Forwarding shall be available:

a) Unconditional, where calls will be automatically rerouted;
b) Call Forwarding Busy, which reroutes an incoming call only if the called terminal is busy;
c) Call Forwarding No Reply, which reroutes an incoming call if there is no answer within a specified amount of time.

To implement Call Forwarding, the subscriber shall dial a configurable special service code appropriate to the type of Call Forwarding, followed by the four-digit number of the terminal to which the calls are to be forwarded.

Upon the completion of a terminal Call Forwarding to a valid terminal, the subscriber shall be notified with a confirmation tone.

To cancel Call Forwarding on a terminal, the subscriber shall dial the configurable special service code assigned for cancelling Call Forwarding.

Call Waiting

A Call Waiting capability shall be available for designated terminals that provide a visual and/or audible indication at a terminal engaged in an established call, to alert it that an incoming call is awaiting connection. A single user action at the designated terminal shall place the engaged call on hold and connect to the waiting call.

Assigned Access

It shall be possible for selected dial terminals to have an assigned access (by class of service) to any combination of the following: individual nets, Public Address systems, Radio trunks, and PSTN connections.

Terminals assigned such access shall be able to obtain the desired connection by keying the appropriate number from the Address Numbering Plan, and terminals that attempt to complete a call to a destination to which access has not been assigned will receive an unavailable tone.

Access/Class Mark Restrictions

It shall be possible to assign Access Restriction (Class Mark) categories to all Interoperability Switch line connections, circuits and terminals for the purpose of controlling intercommunications to or between them. Class Marks (CM) provide a means for software to control user accesses and privileges (such as Call Waiting, Call Forward, and Override).

An assigned or default Class Mark shall apply for each terminal, circuit or call feature so that if the CM appears within the Class of Service (COS) restricted category for a calling party (CLG) terminal, the CLG terminal will be prevented from connecting to the called terminal, circuit or call feature. COS and CM assignments for individual terminals will be provided from the SAT (via the Switch).

Alternates

It shall be possible to designate three alternate terminals to be tested in the event that the primary terminal is busy, unavailable or idle, for a minimum of 16 (T) / 32 (O) dial terminals.

If the primary terminal is busy or unavailable when called, the alternate terminals shall be checked in order and the first idle alternate rung.

If an idle alternate is rung and not answered before the ring period timeout, the next alternate terminal shall be rung.

If the last alternate is idle and not answered a calling ISDN terminal will be placed on-hook while a POTS terminal shall receive unavailable tone.

If the dialed terminal and all alternates are busy, the calling party shall receive busy tone.

If the dialed terminal and all alternates are busy and the caller chooses to override within 3 seconds of receiving busy tone, the dialed terminal shall be overridden.

Call Groups

The Interoperability Switch shall support a telephone Call Groups' capability, for:

a) Rotary hunting (where an incoming call is automatically rerouted to another terminal in a Call group if the first terminal is busy, unavailable, or is not answered during the ring time out period.
b) Call pickup within a Call Group (where any terminal in a Call group can pick up a ringing call to a group member, by dialing a designated call pickup

number), for at least 16 (T) / 32 (O) groups with a minimum of 16 (T) / 20 (O) subscriber members per group.

Plain or Secure Calls

Controls for integrated voice terminals only shall be provided to permit calls in both plain and secure modes of operation.

When a circuit transitions to secure mode all plain-only ports connected to the secure circuit shall have their audio reception blocked until the circuit transitions back to plain mode.

Transmission of plain-only ports shall still occur to the secure circuit. The Interoperability Switch will be responsible for security by configuring, connecting, tracking, and disconnecting circuits. When an incompatible security connection is attempted, the integrated voice terminal shall display a security mismatch with a security mode indication on the display.

An integrated voice terminal shall not have the capability to change the security mode of a call while its PTT is depressed or while the PTT of a terminal connected to the circuit is depressed.

When a Radio Net is switched to secure mode, all Plain-Only terminals in the net shall:

- Be disconnected from the net.
- Receive a Security Mismatch (Unavailable) tone.

If a Plain Only terminal attempts to override a terminal with at least one Call Appearance in a Secure Radio Net, the following shall occur:

- The override is unsuccessful and there is no disturbance to the net.
- The Plain Only terminal gets Unavailable tone.

Call Monitor

A Call Monitor capability shall be supported with integrated voice terminals that permit an integrated voice terminal with an existing call connection to accept or originate a new call connection without disconnecting the existing call. The first key or button pressed in accepting or originating a call will move an existing call into the monitor mode, where it is held and monitored while the user participates in the new call.

The first key pressed in accepting or originating a call shall move the existing call into the monitor mode on the ISDN Bearer 2 channel.

The integrated voice terminal shall be able to monitor calls on the Bearer 2 channel while the user participates in an active call on the Bearer 1 channel.

Discriminating Ringing

The Interoperability Switch shall support a Discriminating Ringing capability, by providing a user selected discriminating ringing for calls originating within the system, originating outside the system (PSTN), or from interface connections (e.g. wireless system).

Caller ID

The Interoperability Switch shall provide a calling line identification capability (Caller ID) on all ISDN terminals equipped with a user display (reference ANSI T1.625 as a guide).

Activity Detection

The Interoperability Switch shall provide an Activity Detect call feature which provides an integrated voice terminal user a visual indication of voice activity on a monitor channel.

The operator shall be provided the ability to toggle this feature on and off from the integrated voice terminal.

When enabled, only the integrated voice terminal keys or buttons that are occupied with calls in monitor mode (illuminated amber) shall blink when audio is being received on the channel associated with the key. This makes it possible for the user to be active in one call while knowing exactly where the monitor audio in the speaker is originating.

When this feature is disabled, monitor calls shall remain solid amber even when audio is being received.

Conferences and Nets

Progressive Conference

For a subscriber terminal that is properly class marked, it shall be possible to set up a full-duplex Progressive Conference capability, whereby terminals are called to join a conference.

A minimum of 15 (T) / 20 (O) Progressive Conferences in progress or in setup at one time shall be allowed, for 12 (T) / 14 (O) conferees per conference. Setup of a conference will be initiated by a conference originator, and add-on permitted by any conference member with the proper permissions (the members Class of Service is not restricted from performing a Progressive Conference)

Preset Conference (and Command Net Call)

A Preset Conference is a call between a set number of previously designated terminals. At least 15 (T) / 20 (O) Preset Conferences of 12 (T) / 15 terminals each shall be supported.

Dialing the Preset Conference directory number from one of the designated terminals shall ring the other designated terminals.

Each designated terminal (of a predefined conference member) shall be added to the Preset Conference if it goes off-hook before the end of the ring period, which shall be programmable up to a maximum of 45 seconds.

Command Net Call is similar to a Preset Conference except that it does not allow automatic Privacy Override.

At least 15 (T) / 20 Command Nets of 12 (T) / 15 terminals each shall be supported.

Meet-Me (Voice) Net

A Meet-me net capability shall be provided, whereby participating terminals are not pre-assigned to the net but will enter it with a single action depression (on a integrated voice terminal) or defined programmable directory number with no additional user action.

Dialing a defined Meet-Me number shall immediately connect a terminal to the Meet-Me net.

Every terminal that dials the meet-me net directory number shall be connected into the net with the ability to disconnect and reconnect without disturbing other net participants.

Each net shall support a capacity of at least 12 (T) / 15 (O) participants. The minimum simultaneous net capacity shall be at least 15 (T) / 20 (O) nets.

Emergency Nets/Calls

An Emergency Reporting Net capability of up to 3 (T) / 4 (O) nets shall be provided to receive emergency calls from any dial terminal, with one terminal assigned to each emergency net for handling incoming emergency calls on that net, and identified as the Responsible Dial Terminal (RDT).

When a called RDT goes off-hook, it will be connected to its emergency net, and any subsequent calls to the emergency number or associated net number will be connected to the emergency net and be able to converse with other net members.

Emergency reporting shall be possible for each of five 'readiness' conditions, and under each condition of readiness a particular RDT may be designated as responsible for handling emergency calls on one or more Emergency Reporting Nets.

An Emergency Reporting Net shall be identified by up to two emergency telephone numbers (i.e., 2211 and 911) in addition to a net number.

The following call/connection procedures shall be implemented:
Any terminal calling the Emergency number and RDT is not-busy, shall receive a ring-back tone until the RDT operator goes off-hook (or integrated voice terminal equivalent), at which time both parties shall be connected to the corresponding emergency net.

Subsequent callers calling the emergency number or the emergency net number shall be connected to the corresponding emergency net and be able to converse with other net members.

If the call to the RDT cannot be completed due to equipment problems or settings, the operator of the calling terminal shall receive an unavailable tone.

If an emergency call is made to the RDT while it is busy on a call to other than its assigned emergency net, all parties on the existing call shall hear a one second emergency tone added to their conversation in progress, and then will be placed on hold while the RDT is automatically connected to the Emergency Net.

The RDT shall be overridden by an emergency net call even if the RDT is currently on a non-overridable call on its non-emergency number. The RDT operator may then retrieve any of the parties on hold.

The RDT shall continue to be connected to the corresponding emergency reporting net even if the calling terminal should go on-hook.

The RDT's connection to the net shall be broken only when the RDT goes on hook or deactivates.

At least 3 (T) / 4 (O) Emergency Nets of 12 (T) / 15 (O) terminal participants each shall be supported.

Address Numbering Plan

An Address Numbering Plan capability will be provided that permits each terminal, net, interface channel or service code to be identified by a discrete four-digit number. The address numbers are used in switch service operations for identification purposes and by the subscriber for service requests.

A numbering plan will typically be divided into two parts: a fixed or reserved set of numbers, and a directory set of numbers.

PTT and Intercom

Push-to-Talk (PTT)

A Push-to-Talk (PTT) capability shall be supported for integrated voice terminal connections and radio mode calls.

A Voice Operated Transmission (VOX) PTT shall be implemented for POTS and BRI/ST Interface Boards.

Intercom Announce

Intercom capability shall be supported for integrated voice terminals, as a dedicated non-blocking service feature that establishes a talk-back connection between designated terminal users. In Intercom Announce the calling integrated voice terminal alerts the called subscriber with an audible tone. An integrated voice terminal permits a called party to hear the calling party even if the called integrated voice terminal is busy, and a single action at the called integrated voice terminal establishes a connection in the reverse direction to permit the called party to talk to the calling party.

The initiator of the IC call shall have an immediate half-duplex connection to the monitor channel of the other integrated voice terminals in the IC group. The other integrated voice terminals will hear the originator without any action on their part.

An integrated voice terminal key in the IC ringing state shall beep and continue flashing until answered or the caller disconnects.

IC ringing shall not time out. If not answered, the call shall remain in the ringing state until the calling party disconnects.

Pressing the IC key or button on a called integrated voice terminal shall establish full-duplex audio between the terminal, the initiating terminal and any other integrated voice terminals that have answered.

If other members disconnect, leaving one remaining member, the call shall remain active.

An integrated voice terminal shall have the ability to leave the IC call and re-enter the call by depressing the IC key.

An integrated voice terminal operator who presses the IC key to return to an active IC call shall be immediately connected.

At least 15 (T) / 20 (O) total Intercom circuits of 12 (T) / 15 (O) participants each shall be supported.

Auto Answer

Applicable to ISDN terminals with Auto Answer capability, an incoming ring signal shall automatically activate the terminal if its Mode switch is set to “Auto-Answer,” allowing the terminal to ring once and the calling party to start speaking.

The integrated voice terminal shall include a locally enabled Auto-Answer feature, whereby the terminal automatically answers incoming telephone and Intercom Announce calls without any user action required.

External Connection Calls

A capability shall be provided to permit dial terminals that are appropriately class marked to dial a connection to an interfacing external system, as described in the paragraphs that follow (such as to a Public Address (PA) system, Radio net, or access to a PSTN trunk using a dialed access code).

Public Address (PA) and Alarm System Connection

A capability shall be provided for connecting to a PA or Alarm system from designated voice terminals, by keying (dialing, with PTT) a designated PA or Alarm system termination number.

8 (T) / 12 (O) total PA or Alarm System Nets of 12 (T) / 15 (O) participants at least each shall be supported.

Radio Net Connection

The Interoperability Switch shall provide a Radio, Analog NT interface capability (application dependent) that permits a secure mode connection via the Switch, from an integrated voice terminal to a site-provided voice radio device. This NT circuit shall present an interface that consists of BRI S/T-to-analog converter circuits and discrete control lines, for an appropriate radio channel connection that has a standardized interface.

15 (T) / 20 (O) total Radio Nets of 12 (T) / 15 (O) participants at least each shall be supported.

PSTN Connection

A capability shall be provided for accessing PSTN trunks from dial terminals and integrated voice terminals that are appropriately class marked, by dialing an access code. The PSTN side shall provide the required dial tone.

Traffic Handling Capabilities

Traffic handling capabilities for the Interoperability Switch will have minimum (threshold) baseline characteristics as specified in the paragraphs that follow:

a) Traffic Load and Distribution - During the busiest hour the Interoperability Switch shall be capable of handling: a) 0.004 terminal-to-terminal calls originated per dial terminal per second (equates to one new call per terminal every 4 minutes), with an average holding time of 30 seconds; and b) 0.002 line-to-net calls originated per dial terminal per second (approximately one new call every 8 minutes), with an average holding time of two minutes. It is assumed that the percentage of these calls completed within the originating node is equal to 100% divided by the number of nodes, and that the traffic load imbalance between multiple nodes does not exceed 1.5 to 1.

b) Call Busy Factor Adjustment - A call busy factor of 25 percent is assumed, to reflect the number of dial terminals unable to make or receive calls because the line is occupied with a previously established call.

c) Call Initiation Delay - The busy hour call initiation delay measured from call initiation to receipt of dial tone shall be less than 3.0 seconds.

d) Call Completion Delay - The busy hour call completion delay measured from the last digit dialed to ring forward shall be less than 0.5 second for calls at one node, or less than 2.5 seconds for calls between nodes.

e) Blocking - An Interoperability Switch shall provide a traffic handling capability of less than one call in one thousand lost or blocked (equates to a call

not going through) as a result of: an error in the controller, or a false trunk, switch or station signal.
f) Misrouting - For security requirements, the probability of call misrouting (call sent to another terminal) due to an Interoperability Switch error shall be less than one in 10^6.

Radio Progressive Conference
Scope
The Radio Progressive Conference (RPC) feature provides a means to establish a true two-way conference call between multiple radios, integrated voice terminals, and other terminals.

Operational Concept
This feature enables an integrated voice terminal user to join two or more Radio Nets together to form one large net. As an example, a VHF link from one land-based agency to a helicopter could be joined to a UHF link from the same agency back to other agencies in the area. The extended network would be half-duplex, but participants on the VHF and UHF links can all hear transmissions and transmit on either link. This represents a concatenation of two nets.

In addition, the feature can be used to bring another terminal into a Radio net. For example, the originator may be participating in a Law Enforcement UHF net and decide that someone on another IVT needs to join the conversation. That operator can call the other IVT and then conference that IVT into the Radio Progressive Conference.

The term progressive in the title implies that additional members (Radio Nets or terminals) may be progressively added (or dropped) one at a time. These conferences can also be referred to as ad hoc conferences.

RPC Requirements
The proposed switching system shall provide Radio Progressive Conferencing with 15 (T) / 20 (O) Preset Conferences.
Each preset conference shall support at least 12 (T) / 15 (O) terminals.

The SAT shall have the capability to configure the Radio Progressive Conference feature for any integrated voice terminal.

If a Radio Net or a Terminal is already involved in a Radio Progressive Conference, attempting to conference that Radio Net or Terminal shall result in an unavailable tone at the attempting integrated voice terminal.

Assignable Speaker/Voice Recorder (AS/VR)
The Assignable Speaker/Voice Recorder (AS/VR) feature of the proposed system shall enable a user to assign speakers or a voice recorder to an Interoperability Switch Radio Net, Public Address Net or Voice Net for monitoring and recording purposes.

The proposed system shall be able to interface with a public address announcing system using industry standard interfaces.

The proposed system shall be able to interface with an alarm system using industry standard interfaces.

The proposed system shall be able to interface to a voice recording device using industry standard interfaces, for the purposes of recording any of the circuits or calls that are routed through the switch.

The voice recorder's record port shall be able to be connected to a net (via the Interoperability Switch) such that all voice transmission on the net is recorded.

The voice recorder's playback port shall be able to be connected to a net (via the Interoperability Switch) such that multiple integrated voice terminals and dial terminals can listen to the playback audio.

The connection of the speaker and/or the voice recorder to a net (via the Interoperability Switch) shall be configurable from the SAT (offline or online) or from the integrated voice terminal.

4.2 Key Performance Parameters (KPPs)

4.2.1 Connectivity

The Interoperability Switching System shall provide at least:

Connectivity to radios 16 (T) / 32 (O)

Connectivity to integrated voice terminals - 24 (T) / 48 (O)

Connectivity to telephones 16 (T) / 32 (O)

Connectivity to wireless systems - 4 (T) / 8 (O)

Connectivity to public switched telephone networks - 1 (T) / 2 (O)

Connectivity to recording systems - 2 (T) / 3 (O)

4.3 System Performance.

4.3.1 Mission Scenarios

The Interoperability Switching System will typically be located at fixed area or mobile communications centers that handle emergency events such as an Emergency Operation Center (EOC). Systems will be installed and can be up and in operation at all times in order to minimize the time needed to establish communications in the event of an emergency.

4.3.2 System Performance Parameters

The Interoperability Switching System shall provide at least:

*Connectivity to radios 16 (T) / 32 (O)

*Connectivity to integrated voice terminals - 24 (T) / 48 (O)

*Connectivity to telephones 16 (T) / 32 (O)

*Connectivity to wireless systems - 4 (T) / 8 (O)

Connectivity to other switches via a PRI interface - One (T) / Two (O)

*Connectivity to public switched telephone networks - One (T) / Two (O)

Connectivity to public address systems - 2 (T) / 4 (O)

Connectivity to other Interoperability Switches via a trunk - One (T) / Two (O)

*Connectivity to recording systems - 2 (T) / 3 (O)

Connectivity to Voice over IP (VoIP) systems - One (T) / Two (O)

4.3.3 Interoperability

The Interoperability Switch will be able to interface to all radios, wireless systems, integrated voice terminals, telephones, PBXs, VoIP Switches, PA systems, recording devices and other communications media that utilize industry standard interfaces.

4.3.4 Human Interface Requirements

An Integrated Voice Terminal (IVT) will be the primary and most functional Human Machine Interface (HMI) connected to the Interoperability Switch for connecting and establishing radio/wireless and telephone calls, circuits, conferences and nets.

Analog and Digital Telephones (also known as dial terminals) will be additional HMI devices connected to the Interoperability Switch for the purpose of making and receiving calls and connecting to conferences and nets.

A system administration terminal (SAT) will act as the HMI for system configuration data entry, system configuration reports, system status reports and failure interrogation.

The SAT can be either continuously connected to the Interoperability Switch for permanent ongoing system status reporting, or be capable of being placed in offline mode during user absence or for configuration database updating (for a later database transfer to the Switch).

When the SAT is not online, Switch status and failure events shall be stored in the Switch for batch transfer to the SAT when it is returned to online status.

A SAT connection shall be able to interface to a local or networked printer, if part of the configuration, for hardcopy printouts of system status.

The SAT can be any PC which is operable from 115 VAC, is available with back-up battery option, provides printer and Ethernet interface connections, is capable of running Interoperability Switch SAT software under Microsoft Windows®.

The SAT shall provide for Interoperability Switch setup and management and for initiating Switch Built-in-Test (BIT) operations.

The SAT shall provide a status screen displaying the latest status of the Interoperability Switch.

The SAT status screen shall contain the Interoperability Switch Call and Fault Logs.

The SAT shall provide the user a capability to manage the system tests and view the status of the tests.

Accepted industry standards shall be applied as guidance for human engineering design criteria in the design of the proposed system, to achieve safe, reliable and effective performance by operator, supervisor and maintenance personnel, and to minimize personnel skill requirements and training time.

4.3.5 Logistics and Readiness

The proposed system is required to be operational for several days of continuous operation without interruption. No user level maintenance or spare part replacement is required. Spare PWAs should be available in case replacement is required.

Mean Time Between Failures (MTBF) shall be 1,500 hours (T) 1,800 hours (O)

System Availability (A_i) requirement shall be 0.999995 (T), 0.999997 (O) based on the following formula:

$$A_i = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

4.3.6 Other System Characteristics

Design drivers are the interfaces and the ability of the proposed Interoperability Switch to interface to all types of radios, wireless systems, telephones, and other communications media.

Cost drivers are the interface cards for the many and varied systems to be connected to the proposed system.

Risk drivers are the ability of the Interoperability Switch to interface with many and varied different systems using readily available off the shelf interface boards without the need of designing or building new boards

5 System Support

5.1 Maintenance

The proposed system shall be designed for unattended operation. Routine, scheduled maintenance will be performed on-line, except for specified infrequent cleaning operations.

Scheduled maintenance checks shall not be required more than once every 24 hours. Scheduled maintenance may include, but not be limited to: air filter cleaning and replacement; battery cleanliness and battery voltage level checks; daily semi-automatic system tests from the SAT; lamp and meter checks; and general cleanliness requirements.

The total 24-hour normal maintenance burden for an operating system, scheduled and unscheduled, shall not average more than two man-hours (T) / one man-hour (O).

5.2 Supply

User Manuals will be provided to the operators and maintenance technicians by the equipment provider (vendor) and will include operator procedures, diagnostic testing/SAT use, and replacement procedures.
No special tools or diagnostic equipment will be required for equipment replacement.

5.3 Support Equipment

Standard support equipment for the Interoperability Switch is the system administration terminal (SAT) described in paragraph 4.3.4 HMI which will handle system diagnostic testing. No special test equipment will be required to maintain or operate the unit. The vendor will provide software upgrades as needed/required and will provide software development services to the buyer for new features as requested.

5.4 Training

Training will be provided by the equipment provider to a system trainer (via a train-the-trainers session) and to the users and operators at the installed site at a time convenient to the users and operators. The training curriculum will be designed to ensure users understand and are fully capable of operating and using all features of the system. Knowledgeable staff members of the equipment provider will also be made available by phone (via a Help Desk type arrangement) should a user or operator need assistance with any part of the proposed system.

5.5 Transportation and Facilities

It is anticipated that this system will most often be used in a fixed station. If the proposed system is to be mobile or used in the field, it will be transportable via truck or van and will be able to be lifted by two or fewer personnel. Sufficient 115V power and cables will be needed to connect the Interoperability Switch to the radios and other equipment necessary to provide connectivity and interoperability commensurate with the event. Any training needed in the field can be provided as on the job training with no special facilities needed.

6 Force Structure

One Interoperability Switch system will typically be required at each Emergency Operating Center (EOC) or similar type communications center. The proposed system will be modular and scale-able (or sizeable) to have enough capacity and interface boards necessary to interface all of the radios, integrated voice terminals, telephones and other communications devices needed by the center personnel to conduct their mission.

Additional systems can be supplied to mobile platforms (vans or trucks) if an EOC or other shore based center is not within communications range of the event.

The high reliability of the system (para. 4.3.5) dictates only a minimum amount of spares needed for interface boards, power supplies and communications devices

7 Schedule

Demonstration of an initial operational capability is required within 3 months (T) / 1 month (O) after executed SECURE Agreement. For the purpose of this effort, initial operational capability is defined as installation and field demonstration of one fully operational Interoperability Switch system to include one SAT and at least two radios, two integrated voice terminals, two telephones, and one other wireless device (such as a cell phone.)

A fully operational system will be required within 9 months (T) / 6 months (O). A fully operational system includes the Interoperability Switch with interface boards, system administration terminal (SAT), and all necessary integrated voice terminals supplied by the proposed system vendor. Radios and other communications devices (telephones, wireless systems) to interface with the Interoperability Switch are typically separate from the Interoperability Switch system and may have different lead times if they are not already available at the site.

8 System Affordability

An Individual unit price cost for such an Interoperable Communications Switch will cost less than $200K (T) / $150K (O).

9 Appendixes

List of Acronyms

CM – Class Mark

COS – Class of Service

COTS – Commercial off the Shelf Equipment

EOC – Emergency Operations Center

ISDN – Integrated Services Digital Network

KPP – Key Performance Parameter

MTBF – Mean Time Between Failures

POTS – Plain Old Telephone System

PSTN – Public Switched Telephone Network

RDT – Responsible Dial Terminal

SAT – System Administration Terminal

IVT – Integrated Voice Terminal

Appendix B: Making it Easier to Work with DHS (Article)

Making it Easier to Work with DHS: The Critical Role of Detailed Operational Requirements

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In today's dynamic homeland security environment, delivering cost-effective products and services that meet well thought-out detailed requirements is a critical objective for the U.S. Department of Homeland Security (DHS). DHS is composed of many organizational elements with an overriding goal: to enable, support and expedite the mission-critical objectives of DHS' seven operating components – Transportation Security Administration (TSA); U.S. Customs and Border Protection (CBP); U.S. Secret Service, (USSS); U.S. Citizenship and Immigration Service (USCIS); U.S. Immigration and Customs Enforcement (ICE); Federal Emergency Management Agency (FEMA); and the U.S. Coast Guard (USCG). These seven operating components work closely with, support and are supported by a large network of first responders at the state, local and tribal levels. DHS must coordinate, drive and prioritize the detailed needs of this diverse group of operating components and supporting elements, whose missions address a wide variety of terrorist and natural threats to our homeland, in order to maximize the effective use of DHS's resources. Ever changing threat dynamics often require new, innovative-technology based solutions in order to prevent or mitigate the potential effects of current and future dangers. The DHS Science and Technology Directorate (DHS S&T) works diligently to understand, document and offer solutions to current and anticipated threats faced by our "customers" (DHS operating components and field agents) and our "customers' customers" (first responders and the eighteen infrastructure industrial sectors such as banking, chemicals and communications, etc.).

Capstone IPTs and Capability Gaps

DHS-S&T, through the Capstone Integrated Product Team (IPT) process[1], ensures that quality, efficacious products are developed in close alignment with customer needs. The Capstone IPT process is the framework that determines that developed capabilities meet operational needs, analyzes gaps in strategic needs and capabilities, determines operational requirements, and develops programs and projects to close capability gaps and expand mission competencies. This process is a DHS customer-led forum through which the identification of functional capability gaps and the prioritization of these gaps

[1] Kikla, Richard V. and Cellucci, Thomas A. "Capstone IPTs: Even in Government the Customer Comes First," April, 2008.

across the Department are formalized. The IPTs oversee the research and development efforts of DHS-S&T and enable the proper allocation of resources to the highest priority needs established by the DHS operating components and first responders.

Capstone IPTs bring together S&T division heads, acquisition partners and end-users (Operating Components, field agents and supporting First Responders – customers of DHS) involved in the Research, Development, Testing and Evaluation (RDT&E) and acquisition activities. Working together, the IPT identifies, evaluates and prioritizes the necessary requirements to complete missions successfully. IPTs also assess the technological and system readiness of products that will ultimately be deployed into the field. Figure 1 shows the organization of a Capstone IPT. The formation of the IPT at an early stage allows key stakeholders to identify and address critical capability gaps. Each Capstone IPT has a DHS operating component chair or co-chairs. The chair/co-chair, representing the end-users of the delivered Enabling Homeland Capabilities (EHCs), or suite of technologies needed to close a capability gap, engage throughout the process to identify, define and prioritize current and future requirements and ensure that planned technology and/or product transitions and acquisition programs, commercialization efforts and standards development are optimally suited to their operational requirements. Operating components, field agents, first responders and other non-captive end-users with an interest in the core functional areas of an IPT are welcome to participate and contribute throughout the Capstone IPT process.

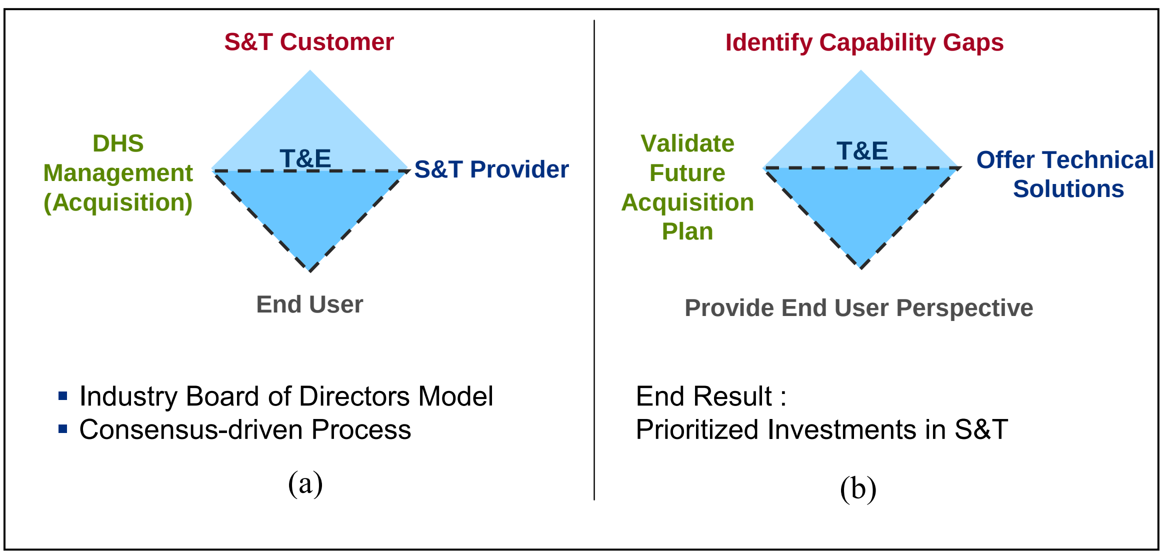


Figure 1 (a) This diagram shows the structure of the Capstone IPT model with (b) the models' output functions carried out by each IPT member.

The Capstone IPTs are structured to focus on functional, department level requirements, articulated as capability gaps, and deal with programmatic and technology issues within the six S&T divisions. Capstone IPTs have been created across twelve major Homeland Security core functional areas: Information Sharing/Management, Cyber Security, People Screening, Border Security, Chemical/Biological Defense, Maritime Security, Counter-Improvised Explosive Devices, Transportation Security, Incident Management, Interoperability, Cargo Security and Infrastructure Protection. Each Capstone IPT is chaired by senior leadership from a DHS operating component with needs that correspond to a specific functional area. All DHS operating components with an interest in a particular Capstone IPT are invited to send a representative to participate as an IPT member. See Figure 2.

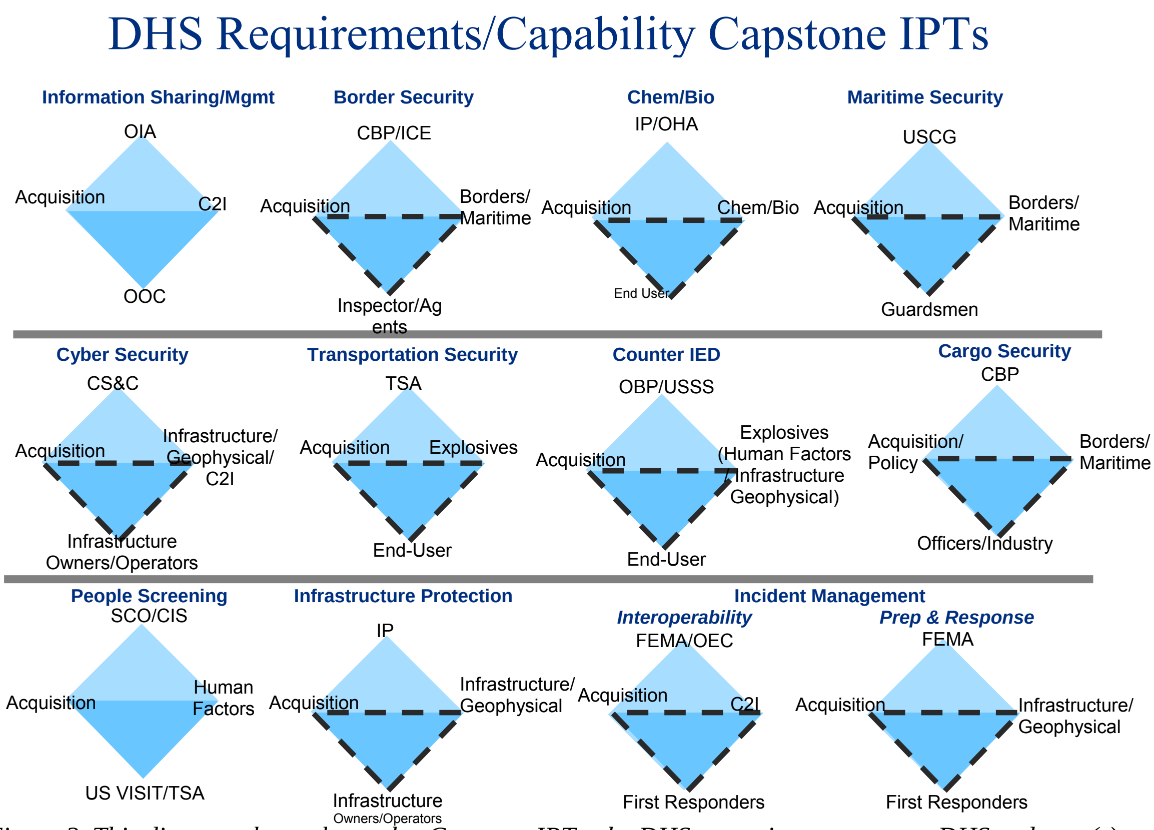


Figure 2. This diagram shows the twelve Capstone IPTs, the DHS operating component, DHS end-user(s), the S&T Division technical provider, and, when applicable, the Acquisition conducted by DHS management.

Technology development is aligned functionally, rather than by operating component "stove pipes," to allow technologies to be used in support of multiple operating components within DHS. This broad focus aids in reducing the duplication of efforts among various operating components of DHS. In order to achieve greater insight into the facets that comprise each Capstone IPT, Project-IPTs are created to manage specific project areas within a functional area. For example, Border Officer Tools and Safety, and Container Security are Project-IPTs for the Border Security and Cargo Security Capstone IPTs, respectively. Project-IPTs consist of several subject matter experts who are responsible for clarifying the capability gaps derived from the Capstone IPTs and for developing detailed operational requirements with the operating components for the systems that will comprise the EHCs. The Project-IPTs work closely with DHS customers, through an Operational Requirements Document (ORD), to define clearly the specific requirements that must be met in order for a technological solution to address a given problem. Integration of these products into systems forms the EHCs for use by the customers. All DHS agencies are responsible for integrating and fielding the technology deliverables into operational systems scheduled for delivery to their operating component.

Beyond Capability Gaps…

Capstone IPTs generate several outputs that guide the development and fielding of products, services and systems for the operating components. The primary role of the IPTs is to conduct strategic needs analysis to determine and prioritize the capability gaps that exist within a particular functional area. Capability gaps are broad descriptions of department level identified mission needs that are not met given current products and/or standards. Capability gaps catalog opportunities for enhanced mission effectiveness or address deficiencies in national capability.

The Capstone IPT process enables our divisions within DHS-S&T to interact regularly with their customer(s) to determine capability gaps. These capability gaps, in many ways, are just the beginning. From a product development standpoint, a capability gap is one of the initial steps in the requirements hierarchy scheme. Additional detailed requirements must be developed to enable the development of a technology or product. In our outreach efforts with the Private Sector, DHS-S&T realizes that we must work with our customers to produce a detailed set of requirements in order to communicate with other operating components and frequently to the private sector, which has the ability to develop products aligned to stated requirements.

Commercialization Model Drives the Need for Detailed Requirements

The U.S. Department of Homeland Security is forging a new paradigm with far-reaching positive consequences for DHS' customers, private sector partners, and U.S. taxpayers through the rapid, cost-effective and efficient development and deployment of products and services to protect the Homeland of the United States. As a recently formed U.S. Federal Government Department (March 6, 2003), DHS is "creating a culture" where public-private sector partnerships, beneficial to both sectors and taxpayers alike, expedite the development of products and services to protect the nation. Recently announced commercialization initiatives like the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program are truly groundbreaking and innovative approaches to foster a mutually beneficial relationship between the public and private sectors by creating an open and freely competitive program accessible by small, medium and large firms to provide potential solutions to DHS requirements. These efforts are a natural extension of the Capstone IPT process.

DHS possesses an "Acquisition Mindset," as do so many government agencies. While the Acquisition model has been, and continues to be, utilized effectively in developing custom, one-off products such as aircraft carriers, it is not particularly germane to a majority of the needs at DHS as well as the first responders (a DHS ancillary market). The timely design, development and deployment of lower priced, widely distributed products for both DHS operating components and the first responder communities represents a critical step in protecting our nation. Recognizing this fact, the Department recently started implementing a "Commercialization Mindset" in order to leverage the vast capabilities and resources of the private sector through an innovative “win-win” private-public partnership called the SECURE Program stressing the need for detailed requirements.

Why is there a need for a commercialization process? DHS requirements, in most instances, are characterized by the need for widely distributed COTS (Commercial-Off-The-Shelf) products. Oftentimes, the need is for thousands, if not millions, of products for DHS’ seven operating components and the fragmented, yet substantial first responder market. Figure 3 shows the major differences between a “pure” Acquisition vice a “pure” commercialization processes, along with the recently developed and implemented DHS “hybrid” commercialization process. In this new “hybrid” process, both the private and public sectors share various roles and responsibilities in the cost-effective and efficient development of products and services for DHS.

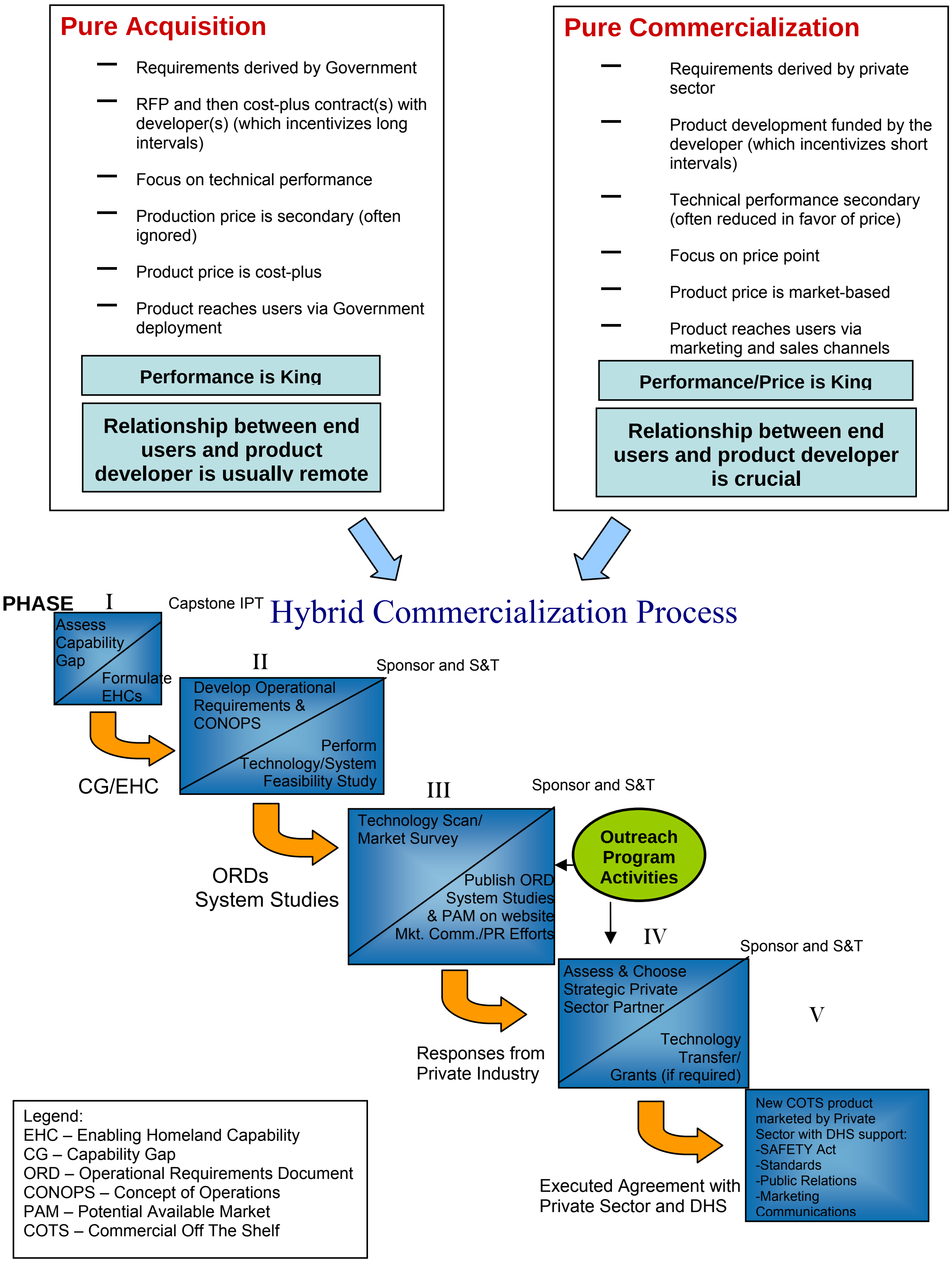


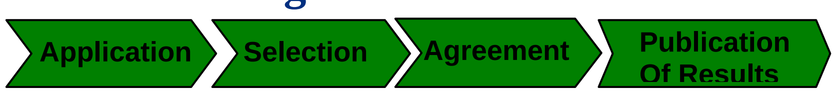
Figure 3: Comparison of "Pure Acquisition" versus "Pure Commercialization" models for product/system development and the resultant hybrid model implemented by DHS.

Figure 4 delineates the overall description of DHS's new commercialization model and its first private sector outreach program called the SECURE Program to develop products and services in a private-public "win-win" partnership described in detail at www.dhs.gov/xres/programs/gc_1211996620526.shtm. The SECURE Program is based on the simple premise that the private sector is willing and able to use its own money, resources, expertise and experience to develop and produce fully developed products and services for DHS if significant market potential exists. The private sector has shown remarkable interest in devoting its time and resources to such activities, if and when an attractive business case can be made related to large revenue/profit opportunities, which certainly exist at DHS and its ancillary markets. The private sector requires two pieces of critical information from DHS: 1. detailed operational requirement(s), and 2. a conservative estimate of the potential available market(s). This information can then be used to generate a business case for possible private sector participation in the program.

A New Model for Commercialization…

- Develop Operational Requirements Documents (ORDs)
- Assess addressable market(s)
- Publish ORD and market assessment on public DHS web portal, solicit interest from potential partners in a way that is open to small, medium and large businesses
- Execute no-cost (CRADA-like) agreement with multiple private sector entities and transfer technology and/or IP(if necessary)
- Develop supporting grants and standards as necessary
- Assess T&E findings after product is developed to assure DHS and ancillary markets that product meet its published specifications
- New Commercial-Off-The-Shelf (COTS) product marketed by private sector with DHS support

SECURE Program



- Application – Seeking products/technologies aligned with posted DHS requirements
- Selection – Products/Technologies TRL-5 or above, scored with internal DHS metrics
- Agreement – One-page CRADA-like document that outlines milestones and exit criteria
- Publication of Results – Recognized third-party T&E conducted on TRL-9 product/service. Results verified by DHS, posted on DHS web-portal to provide confidence to potential customers at DHS and its ancillary markets that product(s) meet or exceed their published specifications in reference to their actual performance.

Figure 4: Step-by-step guide to the commercialization process developed and adopted by DHS with a brief summary of the popular SECURE Program.

To augment the commercialization process, DHS has undertaken the task of developing an easy-to-use comprehensive guide to assist in developing operational requirements. This guide now enables DHS personnel to articulate, in detail, a given system's requirements and communicate those needs to both internal and external audiences. This effort addresses a long-standing need for DHS to fully articulate its requirements. Figure 5 clearly shows how an ORD takes a capability gap to "much higher resolution," a necessary required if the private sector is to aid DHS in its goal of expediting the development and deployment of cost-effective and efficient widely distributed products.

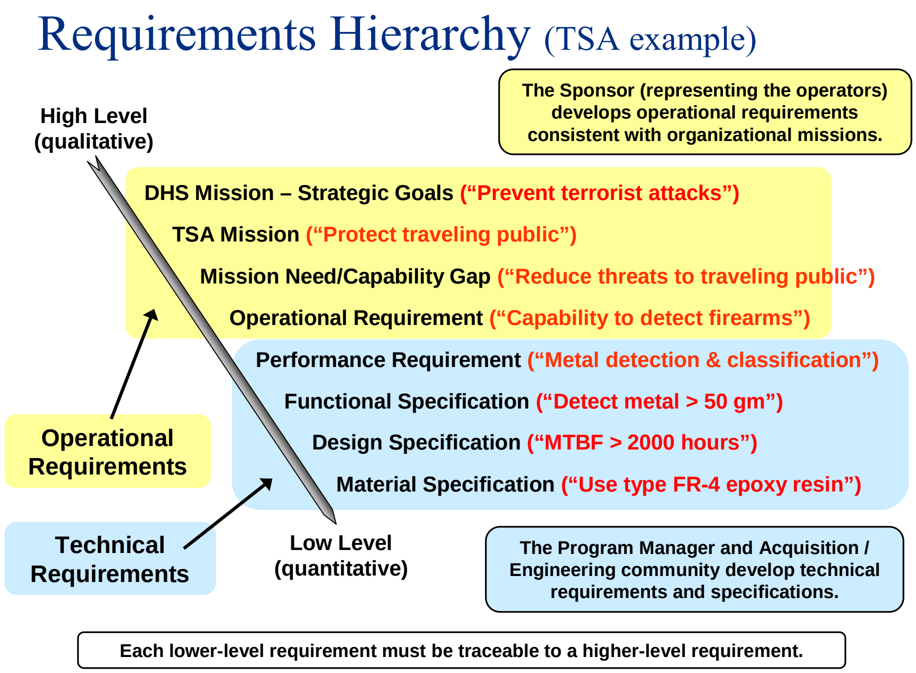


Figure 5. This requirements hierarchy shows the evolution of requirements from a high-level macro set of operational requirements to a low-level micro set of technical requirements. Note that each lower level requirement stems directly from its higher requirement so that all requirements are traceable to the overall DHS Mission.

Early response from groups within DHS, the private sector, and first responders about this guide and programs like SECURE has been very favorable[2]. The Department plans to regularly update its website with Operational Requirements Documents (ORDs) to continually expand this innovative private-public partnership. In addition, as evidenced in Figure 6, the taxpayers, private sector and public sector view programs like this as "win-win-win."

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[2] Margetta, R. "S&T Official Working to Move Product Development Out of DHS, Into Private Sector," Congressional Quarterly Homeland Security. June 27, 2008.

Benefit Analysis – "Win-Win-Win"		
Taxpayers	**Public Sector**	**Private Sector**
1. Citizens are better protected by DHS personnel using mission critical products	1. Improved understanding and communication of needs	1. Save significant time and money on market and business development activities
2. Tax savings realized through private sector investment in DHS	2. Cost-effective and rapid product development process saves resources	2. Firms can genuinely contribute to the security of the Nation
3. Positive economic growth for American economy	3. Monies can be allocated to perform greater number of essential tasks	3. Successful products share in the "imprimatur of DHS"; providing assurance that products really work.
4. Possible product "spin-offs" can aid other commercial markets	4. End users receive products aligned to specific needs	4. Significant business opportunities with sizeable DHS and DHS ancillary markets
5. Customers ultimately benefit from COTS produced within the Free Market System – more cost effective and efficient product development	5. End users can make informed purchasing decisions with tight budgets	5. Commercialization opportunities for small, medium and large business

Figure 6: The SECURE Program is viewed positively by DHS stakeholders. The success of the program lies in the fact that all participants receive significant benefits.

In conclusion, DHS' newly created and implemented commercialization process offers long-awaited benefits to the rapid execution of cost-effective and efficient development of products and services to protect our nation and its resources.

Thomas A. Cellucci, Ph.D., MBA is the U.S. Department of Homeland Security's first Chief Commercialization Officer. In his role, he recently published two comprehensive guides: *Requirements Development Guide* and *Developing Operational Requirements* to aid in effective requirements development and communication for the department. He possesses extensive experience as a scientist and senior executive and Board Member in high-technology firms in the private sector.

Appendix C: Bridging the Communications Gap (Article)

Bridging the "Communications Gap" between the Public and Private Sector – Making it Easier to do Business with DHS

DHS's' new commercialization outreach efforts center on notifying the private sector about opportunities that exist for partnership and business development to address the needs of the Department.

Thomas A. Cellucci, Ph.D., MBA
Chief Commercialization Officer
Commercialization Office
U.S. Department of Homeland Security

If you think about it, there are numerous examples in our professional and private lives where the lack of communication or unclear terminology has created misunderstandings, problems and myriad other issues. As in any worthwhile pursuit, effective communication is critical in the cost-effective and efficient interactions between various parties seeking a mutually beneficial partnership. The U.S. Department of Homeland Security (DHS) is putting into practice the necessary rigor to improve communication that will allow the public and private sectors to work jointly to meet the unsatisfied needs of the DHS in order to protect the Nation.

To this end, the DHS Commercialization Office has developed a number of processes, programs and tools to facilitate the clear articulation of DHS needs (See Figure 1). In that same spirit of working together with the private sector, we recently developed a "Product Realization Chart" (see Appendix H) which is a useful guide to relate concepts and correlate terminology used by both the public and private sector to clearly delineate how science, technology development and product development (terms used in the private sector) are related to basic research, innovation and transition using a Technology Readiness Level (TRL) "backbone" (terms used in the public sector).

Further examination of the Product Realization Chart shows that this resource also provides a stage-gated approach for cost-effective and efficient product development to provide a "discussion framework" useful in private-public sector discussions as well as a template for utilization to develop and communicate agreements. The chart describes the objectives, deliverables and the type of management review necessary to develop and deliver technologies/products/services that meet the specific requirements of the DHS' operating components (U.S. Coast Guard, FEMA, TSA, CBP, USCIS, U.S. Secret Service and ICE) and its end users such as first responders.

Stage One: Needs Assessment

Needs assessment is the critical first stage of product realization (accomplished via acquisition or commercialization processes) that enables DHS to identify capability gaps and investigate new product/technology/service capabilities. By understanding the specific and detailed requirements of its customers, the DHS Science & Technology Directorate (DHS S&T) conducts market research and technology scans to find and assess technology-based solutions that could potentially be developed, matured and delivered to DHS end users.

Commercialization programs, processes and tools…

1) "Developing Operational Requirements" Guide
2) "DHS Implements Commercialization Process" Article
3) "Partnership Program Benefits Taxpayers as well as Private and Public Sectors" Article
4) SECURE Program and website
5) DHS online
6) Invited talks to trade conventions, reaching small, medium and large businesses. Efforts also extend to meet with minority, disadvantaged and HUB Zone groups on a regular basis.

Figure 1: Outreach efforts to inform the public on "How to do Business with DHS" is receiving positive feedback from the private sector and media. See the following website for additional information:

Please note that management reviews for both the public and private sector are required to ensure that exit criteria and deliverables are met when discussing public-private programs like the SECURE Program.

The remainder of the chart shows the various key objectives and deliverables for each major phase of product realization. Entrance at any point of the chart is possible and certainly, the overall objective of many projects currently underway at DHS is to obtain widely distributed products or services (where commercialization is key). DHS also sometimes has unique "custom-like" requirements with lower unit-volume potential (normally using the Acquisition model as shown in Figure 2). It also should be noted that in a basic research program, it may certainly not be possible to generate an ORD, as the objective may be the "exploring uncharted territory" rather than the development of products or services for sale to a particular market. For this reason, a dark box is drawn around Stage 1 to indicate that the Product Realization Chart is a multiple-use chart, rather than a concrete process because it simply offers a framework to visualize several processes, some of which (developing custom or widely distributed products/services) require a Needs Assessment.

Stage Two: Science

At the beginning of the second stage, basic principles are observed and reported, and scientific research begins to be translated into applied research and development (R&D). At this stage, a program sponsor and end user/customer have been identified and the mission needs statement, feasibility study and program management visions have been developed.

Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. In the case of developing products/services, operational requirements analysis has been conducted and operational requirements are applied to functional requirements. A risk management plan has been developed, a program cost analysis has been completed and a preliminary security assessment has been conducted.

As the technology concept and/or application is formulated, active R&D is initiated that results in an analytical and experimental critical function and/or characteristic proof of concept. This includes analytical studies to physically validate the analytical predictions of separate elements of the technology. A Systems Engineering Management Plan (SEMP), Program Management Plan (PMP) and proof of concept plan are key deliverables and serve as exit criteria for the next stage of product realization.

During the second stage, the private sector normally produces a complete product plan during commercialization that addresses marketing opportunities, financial considerations, design concept and many additional analyses. Sales/Marketing team performs a SWOT (strengths, weaknesses, opportunities, and threats), a scenario analysis and a sales forecast estimate. Research assembles the key IP disclosure submissions. Quality Assurance (QA) generates all safety/standards compliance items, calibration requirements and other quality control specifications.

Management reviews for both the public and private sector are required (in partnership projects or programs) to ensure that exit criteria and deliverables are met.

Stage Three: Technology Development

The third stage of product realization ensues when basic technological components are integrated to establish that they will work together, which is a relatively “low fidelity” analysis when compared with the eventual system. The proof of concept report and functional requirements document have been finalized. The SEMP, Test and Evaluation Master Plan (TEMP), quality assurance plan and other deliverables are revised and updated on a continuous basis.

The basic technological components are then integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. The fidelity of the breadboard technology increases significantly in this case. The Operational Requirements Document (ORD) and CONOPS are better developed. The technology scan and market survey are ongoing during the third stage, and an analysis of alternatives is provided.

Once the component is validated in a relevant environment, the system/subsystem model or prototype is demonstrated in a relevant environment. After successful T&E in a simulated operational environment, a preliminary Technology Transition Agreement (TTA) or a Technology Commercialization Agreement (TCA) is executed as applicable. A program manager is identified and an interoperability assessment is performed.

During this stage, the private sector uses its product plan to conduct a beta design review, produce a detailed supplier list and supplier benchmark, begin writing the user’s manual, develop a service strategy, confirm the risk analysis and review engineering change orders. Manufacturing creates a preliminary manufacturing plan and works with

Marketing/Sales to finalize product packaging. Quality Assurance defines regulatory requirements, prepares a preliminary quality plan and procedure for first prototype testing and designs the inspection tooling.

Management reviews for both the public and private sector are required to ensure that exit criteria and deliverables are met.

Acquisition versus Commercialization

Once a representative model or prototype system, which beyond TRL 5, is tested in a relevant environment, the product realization process splits into two paths that are extraordinarily different as evidenced in Figure 2: Acquisition and Commercialization. Acquisition occurs when a government contractor executes design, development and production, driven by DHS requirements, using DHS funding and under contract to DHS. In this case, the product is then deployed to captive users and the product unit price is determined by cost-based pricing. The contractor's customer is DHS and not the end-user community.

Commercialization, on the other hand, is a private-sector driven activity enterprise that executes design, development and production, driven by market requirements, using private funding and perhaps assisted by DHS technology licenses, standards and grants. The product is then sold as commercial-of-the-shelf (COTS) directly to end users and the product unit price is determined by market-based pricing. The vendor's major customer is the end-user community (e.g. first responders) as well as various private sector markets.

Why is there a need for commercialization? As previously mentioned, DHS requirements, in most instances are characterized by the need for widely distributed COTS products. Oftentimes, the need is for thousands, if not millions of products for DHS' seven operating components and the fragmented, yet substantial first responder end-user market. Figure 2 shows the major differences between a "pure" Acquisition versus "pure" commercialization processes, along with the recently developed and implemented DHS "hybrid" commercialization process.

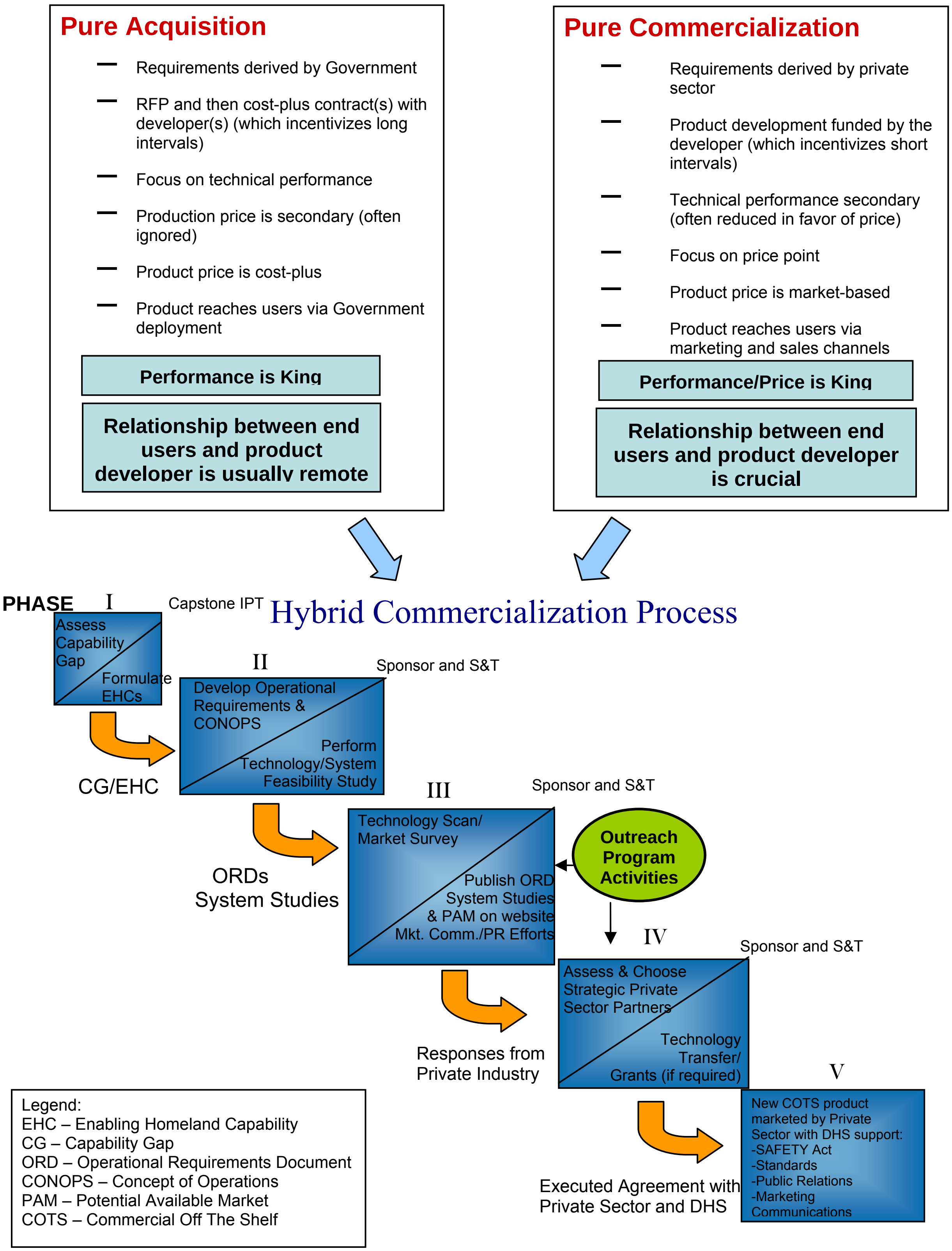


Figure 2: Comparison of “Pure Acquisition” versus “Pure Commercialization” models for product/system development and the resultant hybrid model implemented by DHS.

Figure 3 delineates the overall description of DHS' new commercialization model and its first private sector outreach program called the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program to develop products and services in a private-public "win-win" partnership, recently approved in June 2008 by DHS and described in detail at www.dhs.gov/xres/programs/gc_1211996620526.shtm. Briefly, the SECURE Program is based on the premise that the private sector has shown that it is willing and able to use its own money, resources, expertise and commercialization experience to develop and produce fully developed products and services for DHS if significant market potential exists. The private sector has shown remarkable interest in devoting its time and money to such activities if and when an attractive business case can be made related to large revenue/profit opportunities that certainly exist at DHS and its ancillary markets to participate in the advancement of DHS commercialization efforts. The private sector requires two things from DHS: 1. detailed operational requirements, and 2. a conservative estimate of the potential available market(s). Once this information is posted to the SECURE Program website, small, medium and large companies are open to generate their own business cases and pursue possible participation in the program.

A New Model for Commercialization…

- Develop Operational Requirements Documents (ORDs)
- Assess addressable market(s)
- Publish ORD and market assessment on public DHS web portal, solicit interest from potential partners in a way that is open to small, medium and large businesses
- Execute no-cost (CRADA-like) agreement with multiple private sector entities and transfer technology and/or IP(if necessary)
- Develop supporting grants and standards as necessary
- Assess T&E findings after product is developed to assure DHS and ancillary markets that product meet its published specifications
- New Commercial-Off-The-Shelf (COTS) product marketed by private sector with DHS support

SECURE Program

- Application – Seeking products/technologies aligned with posted DHS requirements
- Selection – Products/Technologies TRL-5 or above, scored with internal DHS metrics
- Agreement – One-page CRADA-like document that outlines milestones and exit criteria
- Publication of Results – Recognized third-party T&E conducted on TRL-9 product/service. Results verified by DHS, posted on DHS web-portal to provide confidence to potential customers at DHS and its ancillary markets that product(s) meet or exceed their published specifications in reference to their actual performance.

Figure 3: Step-by-step guide to the commercialization process developed and adopted by DHS with a brief summary of the popular SECURE Program.

In order to provide DHS operating components, the first responder community and other end-users with products that meet their specific requirements, the SECURE program provides a vehicle by which private sector entities can offer products and/or conduct product development geared specifically toward meeting those needs. Private sector entities currently possessing a technology/product/system rated at a Technology Readiness Level TRL-5 (i.e. applied or advanced R&D) or above that potentially closes a defined DHS capability gap by addressing detailed operational requirements supplied by DHS-S&T on the SECURE Program website will have the opportunity enter into a CRADA-like agreement to continue development of their technology/product/system to TRL-9 (i.e. fully field deployable product) at their expense. The CRADA-like agreement also provides private sector entities with the assurance that DHS-S&T will verify their recognized independent third-party test(s) of a given technology/product/system. A Cooperative Research and Development Agreement (CRADA) is a written agreement between a private company and a government agency to work together on a project[8].

Stage Four: Product Development

After DHS determines whether the Acquisition or the Commercialization process is appropriate, the fourth stage commences and the system prototype is demonstrated in an operational environment. S&T and the end user/customer have begun to develop a final transition plan and updates have been made to the operational and/or functional requirements document. Interoperability has been demonstrated and Management Directives (MD) have been reviewed to assure compliance. An operations and maintenance manual has been completed and a security manual has been developed.

Since the technology has been proven to work in its final form and under expected conditions, TRL 8 represents the end of true system development. Technology components are therefore form, fit, and function compatible with an operational system. The operational test report has been completed and a Limited User Test (LUT) Plan has been developed. A training plan has also been developed and implemented.

The actual system is then proven through successful mission operations and the end user fully demonstrates the technology in the CONOPS. All critical documentation has been completed and planning is underway for the integration of the next generation technology into the existing program components.

During the last stage, the private sector focuses on the manufacturing plan and the development effort includes the final design reviews, product prototypes along with documented product test results and other product development deliverables. Sales/Marketing update the marketing plan, the sales and distribution plan, and all sales

[8]For more information on CRADAs, please visit: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=browse_usc&docid=Cite:+15USC3710a and http://www.usgs.gov/tech-transfer/what-crada.html.

materials. Manufacturing develops assembly and manufacturing procedures, designs and fabricates manufacturing tooling. Quality Assurances updates the Test Q/A plan and creates the quality plan. They also develop testing procedures, create test and fixture designs, perform reliability testing on the prototype and design and test the shipping container.

The goal of the private sector during the final stage is to demonstrate product manufacturing according to quality assurance standards while remaining within cost/schedule targets. The development effort concludes with a customer-adopted defect-free product, implemented engineering change orders and a final user's manual. Applications engineering and technical engineering support are then implemented. Sales/Marketing also provides sales training, creates a promotional plan and coordinates literature advertising and public relations. Manufacturing establishes the final manufacturing/assembly routines and procedures, the final manufacturing tooling, and the manufacturing document release and acceptance, then undertakes an analysis for future product cost reduction. Quality Assurance does the final QA and test pooling, prepares the final QA/test procedures, and compiles the manufacturing yield data.

Management reviews for both the public and private sector are required to ensure that the final exit criteria and deliverables are met. Since the actual system has been proven through successful mission operations, the product is then deployed to captive users or sold as COTS directly to end users.

Conclusion

The Commercialization Office has developed a number of processes, programs and tools to clearly articulate the needs of DHS. Outreach efforts are also critical and center on notifying the private sector about opportunities that exist for partnership and business development to address the needs of the Department. Therefore, we have developed a "Product Realization Chart" that serves as a useful guide to relate and correlate terminology used by both the public and private sector in order to develop and deliver required technologies/products that meet the specific operational requirements of the Department of Homeland Security's operating components and its end users such as first responders.

Thomas A. Cellucci, Ph.D., MBA is the U.S. Department of Homeland Security's first Chief Commercialization Officer. In his role, he recently published two comprehensive guides: *Requirements Development Guide* and *Developing Operational Requirements* to aid in effective requirements development and communication for the department. He possesses extensive experience as a scientist and senior executive and Board Member in high-technology firms in the private sector.

Appendix D: Commercialization: It’s Not Business as Usual at DHS S&T (Article)

Commercialization: It’s Not business as usual at USDHS

Robert R. Hooks and Thomas A. Cellucci, U.S. Department of Homeland Security: Science and Technology Directorate, Washington D.C. 20528

Introduction:

The U.S. Department of Homeland Security (DHS) is comprised of many organizational elements with a single purpose: to enable, support and expedite the mission critical objectives of DHS’ seven operating components – Transportation Security Administration (TSA), U.S. Customs and Border Patrol (CBP), U.S. Secret Service, (USSS), U.S. Citizenship and Immigration Service (USCIS), U.S. Immigration and Customs Enforcement (ICE), Federal Emergency Management Agency (FEMA), and the U.S. Coast Guard (USCG).

In these unprecedented times, there is an immediate need for DHS to provide these operating components with the products and services they require, using efficient and cost-effective product development methods. DHS is working proactively to attract the private sector to develop, produce, test and evaluate products that meet the requirements of DHS operating components and first responders.

Why would the private sector be inclined to develop products at their own expense? This initiative’s high probability for success lies in the following principles and guidelines:

1. DHS operating components determine clearly-defined capability gaps and operational requirements that can be addressed effectively with Commercial-Off-The-Shelf (COTS) items.
2. The private sector wants access to large potential available markets (PAMs) that comprise the DHS operating components and ancillary markets as it enables a presumably strong business opportunity.
3. Taxpayer cost savings will be realized by the “win-win” private-public sector partnership. Figures 2 and 3 respectively outline a market potential template and private sector outreach process of the critical elements to attract the private sector’s interest in partnering with DHS.

“Win-Win” Strategic Partnerships

One often-overlooked vehicle to cost-effectively and efficiently commercialize technology is the formation of a win-win strategic partnership. The relationship between the public and the private sectors can be mutually beneficial in many ways, as each has something of value that the other desires. DHS has substantial potential available markets and direct access to the operating requirement of its large “customer base” as well as detailed information on the unmet needs and wants of ancillary market customers found in state, local and tribal communities.

Requirements development is one of the cornerstones of the commercialization process. DHS’ Science & Technology Directorate (S&T) develops clear, detailed operational requirements documents (ORDs) and intends to publish them on what would be a public web portal accessible by the private sector entities who believe they have the ability to meet those published requirements. Further benefits that DHS has to offer private sector entities come in the form of grants and Small Business Innovative Research (SBIR) programs.

Conversely, the private sector has skills, expertise, capital, established sales channels and the integrated marketing programs necessary to produce and distribute technically advanced products. The private sector appreciates a conservative estimate of the potential available markets within DHS operating component and/or ancillary markets, as well as clear, detailed operational requirements. With these two items in hand, the private sector can verify supplied estimates and generate business cases to determine if it is feasible to conduct research and development to develop and distribute products or services. This relationship enables substantial benefits given the ever-changing nature of the needs of established and potential new security applications. The private sector will need to continue its innovation as DHS adjusts to address new, emerging threats.

Synchronization:

The execution of a radically different methodology to develop, produce and distribute new products for use by DHS operating components does not come without its challenges. For many years, the U.S. government was indoctrinated and accustomed to the acquisition process of commissioning a custom-made product or service to perform a specific objective. The government would oversee the creation of the requirements, concept and technology development, system capability development, testing and evaluation, and production and deployment – paying for each step of the process. The concept of transferring responsibility of many of the steps in the process to the private sector ultimately removes control by the government. Not only is this a new way of thinking about developing and procuring products, it necessitates clear and precise communications between the public and private sectors.

In its new commercialization model, S&T acts as a facilitator between its customers, DHS' operating components and ancillary markets, and the private sector entities potentially developing products. S&T must work with its valued customers in the creation of ORDs as well as conduct market surveys and technology scans to ensure that needed technical capabilities and/or products exist within firms accessible for distribution of these ORDs. Oftentimes, private sector entities have products in development that are closely aligned with current homeland security capability gaps. In these situations, it is important to determine the exact level of development for the product.

As previously stated, clear and precise communications are paramount. To that end, the lexicon of product development was different in the public versus private sectors (see figure 4). Notice that DHS utilizes Basic Research, Innovation, and Transition nomenclature with Technology Readiness Levels as a "backbone" language, while the private sector utilizes Science, Technology Development, and then Product Development as the phases of developing a product from a concept. In order to ensure effective communications, the Technology Readiness Levels (TRL) model is used to standardize communication for all parties involved (see Figure 5). With the TRL system in use, all parties are able to assess quickly the development stage of a given product and determine an anticipated timeline for product deployment.

Open and Fair Competition leads to Cooperative New Product Development:

Once DHS has fulfilled its obligation to create realistic ORDs, conducts technology scans and market surveys to ensure that capabilities exist, the department would then post pertinent requirement information on the proposed publicly available, open access website. This web portal would be the vehicle by which private sector entities can engage DHS to find capability gaps for which solutions exist or can be produced quickly and efficiently. Given this information, private sector entities could to develop or enhance a given product or service in cooperation with S&T to enable or improve upon currently fielded DHS solutions. Close alignment with the detailed requirements are critical in this process.

In theory, in order for a company to be considered by S&T for cooperative development, it should be able to:

1. Demonstrate they possess technology at TRL-5 (i.e. applied or advanced R&D) or above and possess the resources to invest in the commercialization of its technology to TRL-9 (i.e. fully field deployable product);
2. Propose a technology development effort that has clear and substantial alignment with published S&T requirements; and

A simple, straightforward and binding agreement could then be executed whereby the private sector entity will detail milestones with dates to develop its technology to a TRL-9 state (if not already at that level). Once the private sector entity has successfully achieved TRL-9, it will perform independent third-party testing and evaluation (T&E) on the product to ensure it meets all required previously agreed-upon specifications. S&T then would review and evaluate the accuracy of the third-party T&E and publish its factual findings on the proposed Web site. The free market system should yield several companies producing similar products as is often seen in commercial markets. DHS customers and ancillary markets stand to benefit from this system.

Measurable Results:

The ultimate goal of any commercialization initiative is to produce products that are better, faster and less expensive compared to what is currently on the market. S&T hopes to leverage the private sector’s endless pursuit of this idea and marry it with the vast demands created by an organization whose mission is to protect a nation. S&T has a critical role acting as the facilitator between sets of markets and a willing and able private sector looking for large, stable markets to purchase and use advanced technologies. A program like this should result in a demonstrable increase in the quality and quantity of technologies, products and services to assist not only DHS in carrying out its mission objectives, but customers engaged in many other related security applications. It is indeed expected that taxpayers will observe a significant and demonstrative increase in the amount of private sector funding used for the timely development of new and reliable products to help thwart the threat of terrorism.

Conclusion:

The U.S. Department of Homeland Security Science & Technology Directorate is forging a new paradigm that can have far-reaching positive consequences for its customers, private sector partners, and U.S. taxpayers through the rapid, cost-effective and efficient development and deployment of products and services to protect the United States. The relatively recent formation of DHS (its fifth anniversary was on March 1, 2008) is advantageous in many ways, particularly in that it enables flexible and forward thinking in its long-term goals and processes. Our commercialization initiatives are a groundbreaking and innovative approach to foster a mutually beneficial relationship between the public and private sectors, both of whom stand to benefit greatly from this new partnership created in open and free competition. The future of this initiative looks bright; we have already experienced an overwhelmingly positive response to the initial private sector outreach. S&T will continue to monitor and measure the benefit this program stands to provide.

Acknowledgements:
The authors would like to express their sincere appreciation for all of the valuable assistance by Mr. Mark P. Protacio in the preparation of the materials used in this paper.

Robert R. Hooks is the Director of Transition at the U.S. Department of Homeland Security's Science and Technology Directorate (DHS S&T) in Washington, D.C. and recently accepted the position of Deputy Assistant Secretary of Weapons of Mass Destruction and BioDefense of the DHS Office of Health Affairs in Washington, D.C.

Thomas A. Cellucci, Ph.D., MBA is currently the Science & Technology Directorate's first Chief Commercialization Officer in Washington, D.C. He has spent the vast majority of his career as a senior executive and board member in high technology firms in the private sector.

FIGURES

Fig. 1: Capstone IPT Process

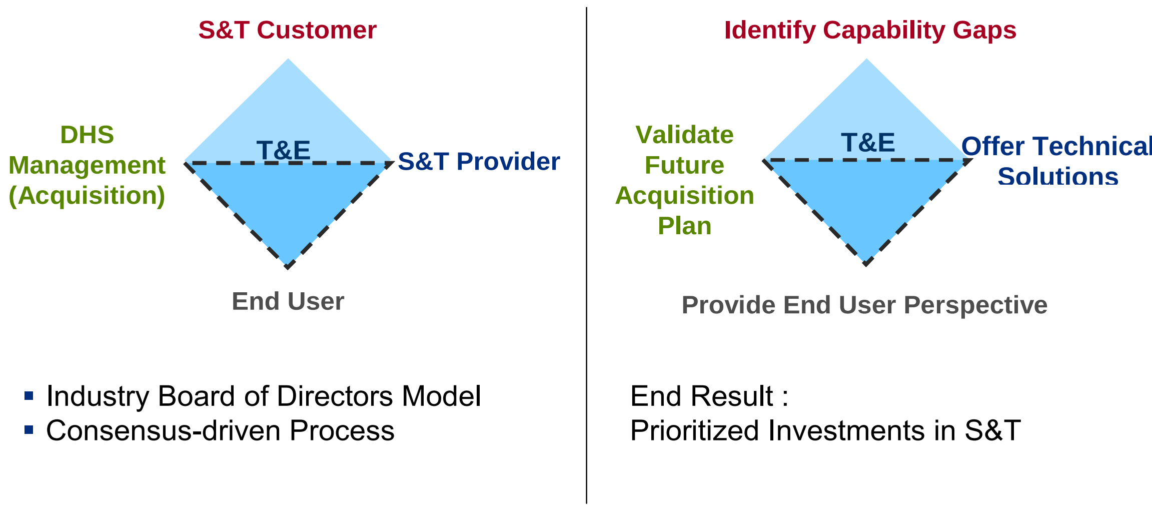


Fig.1 – This graphical representation shows the Capstone IPT (Integrated Product Team) process implemented at S&T that enables all stakeholders to participate actively in identifying and discussing the *Capability Gaps* germane to a specific functional area, such as people screening. S&T works with its customers, pertinent end-users and DHS organizational entities to delineate operational requirements to start a process to close identified capability gaps.

Fig. 2: Market Potential Template

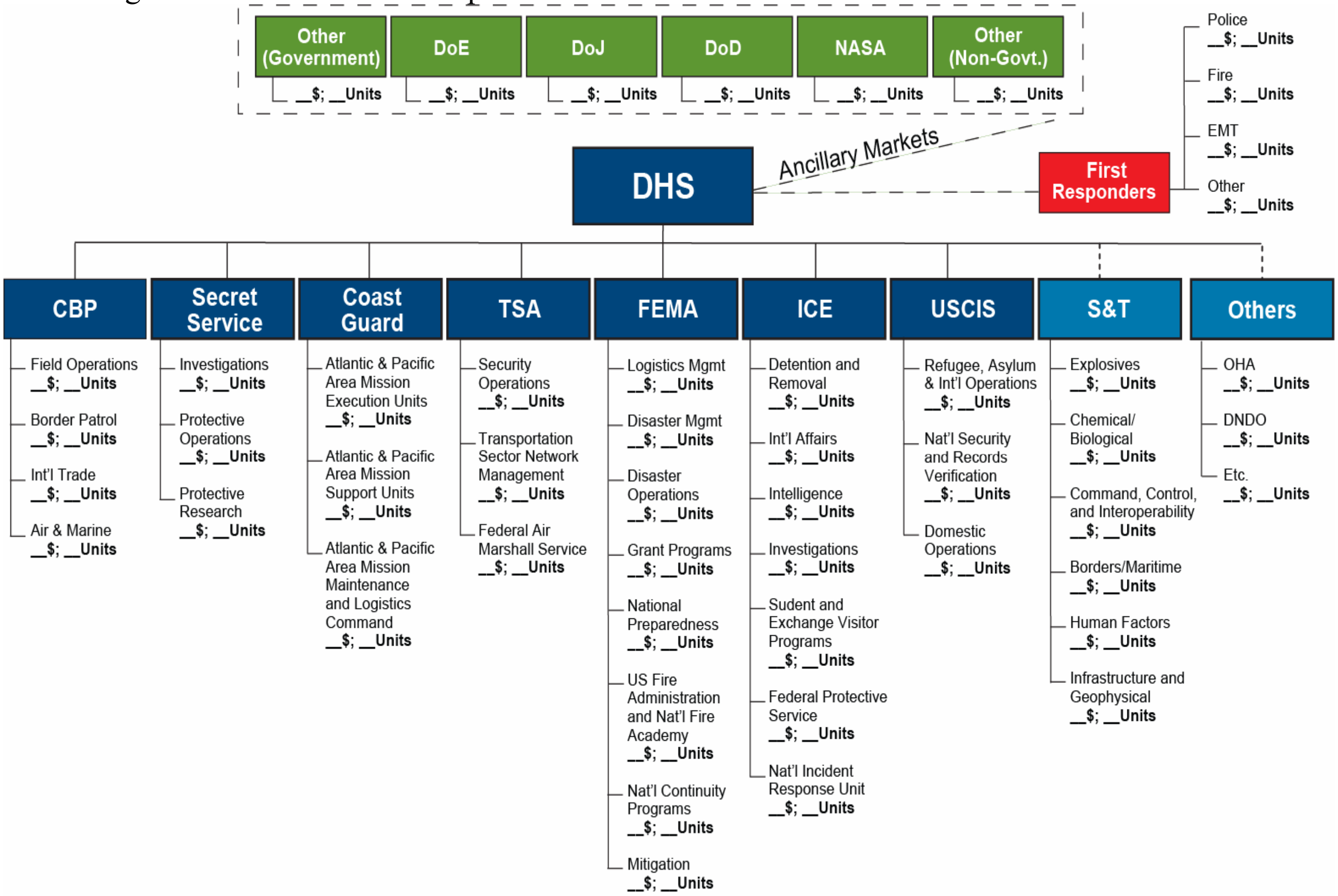


Fig. 2 – This graphic shows a market potential template used to conservatively estimate the DHS market segment by operating components, as well as demonstrate how DHS is a conduit to other large ancillary markets.

Fig. 3 Private Sector Outreach Process

Private Sector Outreach Process

Requirements Identification through Product Release

PHASES	Requirements Development	Market Assessment & Strategy	Open Competition	Product Development	Product Release, Marketing and/or Deployment
ACTIVITIES	• Prioritized capability gaps from Capstone IPTs • Identification of representatives of end users and end customers • Operational and technical requirements • Validation of price points • Technology Commercialization Agreement (TCA) between DHS S&T and its DHS customer • Project plan	• Market survey • Technology scan • Communications plan and implementation (public relations and marketing communications) • Technology Commercialization Plan (TCP) • Test and Evaluation Master Plan (TEMP) • Standards assessment and/or development by S&T • Grant program development by DHS customer	• CRADAs • BAAs • RFPs • RFQs • RFIs • MoUs / MoAs • Technology transfer licenses • OTAs • Influence the private sector	• New Product Development (NPD) process implemented by private sector partner(s) • Project reviews • Test and Evaluation	• Transition to manufacture • QC/QA • Deployment (to Federal users) or Marketing (to independent users) • Measure product effectiveness

Legend: Black text = Government activities
Blue Text = Private-sector activities

Fig.3 – The Private Sector Outreach Process outlines the steps and procedures undertaken to develop and deploy a product or service from capability gap identification to product deployment.

Fig. 4: Lexicon differences

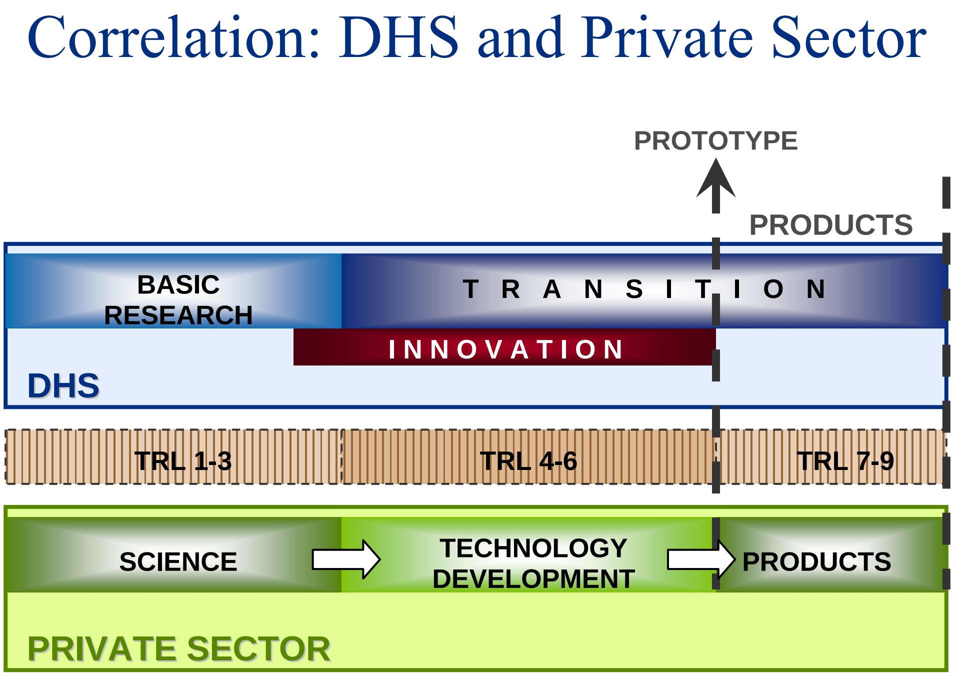


Fig. 4: This chart shows the correlation between the various nomenclatures to delineate differing levels of product development. The Technology Readiness Levels (TRL) serves as a standardized lexicon for enhanced communications.

TRLs are NASA-generated and Used Extensively by DoD

Fig. 5: Technology Readiness Levels

Fig. 5 – TRLs are used to assign a numerical value to a corresponding stage in a technology's development and maturity. This system of standardization is useful to communicate effectively between entities that may have used varying technology-maturity lexicons.

Basic principles observed and reported	1	Basic
Technology concept and/or application formulated	2	
Analytical and experimental critical function and/or characteristic	3	
Component and/or breadboard validation in laboratory environment	4	Advanced
Component and/or breadboard validation in relevant environment	5	
System/subsystem model or prototype demonstration in a relevant environment	6	Applied
System prototype demonstration in a operational environment	7	
Actual system completed and 'flight qualified' through test and demonstration	8	
Actual system 'flight proven' through successful mission operations	9	

Appendix E: Partnership Program Benefits Taxpayers, Private and Public Sectors (Article)

Partnership Program Benefits Taxpayers as well as Private and Public Sectors

SECURE Program enables the cost-effective and efficient development of products and services for Homeland Security.

Thomas A. Cellucci, Ph.D., MBA
Chief Commercialization Officer
Commercialization Office
U.S. Department of Homeland Security

A recently announced initiative at the U.S. Department of Homeland Security (DHS), called the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program is part of an overall effort at the Department to create a "Commercialization Mindset" by leveraging the fact that while DHS has a limited budget compared to the Department of Defense, it does have something much more valuable – a large potential available market comprised of the seven DHS operating components (USCIS, TSA, FEMA, CBP, ICE, U.S. Coast Guard and U.S. Secret Service) and other large ancillary markets such as the diverse, yet substantial first responder market.

The SECURE Program is based on the premise that the private sector has shown that it is willing and able to use its own money, resources, expertise and experience to develop and produce fully developed products and services for DHS. When an attractive business case can be made related to large revenue/profit opportunities, which certainly exist at DHS and its ancillary markets. The private sector requires two vital pieces of information from DHS: 1. detailed operational requirements, and 2. a conservative estimate of the potential available market(s). This information can then be used to generate a business case for possible private sector participation in a program or project.

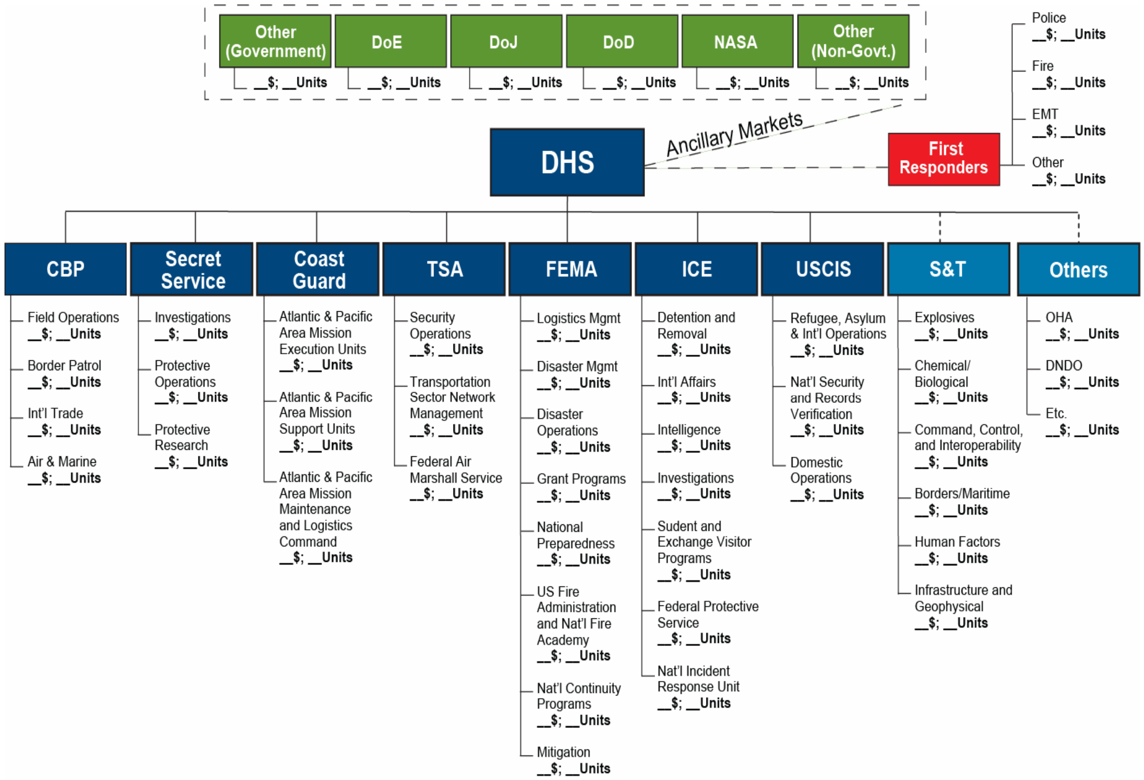


Figure 1: This Market Potential Template is used to estimate the given size of a particular market that DHS has identified as an area requiring new products or services.

This Market Potential Template is used to demonstrate how large (in both a dollar and unit volume perspective) a given market is for a particular product or service. Coupled with an Operational Requirements Document (ORD), the private sector receives ample information from DHS to generate a business case for developing a product or service sought after by DHS for its operating components or first responders, whose combined ranks are significant, as delineated in Figure 2.

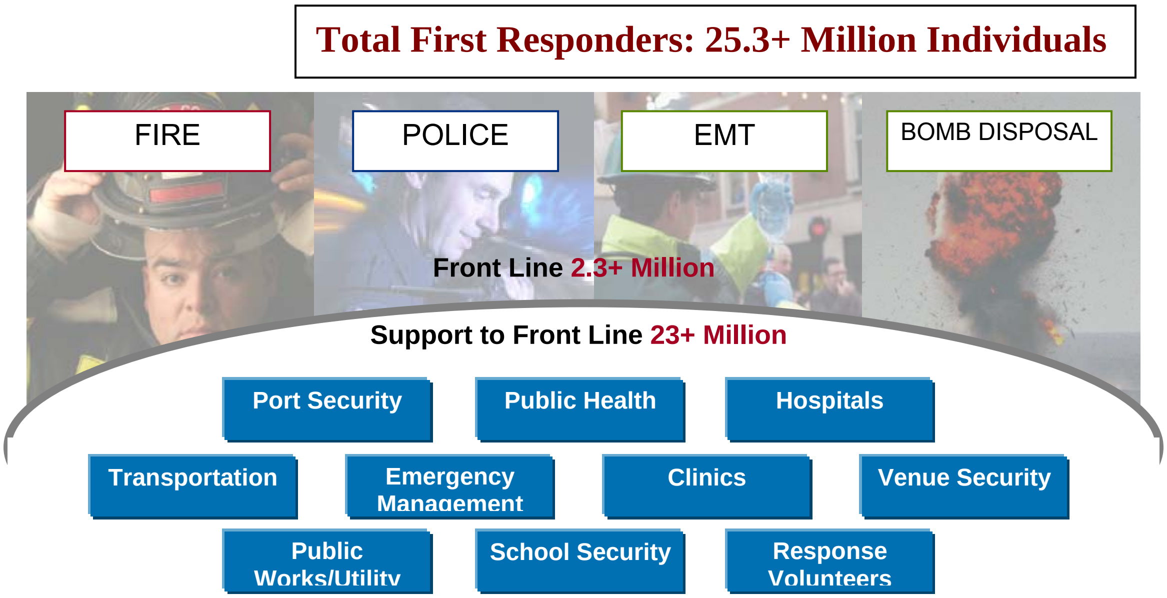
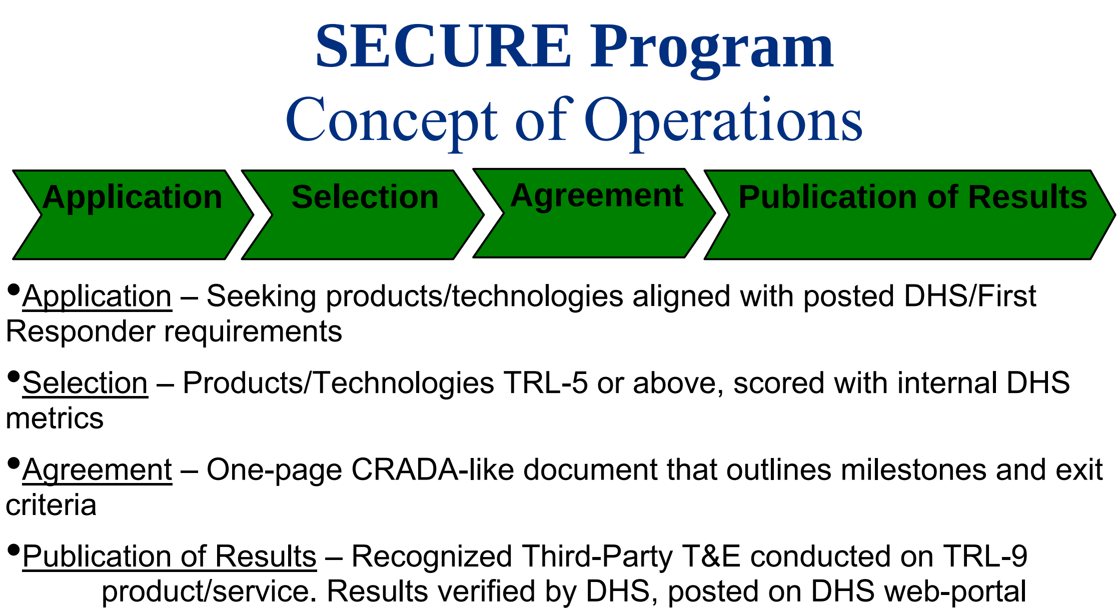


Figure 2: Homeland Security Presidential Directive Number 8 (HSPD-8) conservatively classifies 25.3+ million individuals as First Responders in the United States alone.

In return for providing this critical information, thus saving the private sector considerable time and money related to both market and business development activities, DHS expects the private sector to offer solutions – utilizing the free market system with open and fair competition – to meet published requirements. Simply stated, the private sector receives significant business opportunities, DHS and its supported entities, like the first responder communities, receive products and services developed at faster execution rates at the private sector's cost – all to the benefit of the American taxpayer. See Figure 3 for an overview and benefits analysis of the SECURE Program.



SECURE Program Benefit Analysis – "Win-Win-Win"		
Taxpayers	**Public Sector**	**Private Sector**
1. Citizens are better protected by DHS personnel using mission critical products	1. Improved understanding and communication of needs	1. Save significant time and money on market and business development activities
2. Tax savings realized through private sector investment in DHS	2. Cost-effective and rapid product development process saves resources	2. Firms can genuinely contribute to the security of the Nation
3. Positive economic growth for American economy	3. Monies can be allocated to perform greater number of essential tasks	3. Successful products share in the "imprimatur of DHS"; providing assurance that products really work.
4. Possible product "spin-offs" can aid other commercial markets	4. End users receive products aligned to specific needs	4. Significant business opportunities with sizeable DHS and DHS ancillary markets
5. Customers ultimately benefit from COTS produced within the Free Market System – more cost effective and efficient product development	5. End users can make informed purchasing decisions with tight budgets	5. Commercialization opportunities for small, medium and large business

Figure 3: Brief overview of the SECURE Program' Concept-of-Operations and a benefits analysis.

To learn more about the SECURE Program and other opportunities for the private sector, please visit http://www.dhs.gov/xres/programs/gc_1211996620526.shtm or contact the Commercialization Office at SandT_Commercialization@hq.dhs.gov.

Thomas A. Cellucci, Ph.D., MBA is the U.S. Department of Homeland Security's first Chief Commercialization Officer. In his role, he recently published two comprehensive guides: *Requirements Development Guide* and *Developing Operational Requirements* to aid in effective requirements development and communication for the department. He possesses extensive experience as a scientist and senior executive and Board Member in high-technology firms in the private sector.

Appendix F: Commercialization Briefing to Industry

The following pages include slides used in briefing the private sector on business opportunities with DHS and its stakeholders.

Slide 1

Opportunities for the Private Sector

Thomas A. Cellucci, Ph.D., MBA
Chief Commercialization Officer
Department of Homeland Security
Science and Technology
Email: Thomas.Cellucci@dhs.gov

Slide 2

Discussion Guide

- Overview of Department of Homeland Security
- Commercialization initiatives at DHS
- Capstone Integrated Product Teams (IPTs)
- Market Potential is Catalyst for Rapid New Product Development
- Getting on the Same Page
- SECURE Program
- Safety Act Protection
- Tech Clearing House
- SBIR Opportunities
- Getting Involved
- Summary

Homeland Security

Slide 3

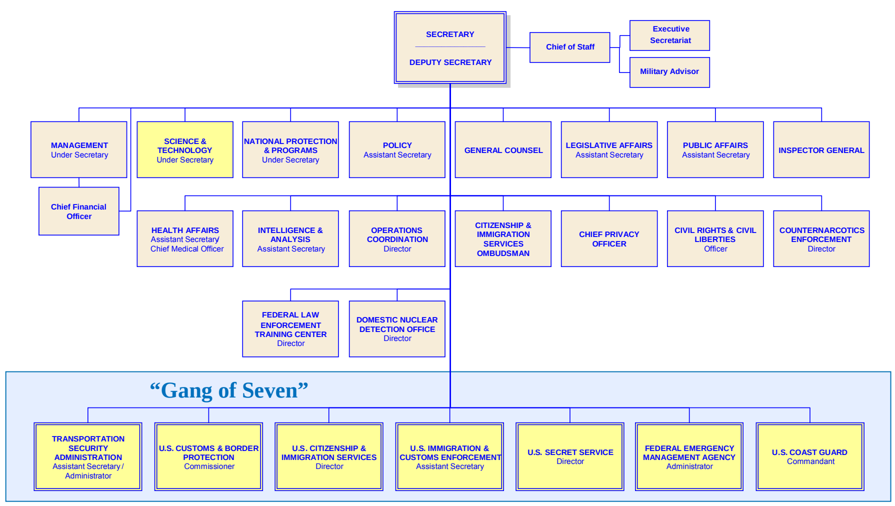
Homeland Security Mission

- Lead Unified National Effort to Secure America
- Prevent Terrorist Attacks Within the U.S.
- Respond to Threats and Hazards to the Nation
- Ensure Safe and Secure Borders
- Welcome Lawful Immigrants and Visitors
- Promote Free Flow of Commerce

Homeland Security

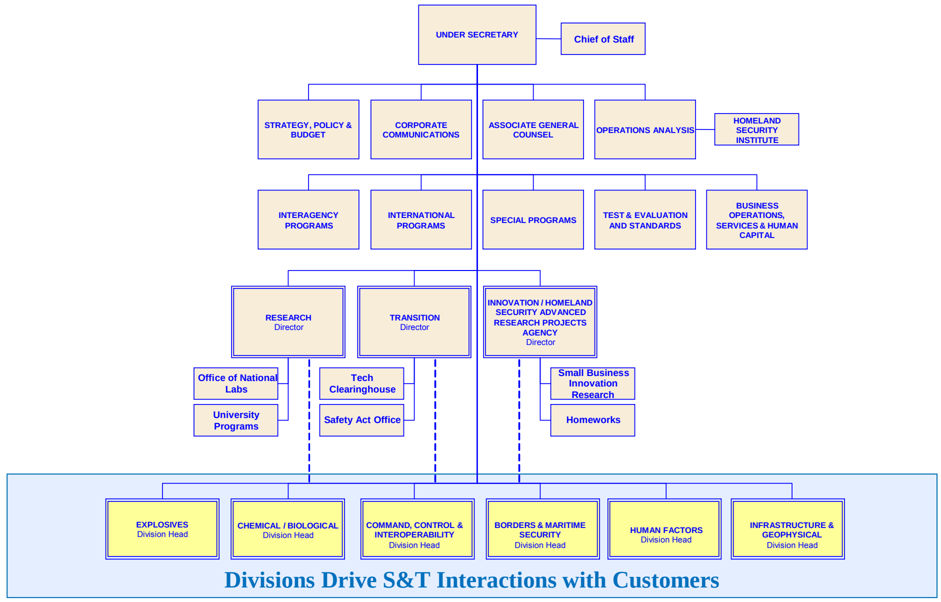
Slide 4

U.S. Department of Homeland Security



Slide 5

Office of the Under Secretary for Science and Technology



Slide 6

S&T Goals

Consistent with the Homeland Security Act of 2002

- **Accelerate the delivery of enhanced technological capabilities** to meet the requirements and fill capability gaps to support DHS agencies in accomplishing their mission.
- Establish a lean and agile world-class S&T management team to deliver the technological advantage necessary to ensure DHS Agency mission success and prevent technological surprise.
- Provide leadership, research and educational opportunities and resources to develop the necessary intellectual basis to enable a national S&T workforce to secure the homeland.

Homeland Security

Slide 7

DHS S&T Investment Portfolio

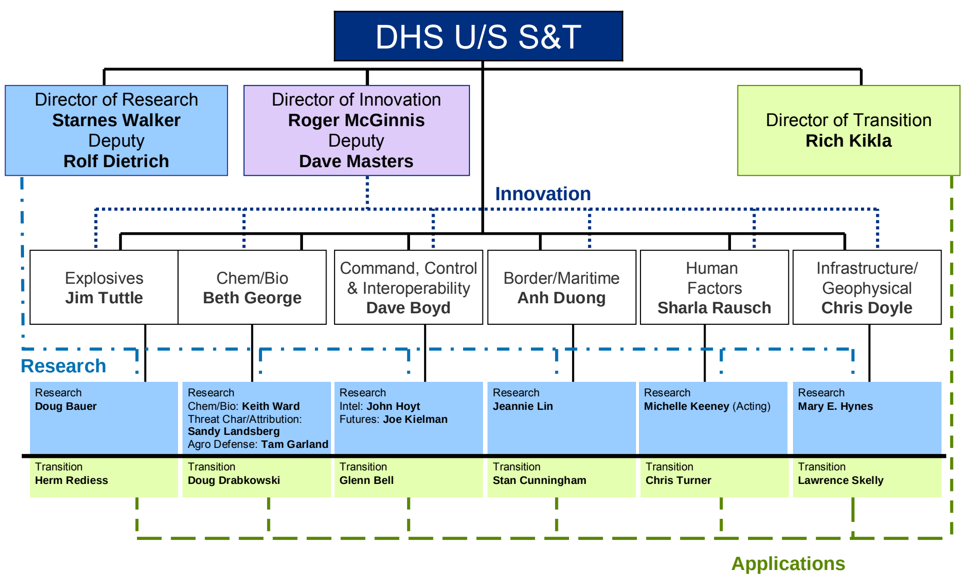
Balance of Risk, Cost, Impact, and Time to Delivery

Product Transition (0-3 yrs)	**Innovative Capabilities (1-5 yrs)**
• Focused on delivering near-term products/enhancements to acquisition • Customer IPT controlled • Cost, schedule, capability metrics	• High-risk/High payoff • “Game changer/Leap ahead” • Prototype, Test and Deploy • HSARPA
Basic Research (>8 yrs)	**Other (0-8+ yrs)**
• Enables future paradigm changes • University fundamental research • Gov’t lab discovery and invention	• Test & Evaluation and Standards • Laboratory Operations & Construction • Required by Administration (HSPDs) • Congressional direction/law

Customer Focused, Output Oriented

Slide 8

S&T Organization



Slide 9

Commercialization Office: Major Activities

Commercialization Office

Requirements Development Initiative

- •Requirements Development Book(s)
- •Operational Requirements Document Template
- •Training for end users and engineers

Commercialization Process

- •"Hybrid" Commercialization Model
- •Product Realization Chart
- •Commercialization Framework and "Mindset"

SECURE Program

- •Concept of Operations
- •Website Development
- •Internal processes developed and socialized
- •Requirements and Conservative Potential Market Available Estimates Communicated

Private Sector Outreach

- •Invited Speeches
- •Meetings with business executives
- •Numerous articles written and published regarding observations and programs in practice.
- •Repository of currently available products, services and/or technologies in the private sector aligned to Capstone IPT Capability Gaps

Homeland Security

Slide 10

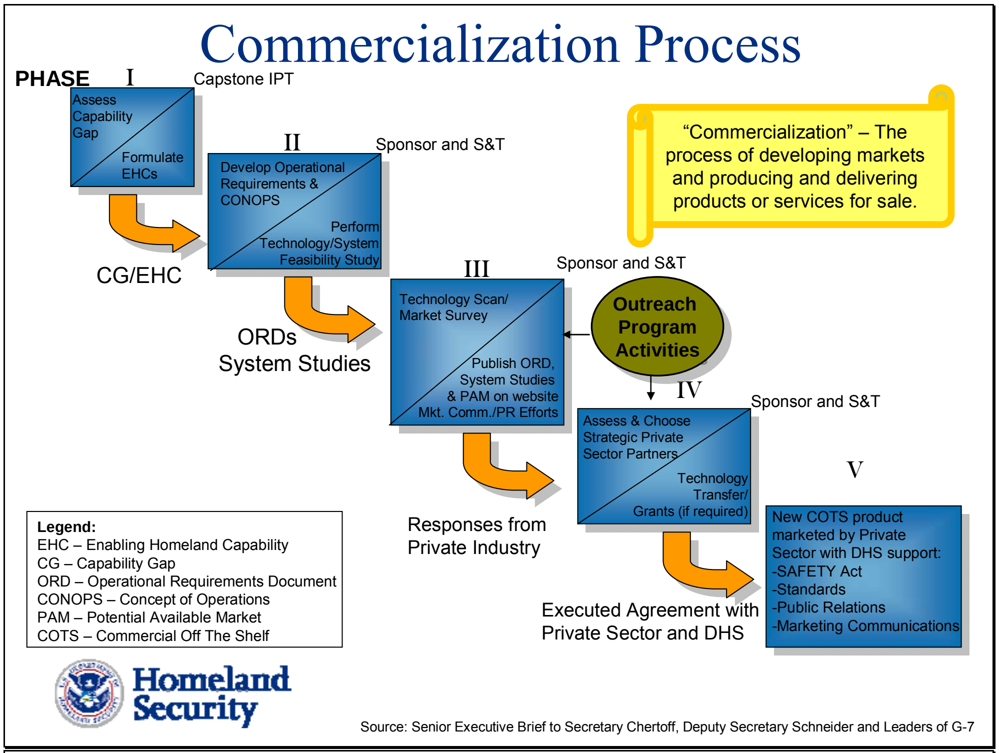
Three Step Approach:
Keep it Simple and Make it Easy

1 Develop Detailed Requirements And Relay Conservative Market Potential

2 Establish Strategic Partnerships
- Business Case Information
- Open Competition
- Detailed Mutual Responsibilities

3 Deliver Products!

Slide 11



Slide 12

10 Reasons to Partner with DHS Science & Technology

Reasons Color Legend:

Economics-based

Public Relations-based

Business Development-based

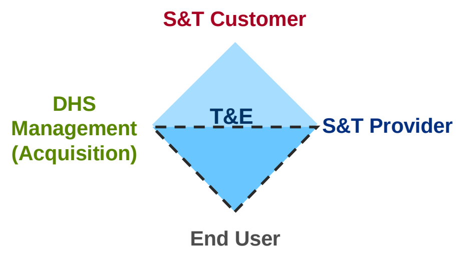
Strategic Marketing-based

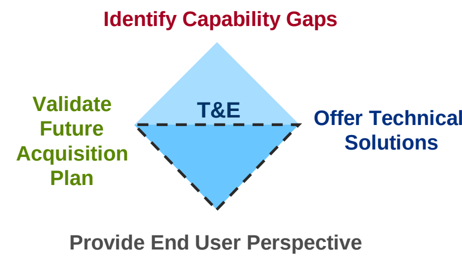
Technical Resources-based

1. Access to Sizeable DHS Market and Ancillary Markets
2. Leverage the Financial Strength/Stability of DHS and off-set R&D costs through participation in mutually beneficial cost-sharing Programs
3. Utilize the SAFETY Act to gain liability protection and access DHS' array of PR and Market Communications services
4. Effectively reach the First Responders Market through FEMA-sponsored grant programs, the AEL (Approved Equipment List), other sponsored equipment lists and fast-track programs
5. Team with Science & Technology Personnel to leverage a vast Network of Laboratory Facilities for Technology and Product Development
6. Gain access to Test and Evaluation (T&E) Facilities for Product Development and actively participate in the generation of Standards, T&E methods and Regulations used at the tribal, local, state, and federal levels
7. Meet and establish Partnerships with others in the University, Business, and National Lab Communities
8. Potentially generate Licensing revenue and capture potential Derivative Product revenue
9. Leverage SBIRs, HITS and HIPS to gain experience with homeland security applications
10. Make a Real Difference by Developing Products to Defend the Homeland for Generations to come as well as gain recognition as a Corporate Citizen contributing to the Security of our Homeland

Slide 13

S&T Transition Capstone IPTs Members and Function





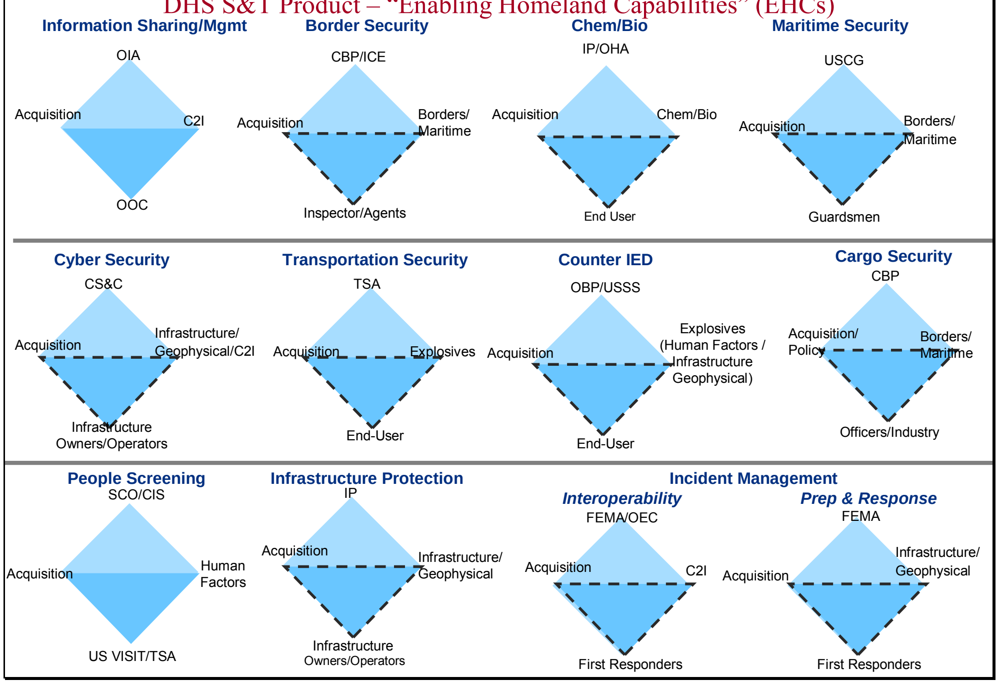
- Industry Board of Directors Model
- Consensus-driven Process

End Result :
Prioritized Investments in S&T

Slide 14

DHS Requirements/Capability Capstone IPTs

DHS S&T Product – "Enabling Homeland Capabilities" (EHCs)



Slide 15

Cargo Security

Representative Technology Needs

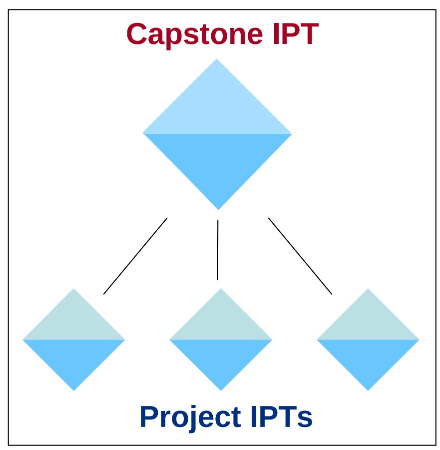
- Enhanced screening and examination by non-intrusive inspection
- Increased information fusion, anomaly detection, Automatic Target Recognition capability
- Detect and identify WMD materials and contraband
- Capability to screen 100% of air cargo
- Test the feasibility of seal security; detection of intrusion
- Track domestic high-threat cargo
- Harden air cargo conveyances and containers
- Positive ID of cargo and detection of intrusion or unauthorized access

Source: S&T High Priority Technology Needs, May 2007

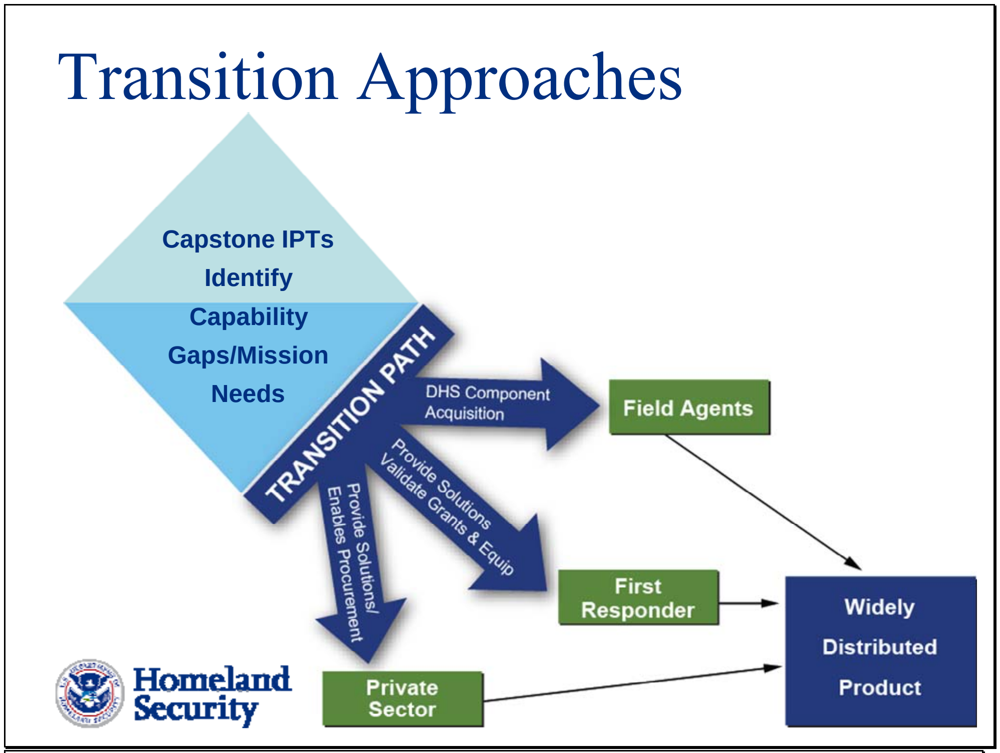
Slide 16

Establishment of Project IPTs: Detailed Specifications/Requirements

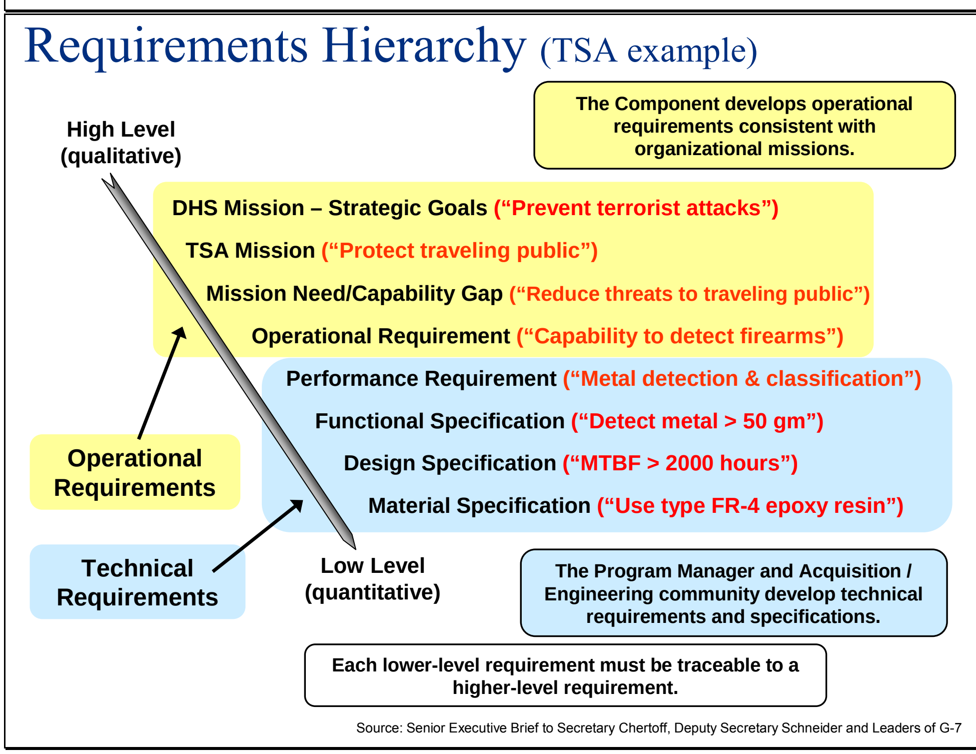
- Members:
  - S&T Program Manager(s)
  - Operating Component's Program Manager(s)
  - End-User(s)
  - Supplier/Provider
- Meet at Least Monthly
- Report to Capstone IPT Quarterly



Slide 17



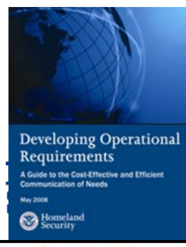
Slide 18

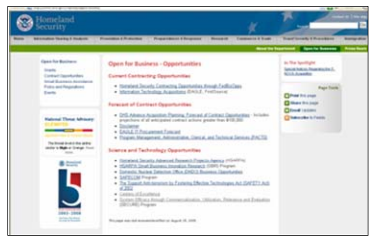


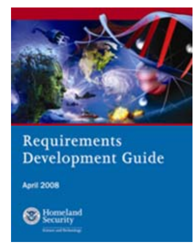
Slide 19

ORD: Operational Requirements Document

- ***What:*** ORDs provide a clear definition and articulation of a given problem.
- ***How:*** Training materials have been developed to assist drafting an ORD.
  - *Developing Operational Requirements,* 194pp. Available online: http://www.dhs.gov/xlibrary/assets/Developing_Operational_Requirements_Guides.pdf
- ***When:*** For Use in Acquisition, Procurement, Commercialization and Outreach Programs –Any situation that dictates detailed requirements (e.g. RFQ, BAA, RFP, RFI, etc.)
- ***Why:*** It's cost-effective and efficient for both DHS and all of its stakeholders.

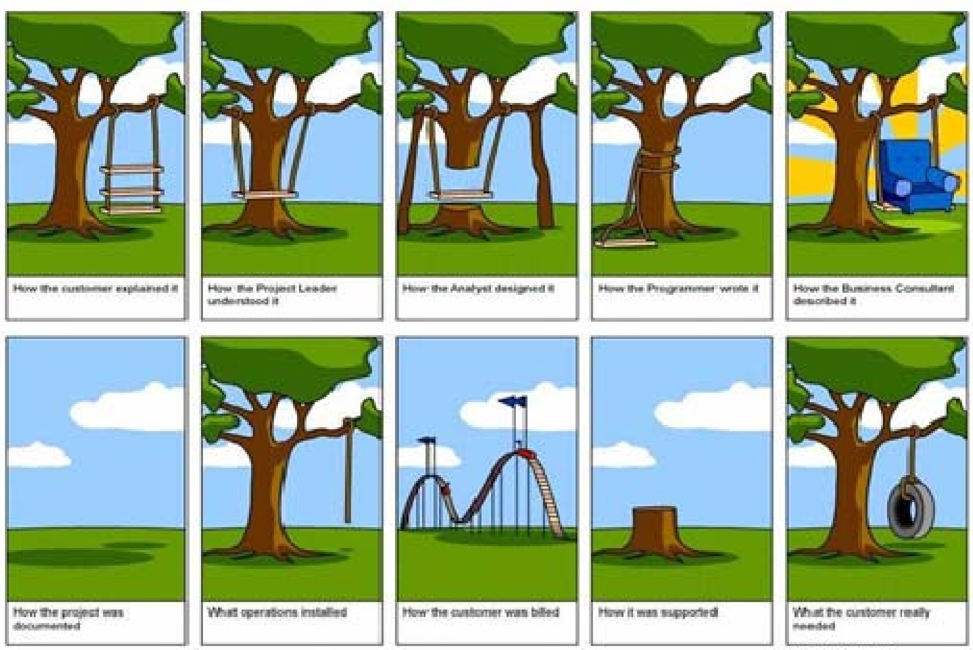






Slide 20

Does this look familiar?!



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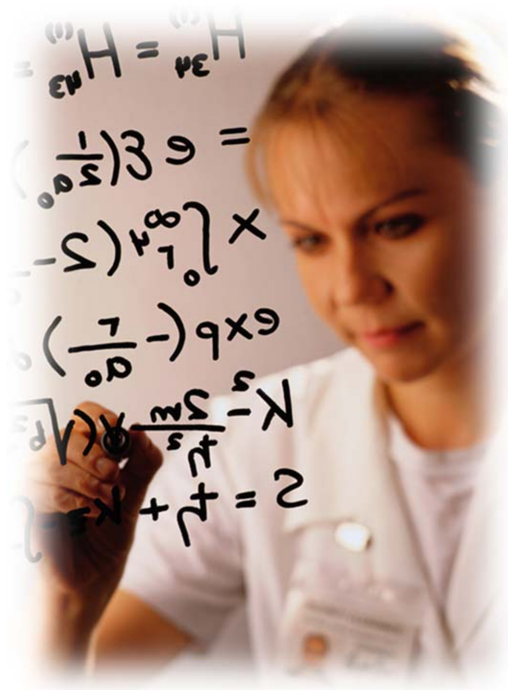
Slide 21

Getting on the "Same Page"

- Historical Perspective
- Language is Key
- Communication is Paramount



Slide 22

Technology Readiness Levels (TRLs): Overview

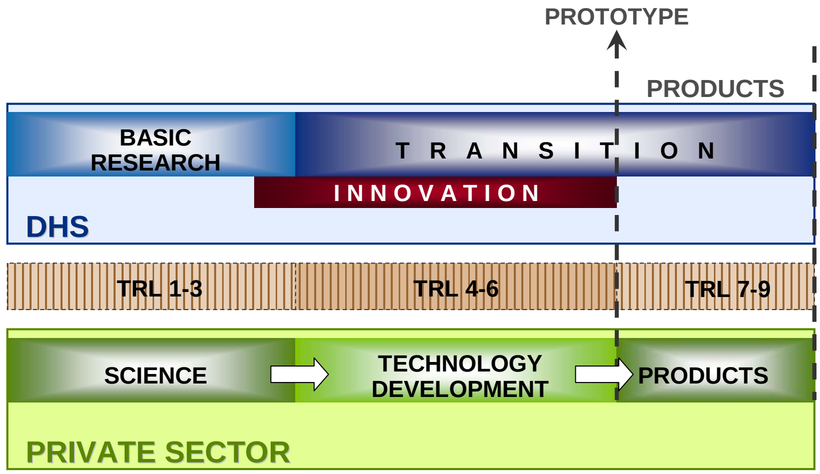
TRLs are NASA-generated and Used Extensively by DoD

Basic principles observed and reported	1	Basic
Technology concept and/or application formulated	2	
Analytical and experimental critical function and/or characteristic	3	
Component and/or breadboard validation in laboratory environment	4	Advanced
Component and/or breadboard validation in relevant environment	5	
System/subsystem model or prototype demonstration in a relevant environment	6	Applied
System prototype demonstration in a operational environment	7	
Actual system completed and 'flight qualified' through test and demonstration	8	
Actual system 'flight proven' through successful mission operations	9	

TECHNOLOGY MATURITY

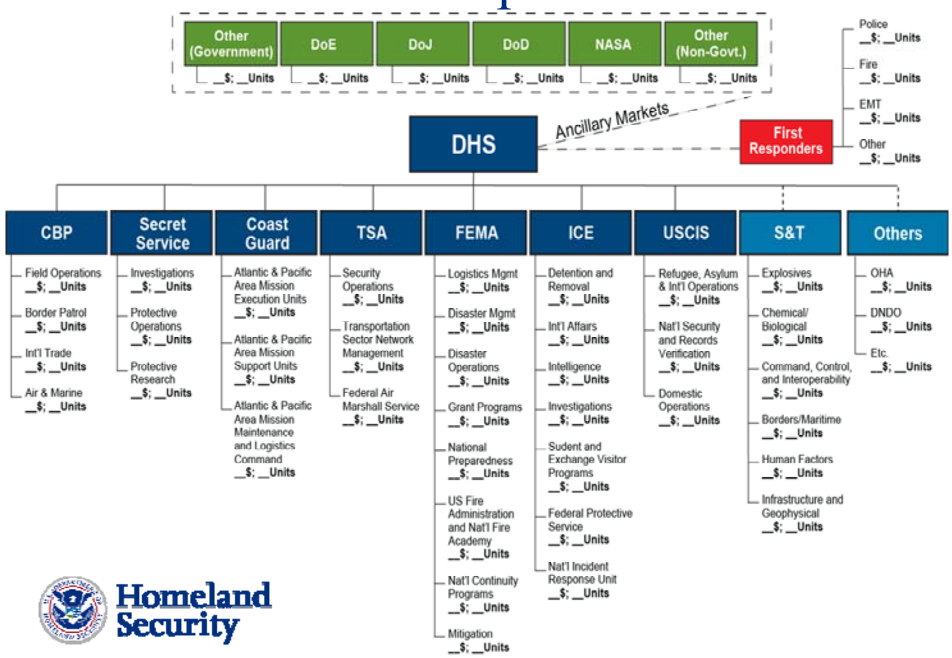
Slide 23

TRL Correlation: DHS and Private Sector



Slide 24

Market Potential Template

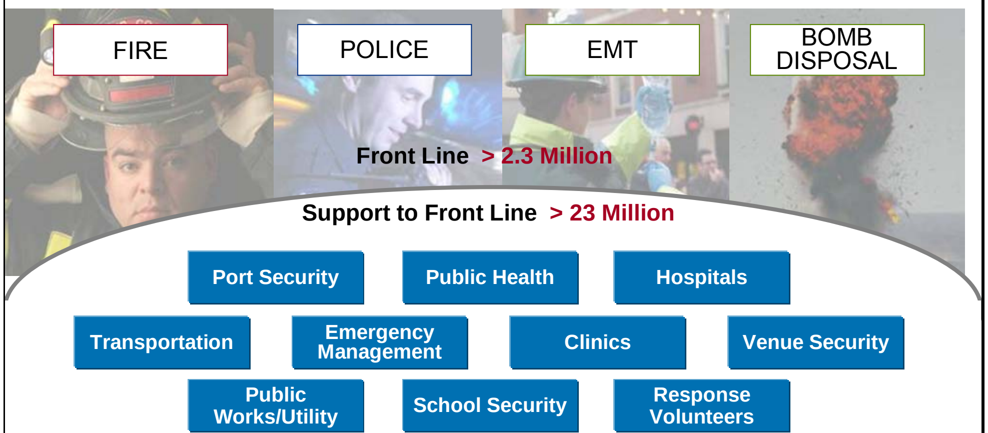


Slide 25

Conservative Estimate: Number of First Responders in the US

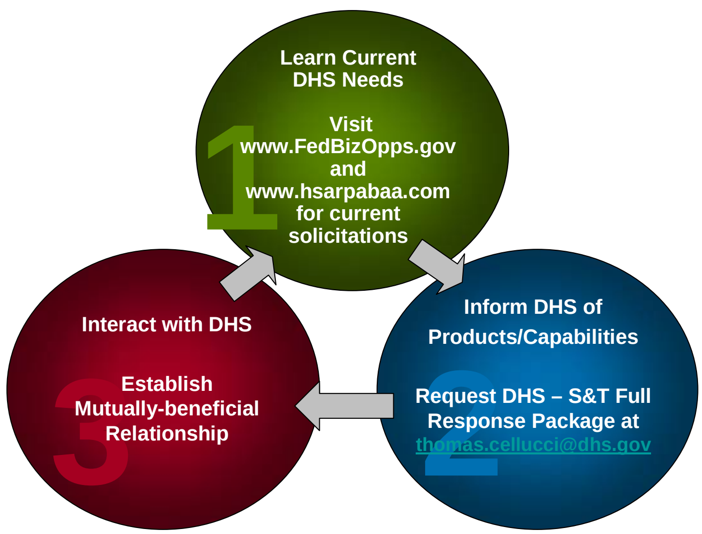
- Homeland Security Presidential Directive 8
- Steve Golubic (FEMA)

Total: > 25.3 Million Individuals



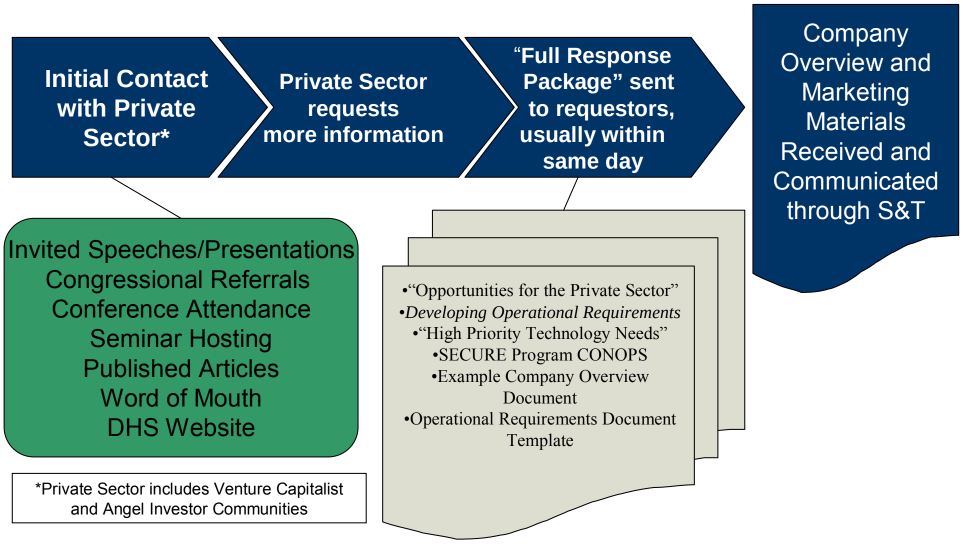
Slide 26

Call to Action: Mutual Benefits Create "Win-Win-Win" Relationships



Slide 27

Contact with the Private Sector



Homeland Security

Slide 28

SECURE Program
Concept of Operations

•Application – Seeking products/technologies aligned with posted DHS requirements

•Selection – Products/Technologies TRL-5 or above, scored on internal DHS metrics

•Agreement – One-page CRADA-like document. Outlines milestones and exit criteria

•Publication of Results – Independent Third-Party T&E conducted on TRL-9 product/service. Results verified by DHS, posted on DHS web-portal

Benefits:
•Successful products/technologies share in the imprimatur of DHS
•DHS Operating Components and First Responders make informed decisions on products/technologies aligned to their stated requirements
•DHS spends less on acquisition programs → Taxpayers win.

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SECURE Program
Benefit Analysis "Win-Win-Win"

Taxpayers	Private Sector	Public Sector
1. Citizens are better protected by DHS personnel using mission critical products	1.Save significant time and money on market and business development activities	1. Improved understanding and communication of needs
2. Tax savings realized through Private Sector investment in DHS	2. Firms can genuinely contribute to the security of the Nation	2. Cost-effective and rapid product development process saves resources
3. Positive economic growth for American economy	3. Successful products share in the "imprimatur of DHS"; providing assurance that products really work	3. Monies can be allocated to perform greater number of essential tasks
4. Possible product "spin-offs" can aid other commercial markets	4. Significant business opportunities with sizeable DHS and DHS ancillary markets	4. End users receive products aligned to specific needs
5. Customers ultimately benefit from COTS produced within the Free Market System – more cost effective and efficient product development	5. Commercialization opportunities for small, medium and large business	5. End users can make informed purchasing decisions with tight budgets

Slide 30

Slide 31

Federal Business Opportunities

Sites where the Office of Procurement Operations (OPO) posts opportunities for prospective suppliers to offer solutions to DHS – S&T's needs:

- www.FedBizOpps.gov
- www.HSARPAbaa.com
- www.SBIR.dhs.gov
- www.Grants.gov

take advantage of...

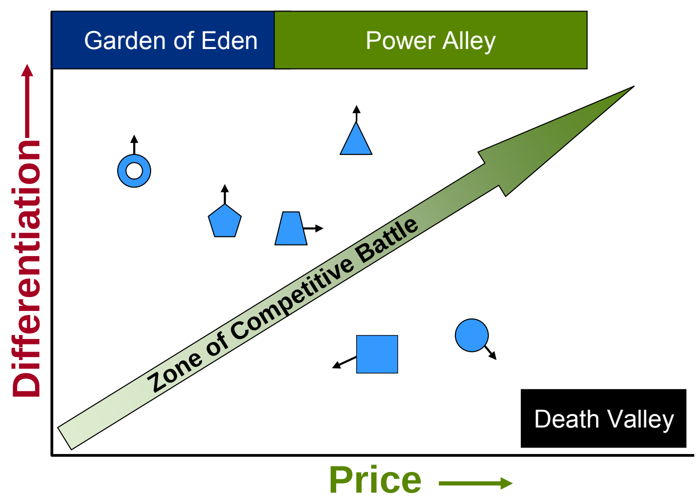
- **Vendor Notification Service:** Sign up to receive procurement announcements and solicitations/BAA amendment releases, and general procurement announcements. http://www.fedbizopps.gov
- **S&T's HSARPA website:** Register to join the HSARPA mailing list to receive various meeting and solicitation announcements. Link to Representative High Priority Technology Areas, where DHS areas of interest can be found. http://www.hsarpabaa.com
- **Truly Innovative and Unique Solution**: Refer to Part 15.6 of the Federal Acquisition Regulation (FAR) which provides specific criteria that must be met before a unsolicited proposal can be submitted to Kathy Ferrell. http://www.acquisition.gov/far/current/html/Subpart%2015_6.html

Contact Information:
Kathy Ferrell
Department of Homeland Security
Office of the Chief Procurement Officer
245 Murray Dr., Bldg. 410
Washington, DC 20528
unsolicited.proposal@dhs.gov
202-447-5576

Slide 32

Show Us the Difference…

Hall's Competitive Model



As a function of:
- Market
- Application
- Technology

Differentiation = (A+B)C/(D+E)

Slide 33

More Opportunities with DHS Science and Technology

Slide 34

SAFETY Act

Support Anti-Terrorism by Fostering Effective Technologies Act of 2002

- Enables the development and deployment of qualified anti-terrorism technologies
- Provides important legal liability protections for manufacturers and sellers of effective technologies
- Removes barriers to industry investments in new and unique technologies
- Creates market incentives for industry to invest in measures to enhance our homeland security
- The SAFETY Act liability protections apply to a vast range of technologies, including:
  - Products
  - Services
  - Software and other forms of intellectual property (IP)

Examples of eligible technologies:

- Threat and vulnerability assessment services
- Detection Systems
- Blast Mitigation Materials
- Screening Services
- Sensors and Sensor Integration
- Vaccines
- Metal Detectors
- Decision Support Software
- Security Services
- Data Mining Software

Protecting You, Protecting U.S.

Slide 35

Criteria as stated in the SAFETY Act

- Is it an Anti-Terrorism Technology?
- Is it effective and available?
- Does it possess large potential third party liability risk exposure?
- Does Seller need SAFETY Act?
- Does it perform as intended?
- Does it conform to Seller's specifications?
- Is it safe for use as intended?

Addition SAFETY Act information…
Online: www.safetyact.gov Email: helpdesk@safetyact.gov
Toll-Free: 1-866-788-9318

Slide 36

Award Criteria

	Developmental Testing and Evaluation (DT&E)	Designation	Certification
Effectiveness Evaluation Conclusion	Needs more proof, has potential	Demonstrated effectiveness, i.e. Developmental testing (with confidence of repeatability)	Consistently proven effectiveness, i.e. operational performance (with high confidence of enduring effectiveness)
Protection	Liability cap • only for identified test event(s) and for limited duration (=3yrs)	Liability cap • for any and all deployments in 5-8 year term	Government Contractor Defense (GCD) • for any and all deployments in 5-8 years term
Examples	• EDS not yet TSL Certified • Novel incident pattern matching service	• Radiological detector with laboratory success Opt-out screeners, only similar projects completed	• EDS TSL Certified • Well-documented infrastructure protection service with history of excellent performance and meeting DoE standards

EDS=Explosive Detection System TSL=Transportation Security Laboratory (TSA)

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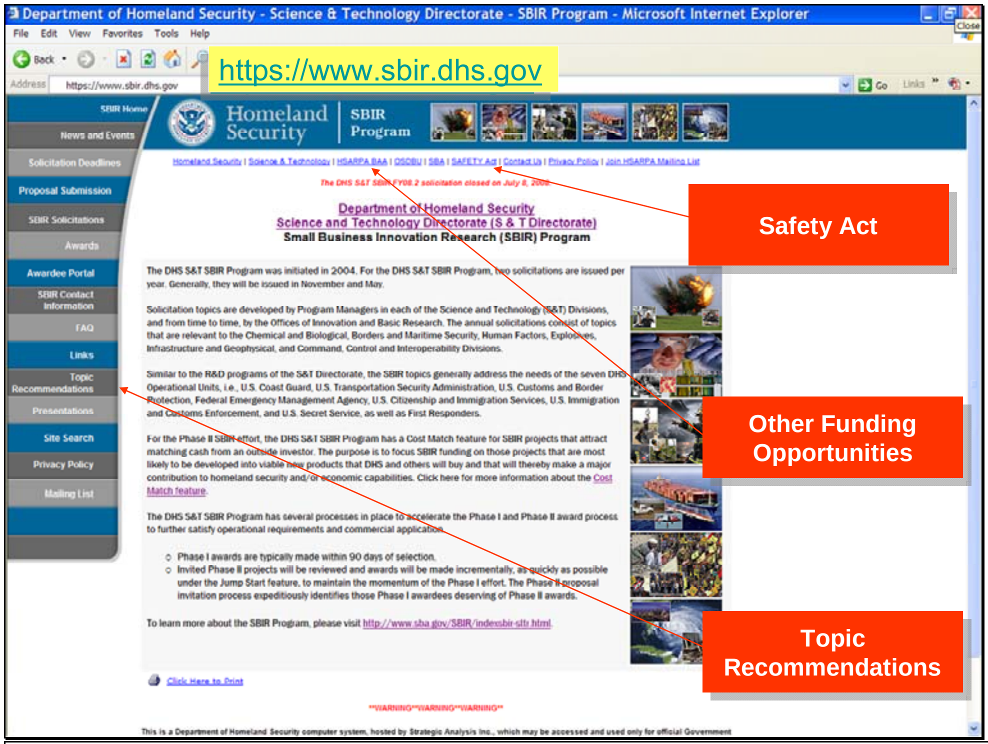

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Tech Clearinghouse Mission

To rapidly disseminate technical information concerning existing and desired products and services to/between Federal, State, Local, and Tribal Government and the Private Sector in order to encourage technological innovation and facilitate the mission of the Department of Homeland Security.

- Establishes Central Federal Technology Clearinghouse
- Issues Announcements for Innovative Solutions
- Establishes S&T Technical Assessment Team
- Provides guidance for the evaluation, purchase, and implementation of homeland security enhancing technologies
- Provides users with information to develop or deploy technologies that would enhance homeland security
- Enables technology transfer

Improved Knowledge Sound Acquisition Decisions

Slide 39

TechSolutions

The mission of TechSolutions is to rapidly address technology gaps identified by Federal, State, Local, and Tribal first responders

- Field prototypical solutions in 12 months
- Cost should be commensurate with proposal but less than $1M per project
- Solution should meet 80% of identified requirements
- Provide a mechanism for Emergency Responders to relay their capability gaps
  - Capability gaps are gathered using a web site (www.dhs.gov/techsolutions)
- Gaps are addressed using existing technology, spiral development, and rapid prototyping
- Emergency Responders partner with DHS from start to finish

Rapid Technology Development
Target: Solutions Fielded within 1 year, at <$1M

Slide 40

TechSolutions Investments

Seatbelt Safety for Emergency Vehicles

Next Generation Breathing Apparatus

Fire Ground Compass

Under Consideration

Vehicle Mounted Chem/Bio Sensor Detection

Slide 41

Getting Involved: S&T Contacts

Division	Email
Jim Tuttle	S&T-Explosives@dhs.gov
Beth George	S&T-ChemBio@dhs.gov
David Boyd	S&T-C2I@dhs.gov
Anh Duong	S&T-BordersMaritime@dhs.gov
Sharla Rausch	S&T-HumanFactors@dhs.gov
Chris Doyle	S&T-InfrastructureGeophysical@dhs.gov
Rich Kikla	S&T-Transition@dhs.gov
Starnes Walker	S&T-Research@dhs.gov
Roger McGinnis	S&T-Innovation@dhs.gov

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Summary

Detailed Requirements
Sizeable Market Potential
Delivered Products – PERIOD!

How Can You Afford NOT to Partner with DHS S&T?

Questions/Comments:
Thomas A. Cellucci, Ph.D., MBA
thomas.cellucci@dhs.gov

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Homeland
Security

Appendix G: Capability Gap-Based Thinking

The following slides were prepared by Dr. Arch Turner of DHS S&T and discuss capability gap driven thinking and processes.

Slide 1

Homeland Security Capabilities

Arch Turner, Ph.D.
U. S. Department of Homeland Security
Science &Technology Directorate
Operations Analysis Division

12 November, 2008

Slide 2

Purpose

Discuss Capabilities-Based Thinking for Defining, Developing, and Fielding Homeland Security Needs

Slide 3

Capabilities in Department of Homeland Security (DHS)

DHS Strategic Requirements Planning Process "Foundational Principle 1": "Requirements will be described in terms of **operational capability**[1] need"

DHS Strategic Planning Process: "Through its recurring strategic planning process, the Department identifies **capabilities** needed across components to accomplish its strategic objectives"

DHS S&T Mission: "To conduct, stimulate and enable research, development, test, evaluation, and timely **transition of homeland security capabilities** to Federal, State, and Local operational end-users"

DHS S&T Strategy: "The S&T Directorate is committed to being customer focused and to **delivering capabilities** that DHS Components can rely on to meet their operational needs."

DHS S&T Capstone IPTs: "Will identify, validate, and prioritize **capability requirements** for S&T Directorate customers"

DHS Has Operational Capability Focus

Note: 1. All emphases (bold) added.

Slide 4

Capability Definition/Capability Construct

- **What Is A "Capability"?**
  - "means To Accomplish A Mission And Achieve Desired Outcomes By Performing Critical Tasks, Under Specified Conditions, To Target Levels Of Performance" (DHS, TCL[2] 2, Sept., 2007)
- **Capabilities Can Be Defined In Terms Of**
  - **Outcome/Mission** → What Needs To Be Achieved
  - **Tasks** → Actions That Must Be Accomplished To Achieve Outcome/Mission
  - **Conditions** → Circumstances Under Which Mission/Tasks Must Be Achieved And Which Can Affect Performance
  - **Standards** → Performance Levels To Which Mission/Tasks Must Be Completed For Outcome/Mission To Be Considered Successfully Achieved (E.G., Time, Affordability, Ease/Difficulty, Etc.)

We Need Common Terminology & Understanding

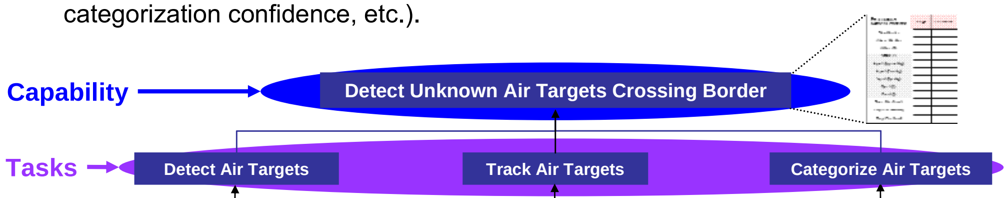
Note 2. Target Capabilities List

Slide 5

Notional O/M-T-C-S* Capability Visualization

***(Outcome/Mission-Task-Condition-Standard)**

Detect Unknown Air Targets Crossing Border involves three Tasks (Detect, Track, Categorize) that must be performed under various Conditions (e.g., weather, altitude, aspect, speed, target size/RCS, target density, etc.) each with several Performance Standards (e.g., range, location accuracy, track continuity, categorization confidence, etc.).



Conditions

Performance Standards/Conditions	Range	Location Accuracy	Confidence
Clear Weather			
Adverse Weather			
Altitude (H)			
Altitude (L)			
Aspect (Approaching)			
Aspect (Crossing)			
Speed (H)			
Speed (L)			
Target Size (Large)			
Target Size (Medium)			
Target Size Small			

Performance Standards/Conditions	Range	Track Continuity	Confidence
Clear Weather			
Adverse Weather			
Altitude (H)			
Altitude (L)			
Aspect (Approaching)			
Aspect (Crossing)			
Speed (H)			
Speed (L)			
Target Size (Large)			
Target Size (Medium)			
Target Size Small			

Performance Standards/Conditions	Range	Confidence
Clear Weather		
Adverse Weather		
Altitude (H)		
Altitude (L)		
Aspect (Approaching)		
Aspect (Crossing)		
Aspect (Opening)		
Speed (H)		
Speed (L)		
Target Size (Large)		
Target Size (Medium)		
Target Size Small		

Standards

Slide 6

Capability-Based Planning (C-BP)

Capability-Based Planning

"planning under uncertainty to provide capabilities for a wide range of modern-day challenges and circumstances while working within an economic framework that necessitates choice" (Davis, Analytic Architecture for Capabilities-Based Planning, RAND)

"involves a functional analysis of operational requirements. ….capabilities are identified based on tasks required…" (NATO Handbook in Long Term Defense Planning)

U.S./Close Ally Defense Institutions Have Embraced C-BP To Deal With Uncertainty of 21st Century Security Environment

Slide 7

C-BP "Building Blocks"

- High Level Capability Objectives Derived from Top Level Government Guidance
- Understanding Of How Organization Will Operate - Top Level Doctrine Or Overarching Operational Concept
- Capability Assessment In Context Of Multiple Plausible But Uncertain Futures/Scenarios
- Resource Constraint Requiring Tradeoffs in Definition/ Prioritization of Capabilities

Slide 8

Characteristics of C-BP

- **Outcome Oriented**
  - Focused On Ability To Perform Assigned Missions
  - "What Do We Need To Do?" Not "What Do We Have Or Need To Replace?"
- **Holistic**
  - Explicit Recognition/Consideration Of Interdependence Of Material Resources, People, Doctrine, Organization, Support In Capability In Performing Mission
  - Emphasis On Cost, Performance, Risk Tradeoffs Among Resources Comprising Capabilities
- **Cross-Organization Focus**
  - Helps Break Down Stovepipes
  - Reveal Redundant/Excess Capacity
- **Encourages Innovation**
  - Avoids Identifying Solutions Early In Process, Keeps Options Open
  - Opens Door To New Ideas - "Overcome Simply Replacing Platforms"

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Homeland Security

Characteristics of C-BP (2)

- **Hedges Against Uncertainty**
  - Contrast With *"Threat Based Planning"* A "Red Herring"
  - Capabilities Tested Against Multiple Diverse Scenarios/Time Frames
  - Does Not Focus On "Bounding Threat" Of One/Few Scenarios
  - Stressing Scenarios Context For Identifying Tasks Most Critical To Achieving Desired Outcomes/End States Across Scenario Spectrum
- **Product**
  - Robust, Adaptable, Flexible And Affordable Capability Set
  - Set Best Suited Across Multiple Plausible, Uncertain Futures

"Nothing New" - Eliminates Cold War Practice Of Focusing On Single/Few Well-Defined "Bounding Threats" **(Paul Davis, RAND)**

Slide 10

Homeland Security

Capability Definition & Capability Construct

Capability - "means to accomplish a mission and achieve desired outcomes by performing critical tasks, under specified conditions, to target levels of performance" (DHS, TCL 2, Sept., 2007)

- **Capabilities Defined By O/M-T-C-S Construct**
  - **Outcome/Mission** → What do we need to achieve?
  - **Tasks** → What actions must be accomplished to achieve outcome/mission?
  - **Conditions** → What are the operational circumstances under which mission/tasks must be performed and which can affect performance?
  - **Standards** → How well must we be able to perform mission/tasks under these conditions for outcome/mission to be successfully achieved?

Operational Outcome/Mission – Not Process – Oriented

Slide 11

Second Essential Way of Looking At Capabilities

Capabilities must also be considered from resource perspective

- "Combination of resources (people, equipment, and other elements) that provide a means to achieve an outcome, under specified conditions and to national standards" (DHS ODP[3] Concept Paper, 2004)
- "Capability elements define the resources required to perform the critical tasks to the specified levels of performance" (DHS, TCL, Sept., 2006)
- "Capability elements serve as a guide for identifying and prioritizing investments when working to establish a capability" (DHS, TCL, Sept., 2007)
- "There is rarely a single combination of capability elements that can be used to achieve a capability" (DHS, TCL, Sept., 2006)

Capabilities Defined By O/M-T-C-S And By Resources Needed To Constitute & Apply Them

Note 3. Office of Domestic Preparedness

Slide 12

DHS Operational Capability Elements (OCE)

- DHS OCE From HSPD-8 National Preparedness Guidelines

DHS Operational Capability Elements (DHS, Target Capabilities List 2, September, 2007)	
Planning	Collection and analysis of intelligence and information, and development of policies, plans, procedures, mutual aid agreements, strategies, and other publications that comply with relevant laws, regulations, and guidance necessary to perform assigned missions and tasks.
Organization & Leadership	Individual teams, an overall organizational structure, and leadership at each level in the structure that comply with relevant laws, regulations, and guidance necessary to perform assigned missions and tasks
Personnel	Paid and volunteer staff who meet relevant qualification and certification standards necessary to perform assigned missions and tasks
Equipment & Systems	Major items of equipment, supplies, facilities, and systems that comply with relevant standards necessary to perform assigned missions and tasks
Training	Content and methods of delivery that comply with relevant training standards necessary to perform assigned missions and tasks
Exercises, Evaluations, and Corrective Actions	Exercises, self-assessments, peer assessments, outside review, compliance monitoring, and actual major events that provide opportunities to demonstrate, evaluate, and improve combined capability and interoperability of the other elements to perform assigned missions and tasks to standards necessary to achieve successful outcomes.

- Analogous to DOD DOTMLPF Capability Element Construct

Capability = Planning + Organization/Leadership + People + Equipment/Systems + Training + Exercises/Evaluations

Slide 13

Capabilities Must Be Complete

(Lt. Gen. (Ret.) George Mac Donald, Canadian Defence Staff Vice Chief, 2001-2004, Testimony to Standing Committee on National Defence, 13 Feb., 2007)

"I should add an aside at this point to be clear about what I mean by a capability.

Too often the assumption is made that the purchase and delivery of capital equipment constitutes a new capability, where in fact it is usually only the first step, and often not even the most expensive portion.

To provide a complete, balanced capability, personnel must be available and they need to be properly trained and supervised.

Operating concepts need to be put in place and access to robust command and control must be assured.

Infrastructure – both buildings and information technology – must be accounted for.

Also, it is critical to ensure that the necessary support services for spares, maintenance, repair and overhaul are provided for the long term.

In short, ***capabilities must be complete to be useful*****."** **(Emphasis added)**

Avoid Becoming Overly Focused On "Guns, Guards, Gates, Gadgets & Gizmos" (i.e. "Things") → Outcome Is The Key

Slide 14

Capability Gaps

- Capability Gap: Mismatch Between What We Need To Be Able To Do And What We Can Currently Do
  - Discrepancy Between Required Capability and Current Capability
  - Can Be Either a Capability Excess or a Shortfall
  - Both Important - Focus Here on Capability Shortfalls
- What Are Attributes of "Good" – i.e. "Actionable" - Capability Gap Statement
  - √ Specifies Required Outcome(s)/Mission(s) Presently Not Achievable
  - √ Specifies Required Tasks/Conditions/Standards Combinations Which Cannot Presently Be Achieved
  - √ Is "Solution Agnostic" – Specifies "What" needs to be done, Not "How" it needs to be done (i.e., A "Problem" not a "Solution")

What DHS Operators Need To Be Able To Do to Perform Mission, But Can't. How Well? Under What Conditions?

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Homeland Security

Capability Gap Statements Compared

Poor Initial Capability Gap Statement:

"Need New Border Air Surveillance Radar"

- × Not Outcome/Mission Oriented
- × No Condition/Performance Standard Information
- × Not Solution Agnostic

More Actionable Initial Capability Gap Statement:

"Need ability to reliably (≥.95 Confidence) categorize approaching/closing (≥ = 25 nm. range, slow (≤100 knots), low-flying (500 - 2,500 feet altitude), unknown small (light plane sized) air contacts in adverse weather conditions from site located in benign terrain"

- ✓ Identifies Specifically What User Needs To Be Able To Do But Can't
- ✓ Provides Some Key Condition/Performance Standard Information
- ✓ Solution Agnostic

Accurate/Precise Capability Gap Statement More Likely To Be Filled Sooner, Correctly, More Affordably

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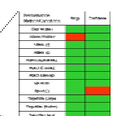
Homeland Security

Notional O/M-T-C-S Capability Gap Visualization



Detect Unknown Targets Crossing Border

Detect Air Targets

Performance Metrics/Conditions	Range	Location Accuracy	Confidence
Clear Weather	✓	✓	✓
Adverse Weather	✓	✓	✓
Altitude (H)	✓	✓	✓
Altitude (L)	✓	✓	✓
Aspect (Approaching)	✓	✓	✓
Aspect (Crossing)	✓	✓	✓
Aspect (Opening)	✓	✓	✓
Speed (H)	✓	✓	✓
Speed (L)	✓	✓	✓
Target Size (Large)	✓	✓	✓
Target Size (Medium)	✓	✓	✓
Target Size Small	✓	✓	✓

Track Air Targets

Performance Metrics/Conditions	Range	Track Continuity	Confidence
Clear Weather	✓	✓	✓
Adverse Weather	✓	✓	✓
Altitude (H)	✓	✓	✓
Altitude (L)	✓	✓	✓
Aspect (Approaching)	✓	✓	✓
Aspect (Crossing)	✓	✓	✓
Aspect (Opening)	✓	✓	✓
Speed (H)	✓	✓	✓
Speed (L)	✓	✓	✓
Target Size (Large)	✓	✓	✓
Target Size (Medium)	✓	✓	✓
Target Size Small	✓	✓	✓

Categorize Air Targets

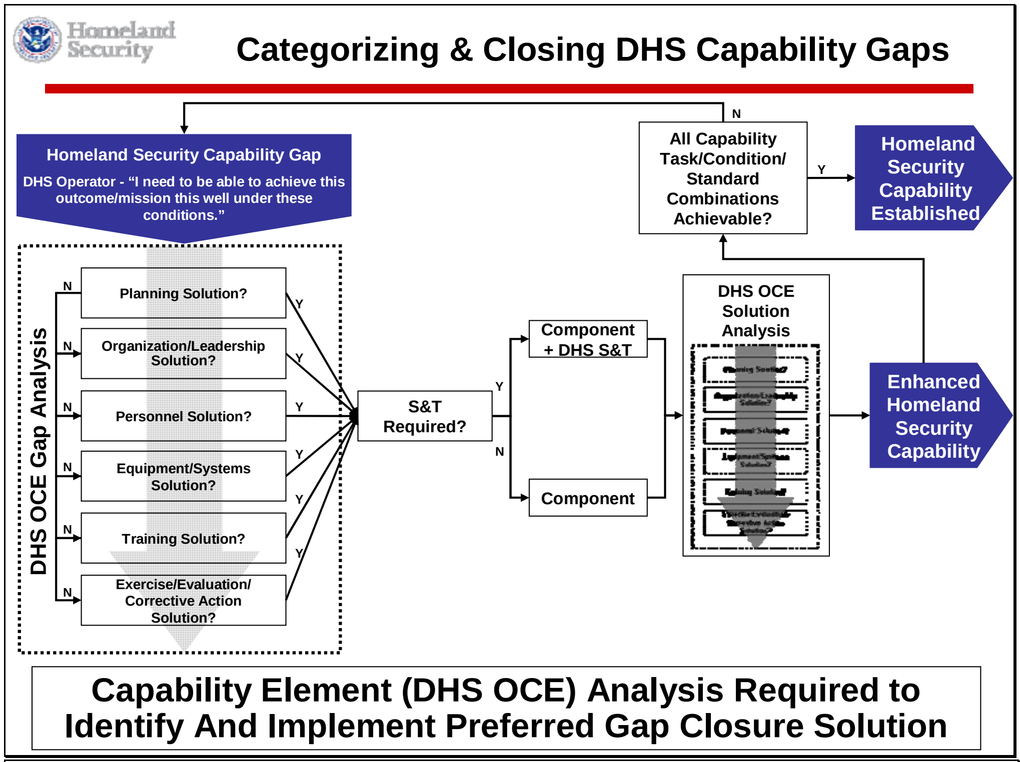
Performance Metrics/Conditions	Range	Confidence
Clear Weather	✓	✓
Adverse Weather	X	X
Altitude (H)	✓	✓
Altitude (L)	✓	X
Aspect (Approaching)	✓	X
Aspect (Crossing)	✓	✓
Aspect (Opening)	✓	✓
Speed (H)	✓	✓
Speed (L)	✓	X
Target Size (Large)	✓	✓
Target Size (Medium)	✓	✓
Target Size Small	✓	X

Legend: ✓ Can achieve performance standard in condition — X Cannot achieve performance standard in condition

Green: "Current Capability" — **Red: "Capability Gap"**

More Specific Statement Of Need Enables Solution Providers To Focus Quickly On What Needs To Be "Fixed"

Slide 17



Slide 18

DHS Strategic Requirements Planning Process

- Management Directorate/Office of Policy initiative
- Important element of over arching PPBE process
  - Requirements Generation + Programming + Acquisition → DHS PPBE
- Embodies Key C-BP precepts
  - Flows from 5 DHS Strategic Goals
  - Identifies 7 DHS "Functional Requirement Areas" (FRA)
  - First Foundational Principle: "Requirements" must be described "in terms of strategic capabilities"
  - Deputy Secretary chaired Joint Requirements Council
  - Multi-discipline Requirements Planning Teams review selected FRA "Areas of Interest"
  - **C**apability-**O**bjectives-**R**esources-**E**valuative Measures (CORE) Document Capability Mismatches
  - Embraces integrated capability resource perspective (DOTMLPF RAGS)
  - Primary Input to DHS Integrated Planning Guidance

Slide 19

DHS Strategic Requirements Planning Process

- DHS Strategic Goals
  - Protect U.S. from Dangerous People
  - Protect U.S. from Dangerous Goods
  - Protect Critical Infrastructure
  - Build Effective Emergency Response System & Culture of Preparedness
  - Strengthen & Unify DHS Operations Management
- DHS Functional Areas
  - Screening (e.g., Cargo and People)
  - Securing (e.g., Critical Infrastructure)
  - Law Enforcement (e.g., Investigations, Immigration)
  - Domain Awareness (e.g., Border Surveillance)
  - Benefits Administration (e.g., FEMA, USCIS benefits)
  - Incident Management (e.g., Hurricane, Terrorist Attack)
  - Enterprise Operations (e.g., Operations Integration)

Slide 20

Closing Thoughts

- Capability-Based Planning A Strategy For Dealing With Uncertain Threat In Resource-Constrained Environment
- Common Capability/Gap Understanding And Terminology Important
- Capabilities Can Be Characterized Using Outcome/Mission-Task-Conditions-Standards Construct (O/M -T-C-S)
- Capabilities Can Also Be Characterized In Terms Of Capability Elements – Resources Needed To Realize Them – Which Must Be Considered When Classifying Gaps And Designing/Fielding Solutions
- Important To Think Of Capabilities And Gaps With Both O/M-T-C-S And Capability Element/Resource Perspectives In Mind
- DHS Office of Policy/Management Directorate Providing Important Leadership Toward Institutionalizing Capability-Based Thinking And Planning

Appendix H: Product Realization Chart

U.S. Department of Homeland Security: Commercialization Office

Product Realization Chart

DHS S&T Portfolio	N/A	Basic Research			Innovation and Transition					
Technology Phase	Needs Assessment	Science			Technology Development			Product Development		
Technology Readiness Level (TRL)	N/A	TRL 1 – TRL 3			TRL 4 – TRL 6			TRL 7 – TRL 9		
		TRL 1	**TRL 2**	**TRL 3**	**TRL 4**	**TRL 5**	**TRL 6**	**TRL 7**	**TRL 8**	**TRL 9**
Key Objectives	❑ Identify S&T capability gaps (mission needs) requiring material solutions. ❑ Preliminary operational requirements are developed. ❑ Market survey. ❑ Technology scan. ❑ Assess technology-based solutions to address gaps. ❑ Develop rough order-of-magnitude (ROM) estimates of project cost and schedule. ❑ Investigate the value proposition of a product idea. ❑ Establish technical objectives and milestones. ❑ Conduct preliminary IP review. ❑ Ensure the qualification of tools, materials, processes, and suppliers as required. ❑ Provide a preliminary production plan. ❑ Develop preliminary marketing objectives and milestones. ❑ Initiation of Congressional Appropriations Memo, Technology Transition Agreements (TTA), Program Descriptions (Research and Innovation), and Feasibility Studies lead to Program and Budget Execution. ❑ List other objectives when defined.	❑ A program sponsor and end-users / customers have been identified. ❑ Mission Needs Statement has been developed. ❑ Communication with end-users and customers has been initiated. ❑ Preliminary operational requirements have been defined. ❑ Program Management Vision has been developed. ❑ A Feasibility Study White Paper has been developed and accepted. (TRL1 and 2) ❑ A threat, vulnerability, or gap has been identified. ❑ Initial risks have been identified. ❑ Develop and update the preliminary product plan. ❑ List other objectives when defined.	❑ End-user is involved in concept and requirements development. ❑ An empirical or theoretical design solution has been identified. ❑ Analytical studies to confirm the basic principles of the technology have been developed. ❑ Operational requirements analysis has been conducted; Operational requirements are applied to Functional Requirements. (TRL 2 and 3) ❑ System concept(s) / architecture have been assessed. ❑ Program Risk Assessment has been conducted; Risk Management Plan has been developed. (TRL 2 and 3) ❑ Program Cost Analysis has been completed and updated. (TRL 2 and 3) ❑ Preliminary Security Assessment has been conducted. ❑ Develop a Technology Roadmap. ❑ Refine the market assessment and technology scan. ❑ List other objectives when defined.	❑ Supplemental and alternate technologies throughout DHS S&T have been surveyed. ❑ Technology's physical validity has been proven in laboratory experiments. ❑ Program Management Plan (PMP) has been developed. ❑ Systems Engineering Management Plan (SEMP) draft. ❑ Proof of Concept Plan has been developed. ❑ Manufacturing / production strategy has been developed. ❑ Develop Quality Control Plan to include standards conformance, reliability testing, etc. ❑ Develop Marketing Plan to include market size and research. ❑ List other objectives when defined.	❑ All required technology components are integrated for Proof of Concept. ❑ Proof of Concept is conducted. ❑ IPT has been briefed on progress of the technology's development. ❑ The customer has been briefed on the Proof of Concept results. ❑ Functional Requirements Document has been finalized. ❑ SEMP has been finalized and updated. (TRL 4, 5, & 6) ❑ TEMP has been completed and updated. (TRL 4, 5, & 6) ❑ Configuration Management Plan exists. ❑ PMP has been updated. (TRL 4, 5, and 6) ❑ Risk Management Plan is updated. (TRL 4, 5, and 6) ❑ Program Cost Analysis is updated. (TRL 4, 5, and 6) ❑ Quality Assurance Plan exists. ❑ Program Transition Manager is engaged in transition planning. ❑ List other objectives when defined.	❑ ORD and CONOPS are developed. ❑ Security Assessment is updated. ❑ OMB 300 and Acquisition Plan have been completed (if required). ❑ IPT has certified readiness for the transition of the Technology. ❑ Program Transition Manager has assisted in transition documentation development. ❑ Technology scan and market survey. (ongoing) ❑ Analysis of Alternatives is developed and updated. (TRL 5 & 6) ❑ Entry Criteria Checklist is completed and delivered to the TM. ❑ PDD has been created, approved, and signed. (TRL 5 & 6) ❑ Director has approved the transition. ❑ List other objectives when defined.	**Germane to both Acquisition and Commercialization** ❑ Execute a preliminary Technology Transition Agreement (TTA), or Technology Commercialization Agreement (TCA) as applicable ❑Program Manager has been identified. ❑ Successful T&E in a simulated operational environment has been conducted. ❑ End user / customer has been briefed on the results of T&E. ❑ Initial Security Guidelines have been developed. ❑ Draft Program Assessment Rating Tool (PART) plan exists, if required. ❑National Environmental Policy Act (NEPA) plan / assessment, if required. ❑ Interoperability Assessment. ❑ List other objectives when defined. **Specific to Commercialization** ❑ Finalize Manufacturing Plan. ❑ Finalize engineering documentation. ❑ Update Marketing Plan. ❑ Develop and implement a test plan for quality control. ❑ List other objectives when defined.	**Germane to both Acquisition and Commercialization** ❑ S&T and the end-user / customer have begun to develop final transition planning document; Transition Plan has been developed. (TRL 7 and 8) ❑ Technology has been successfully demonstrated in an operational environment. (TRL 7 and 8) ❑ Updates (if required) have been made to the Operational and / or Functional Requirements Document. ❑ Risk Management Plan, Program Cost Analysis and PMP have been updated (as needed). ❑ Strategic Program Planning (e.g., Balanced Scorecard) has been conducted. ❑ Operations and Maintenance Manual has been completed / updated. ❑ Security Manual has been developed. ❑ Interoperability has been demonstrated. ❑ Management Directives (MD) have been reviewed to assure compliance. ❑ List other objectives when defined. **Specific to Commercialization** ❑ IP Protection and Licensing. ❑ Prepare sales release package. ❑ Verify and update quality control requirements. ❑ List other objectives when defined.	**Germane to both Acquisition and Commercialization** ❑ Technology components are form, fit, and function compatible with an operational system. ❑ Technology production has been addressed and planned by DHS and the end-user / customer. ❑ Training Plan has been developed and implemented. (TRL 8 and 9) ❑ Operational Test Report has been completed. ❑ Limited User Test (LUT) Plan has been developed. ❑ List other objectives when defined.	**Germane to both Acquisition and Commercialization** ❑ All critical program documentation has been completed. ❑ Planning is underway for the integration of the next generation technology into the existing program components. ❑ End-user fully demonstrates the technology in CONOPS. ❑ Lessons Learned completed. ❑ After Action Review completed. ❑ Sustainment Plan is completed. ❑ List other objectives when defined. **Specific to Commercialization** ❑ Finalize quality plan. ❑ Finalize marketing plan. ❑ Finalize manufacturing and assembly routines. ❑ List other objectives when defined.
Key Deliverables	❑ Preliminary market assessment and technology scan. ❑ Congressional Appropriations Memo, Technology Transition Agreements, Program Descriptions (Research and Innovation), and Feasibility Studies lead to Program and Budget Execution. ❑ Preliminary product plan that assesses features, benefits, and risk. ❑ Initial plan for marketing, production, and quality control. ❑List other deliverables when defined.	❑ Mission Needs Statement. ❑ Feasibility Study. ❑ Program Management Vision, or ❑ Description of Leap-ahead Capability. ❑ Written report of findings and recommendations (preliminary product plan). ❑ Feasibility Review meeting. ❑ List other deliverables when defined.	❑ Preliminary Operational Requirements Document (end-user / customer validation). ❑ Program Cost Analysis (updated). (TRL 2 and 3) ❑ Program Risk Assessment (technology, schedule, etc.); Risk Management Plan (TRL 2 and 3) ❑ Preliminary Security Assessment. ❑ Functional Requirements (draft). (TRL 3) ❑ Preliminary product plans (approved and ongoing). ❑ New Technology roadmaps (approved for further development and implementation). ❑ Updated market assessment and technology scan. ❑ List other deliverables when defined.	❑ Systems Engineering Management Plan (SEMP) draft. ❑ Proof of Concept Plan. ❑ Program Management Plan (PMP) draft. ❑ End-user / Customer Status Review. ❑ Detailed product and marketing plan. ❑ Quality control plan. ❑ Optimization Review meeting. ❑ List other deliverables when defined.	❑ Proof of Concept Report. ❑ Functional Requirements Document. ❑ SEMP (TRL 4, 5, and 6) ❑ TEMP (TRL 4, 5, and 6) ❑ Quality Assurance Plan. ❑ Configuration Plan Management. ❑ PMP (updated). (TRL 4, 5, & 6) ❑ Risk Management Plan (updated). (TRL 4, 5, and 6) ❑ Program Cost Analysis (updated). (TRL 4, 5, and 6) ❑ End-user / Customer Status Review. ❑ List other deliverables when defined.	❑ ORD and CONOPS. ❑ Security Assessment (updated). ❑ Program Definition Document (PDD). ❑ OMB 300 Capital Asset Plan. ❑ Acquisition Plan. ❑ Entry Criteria Checklist. ❑ Analysis of Alternatives. (TRL 5 and 6) ❑ List other deliverables when defined.	**Germane to both Acquisition and Commercialization** ❑ Technology Transition Agreement (TTA), or Technology Commercialization Agreement (TCA) as applicable ❑ Initial Security Guidelines. ❑ Draft Program Assessment Rating Tool (PART) plan, if required. ❑ National Environmental Policy Act (NEPA) initial assessment, if required. ❑ Interoperability Assessment. ❑ List other deliverables when defined. **Specific to Commercialization** ❑ Engineering documentation package release and manufacturing plan. ❑ Updated marketing plan. ❑ Test plan for quality control. ❑ Development Phase Review meeting. ❑ List other deliverables when defined.	**Germane to both Acquisition and Commercialization** ❑ Transition Plan (draft). ❑ Operational and Functional Requirements Documentation (updated). ❑ Risk Management Plan (updated). ❑ Program Cost Analysis (updated). ❑ PMP (updated). ❑ Strategic Program Planning Documentation (if conducted). ❑ Operations and Maintenance Manual. ❑ Security Manual. ❑ Finalized Interoperability Assurance Report. (TRL 7 and 8) ❑ Applicable Management Directives (MD), if required. (TRL 7) ❑ List other deliverables when defined. **Specific to Commercialization** ❑ IP Protection and Licensing. ❑ Manufacturing and sales plan release package is to be distributed. ❑ Pilot Phase Review meeting. ❑ List other deliverables when defined.	**Germane to both Acquisition and Commercialization** ❑ Limited User Test (LUT) Plan. ❑ Deployment or Transition Plan. ❑ Training Plan. ❑ Operational Test Report. ❑ Customer Acceptance Document. ❑ Initial Systems-level Metrics Assessment. ❑ List other deliverables when defined. **Specific to Commercialization** ❑ Demonstrate that a defect-free product can be manufactured on schedule and at a cost consistent with the target price points. ❑ List other deliverables when defined.	**Germane to both Acquisition and Commercialization** ❑ Customer Feedback. ❑ Lessons-learned. ❑ After-action Review. ❑ Sustainment Plan is completed (a. Spiral Development Assessment, b. Preplanned Product Improvement, c. Emerging Threat(s) Assessment, d. Technology Refresh / Insertion, e. Quality Assurance / Metrics Report, f. Risk Management Reassessment.). ❑ List other deliverables when defined. **Specific to Commercialization** ❑ Finalized product plan sales release package is to be distributed. ❑ Sales Release Phase Review meeting. ❑ Execution of the acceptance, shipment, and after-sales support of the new product. ❑ List other deliverables when defined.
Management Review	❑STIC review meeting to ensure exit criteria / deliverables are met. ❑ EOC review and approval to move onto the next phase. ❑ Corporate review meeting of value proposition and product overview. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Research). ❑ Corporate review meeting of the preliminary product plan. ❑ Feasibility Review meeting. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Research). ❑ Corporate review meeting to approve preliminary product plan and technology roadmap. ❑ Results and follow up actions	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Research). ❑ EOC review and approval to move onto the next phase. ❑ Optimization Review meeting. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Innovation, or Transition). ❑ Analysis of the engineering and manufacturing plan. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Innovation, or Transition). ❑ Analysis of the engineering and manufacturing plan. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Innovation, or Transition). ❑ EOC review and approval to move onto the next phase. ❑ Development Phase review meeting. ❑ Comprehensive analysis of the engineering and manufacturing plan. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Transition). ❑ Corporate review of the manufacturing release package. ❑ Pilot Phase review meeting. ❑ Results and follow up actions.	❑ STIC review meeting to ensure exit criteria / deliverables are met (incorporate S&T Director of Transition). ❑ Analysis and review of the manufacturing plan. ❑ Results and follow up actions.	❑ S&T Director of Transition) ❑ EOC review and approval to move onto the next phase / transition. ❑ Corporate review of the finalized product plan and sales release package. ❑ Sales Release Phase Review meeting.

SECURE PROGRAM

U.S. Department of Homeland Security Commercialization Office August 2008 Version 1.0 *Definition:* Commercialization – the process of developing markets and producing and delivering products or services for sale. *Legend:* Black Type – Primary Public Sector Blue Type – Primary Private Sector ▲- EOC Review ● – STIC Review

Notes

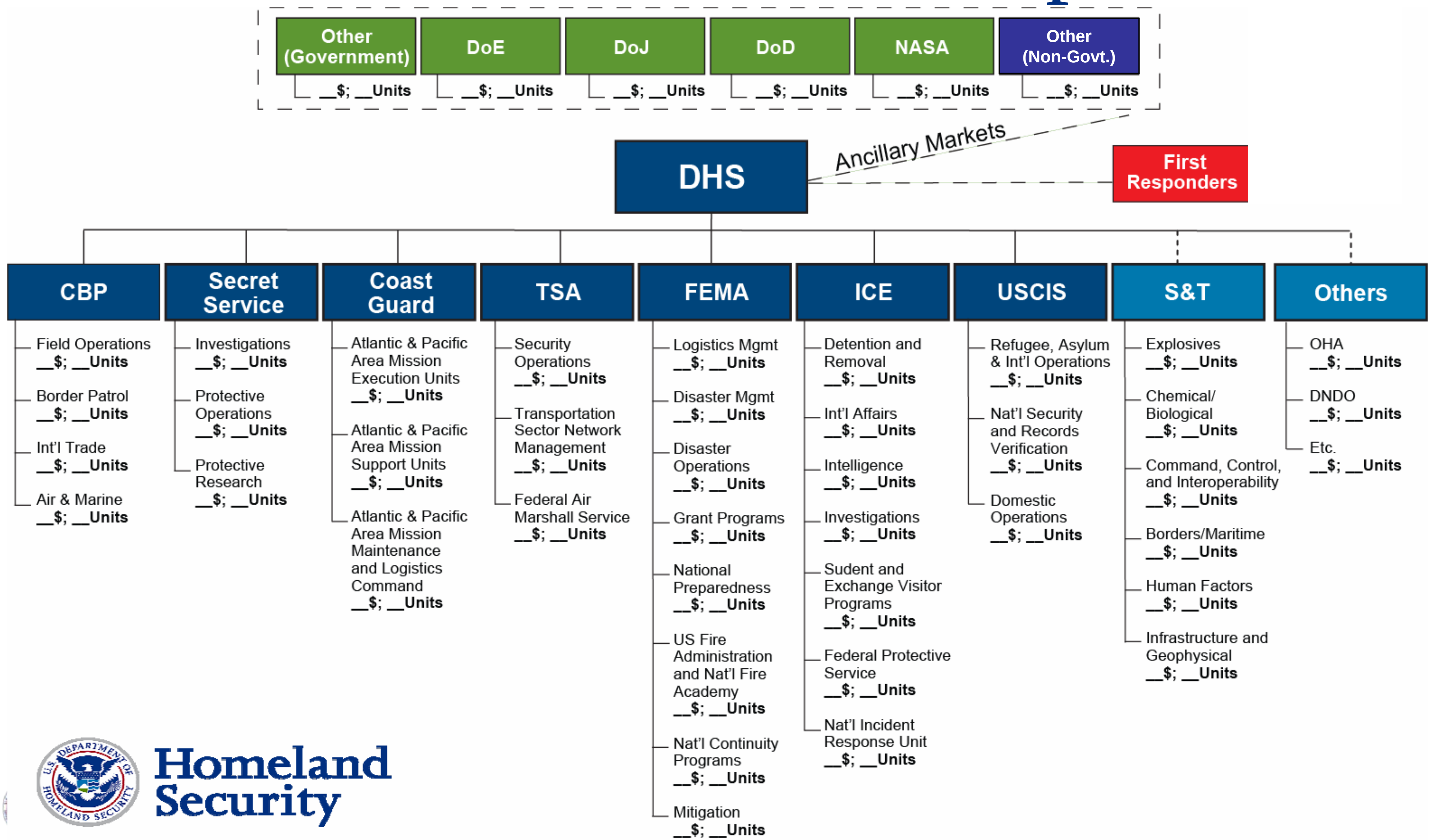
Executive Oversight Committee (EOC) – consists of the Dep Sec, Under Secretary of Management, Under Secretary of DHS S&T, and the corresponding G7 Head (appropriate representative from the operating component)

Science and Technology Internal Committee (STIC) – consists of the relevant S&T Director (Research, Innovation, or Transition), S&T Division Head, S&T Division Program Manager, and the corresponding G7 Head (appropriate representative from the operating component)

SEPTEMBER 2008

Appendix I: Market Potential Templates

Market Potential Template



Homeland Security

Critical Infrastructure Key Resources (CIKR)

- **Agriculture and Food**
  - Food Retail _$; _ Units
  - Farm Equipment _$; _ Units
  - Meat/Poultry Processing _$; _ Units
  - Food Processing _$; _ Units
  - Dairy Processing _$; _ Units
  - Dairy Farms _$; _ Units
  - Ranching _$; _ Units
  - Organic Farming/Sustainable Agriculture _$; _ Units
  - Traditional Planting _$; _ Units
  - Commercial fishing _$; _ Units
- **Defense Industrial Base**
  - Defense Contractors _$; _ Units
  - Industry analysts _$; _ Units
  - Think tanks/research institutions _$; _ Units
  - University partnership programs _$; _ Units
  - National laboratories _$; _ Units
- **Energy**
  - Coal mining operations _$; _ Units
  - Coal power plants _$; _ Units
  - Coal equipment manufacturers _$; _ Units
  - Hydroelectric _$; _ Units
  - Dam operations _$; _ Units
  - Wind power _$; _ Units
  - Solar power _$; _ Units
  - Public utilities companies _$; _ Units
  - Oil companies _$; _ Units
- **Public Health and Healthcare**
  - Public/University hospitals _$; _ Units
  - Private/For Profit hospitals _$; _ Units
  - Clinics _$; _ Units
  - Private medical practices _$; _ Units
  - Medical laboratories _$; _ Units
  - Pharmaceutical _$; _ Units
  - Health insurance _$; _ Units
  - Medical material providers _$; _ Units
  - Medical equipment manufacturers _$; _ Units
  - Medical technology manufacturers _$; _ Units
  - Biotechnology _$; _ Units
- **National Monuments and Icons**
  - Guided tour services _$; _ Units
  - Travel services _$; _ Units
  - Lodging/Hotel _$; _ Units
  - Guest services/ tourist hospitality _$; _ Units
  - People moving services _$; _ Units
  - Queuing equipment makers _$; _ Units
  - Private security _$; _ Units
- **Banking and Finance**
  - Credit lending institutions _$; _ Units
  - Commercial banking _$; _ Units
  - Private equity _$; _ Units
  - Consumer banking _$; _ Units
  - Building societies/ Private banks _$; _ Units
  - Merchant banks _$; _ Units
  - Global financial services firms _$; _ Units
  - Community development institutions _$; _ Units
  - Community banks _$; _ Units
  - Savings and Loans _$; _ Units
  - Credit unions _$; _ Units
  - Insurance companies _$; _ Units
  - Insurance brokerages _$; _ Units
  - Reinsurance companies _$; _ Units
  - Stock brokerages _$; _ Units
  - Capital market banks _$; _ Units
  - Custody services _$; _ Units
  - Angel investment _$; _ Units
  - Venture capital _$; _ Units
- **Water**
  - Public utilities _$; _ Units
  - Desalinization plants _$; _ Units
  - Treatment plants _$; _ Units
  - Equipment manufacturers _$; _ Units
  - Pipe and water control device manufacturers _$; _ Units
- **Chemical**
  - Inorganic chemical production _$; _ Units
  - Organic industrial production _$; _ Units
  - Ceramics _$; _ Units
  - Petrochemicals _$; _ Units
  - Agrochemicals _$; _ Units
  - Polymers _$; _ Units
  - Elastomer production _$; _ Units
  - Oleochemicals _$; _ Units
  - Explosives _$; _ Units
  - Fragrance production _$; _ Units
  - Chemical wholesale _$; _ Units
  - Exotic chemicals _$; _ Units
- **Commercial facilities**
  - Hotels _$; _ Units
  - Shopping centers _$; _ Units
  - Stadiums and sport arenas _$; _ Units
  - Schools _$; _ Units
  - Commercial office buildings _$; _ Units
  - Museums _$; _ Units
  - Zoos and Aquariums _$; _ Units
  - Public Libraries _$; _ Units
  - Amusement parks _$; _ Units
- **Emergency Services**
  - Fire Departments _$; _ Units
  - Law enforcement agencies _$; _ Units
  - Search and rescue teams _$; _ Units
  - Ambulance companies _$; _ Units
  - Mountain/Cave/ Mine rescue teams _$; _ Units
  - Other technical rescue teams _$; _ Units
  - Bomb disposal units _$; _ Units
  - Blood/Organ transplant supply _$; _ Units
  - Amateur radio emergency comms _$; _ Units
  - Public utility protection providers _$; _ Units
  - Emergency Road services _$; _ Units
  - Emergency Social services _$; _ Units
  - Community emergency response teams _$; _ Units
  - Disaster relief _$; _ Units
  - Famine relief teams _$; _ Units
  - Poison Control units _$; _ Units
  - Animal control teams _$; _ Units
  - Wildlife services _$; _ Units
- **Nuclear Materials, Reactors and**
  - Electric utilities _$; _ Units
  - Reactor and associated materials _$; _ Units
  - University and educational institutions _$; _ Units
  - Control systems _$; _ Units
  - Nuclear safety systems _$; _ Units
  - Waste disposal services _$; _ Units
  - Uranium processors _$; _ Units
  - Protective garment manufacturers _$; _ Units
- **Telecommunications**
  - Telephone/Cellular services _$; _ Units
  - Satellite data transmission _$; _ Units
  - Broadcasting entities _$; _ Units
  - Broadcast equipment manufacturing _$; _ Units
  - Radio equipment manufacturing _$; _ Units
  - Internet equipment manufacturing _$; _ Units
  - High speed data transmission _$; _ Units
  - Internet service providers _$; _ Units
  - Print media _$; _ Units
  - Internet technology providers _$; _ Units
- **Critical Manufacturing**
  - Iron and Steel mills _$; _ Units
  - Aluminum production and processing _$; _ Units
  - Nonferrous metal production and processing _$; _ Units
  - Engine, Turbine and Power transmission _$; _ Units
  - Electrical Equipment manufacturing _$; _ Units
  - Motor Vehicle manufacturing _$; _ Units
  - Aerospace product & parts manufacturing _$; _ Units
  - Railroad rolling stock _$; _ Units
  - Other Transportation equipment _$; _ Units
- **Postal and Shipping Services**
  - United States Postal Service _$; _ Units
  - High volume document and parcel shipping _$; _ Units
  - Container shipping services _$; _ Units
  - Marine shipping _$; _ Units
  - Trucking industry _$; _ Units
  - Airborne shipping _$; _ Units
  - Distribution services _$; _ Units
- **Transportation**
  - AMTRAK _$; _ Units
  - Commuter rail _$; _ Units
  - Intracity rail services _$; _ Units
  - Commercial airline _$; _ Units
  - Private air services _$; _ Units
  - Cruise lines _$; _ Units
  - Subway systems _$; _ Units
  - Long-haul maritime shipping _$; _ Units
  - Trucking _$; _ Units
  - Bus services _$; _ Units
  - Freight rail service _$; _ Units
  - Automobile travel _$; _ Units
  - Roads, Highways, bridges and tunnels _$; _ Units
- **Information Technology**
  - Hardware providers _$; _ Units
  - IT Conglomerates _$; _ Units
  - Semiconductor production _$; _ Units
  - Electronics manufacture _$; _ Units
  - IT services _$; _ Units
  - Server and network hardware _$; _ Units
  - Display/digital TV _$; _ Units
  - Software production _$; _ Units
  - Gaming _$; _ Units
  - Information security _$; _ Units
  - Semiconductor equipment _$; _ Units

Homeland Security

First Responders

- **EMT**
  - Ambulance Corps _$; _ Units
  - Basic life support providers (i.e., EMTs) _$; _ Units
  - Advanced life support (i.e. Paramedics) _$; _ Units
  - Aero medical evacuation _$; _ Units
- **Fire Fighting**
  - Retained fire departments _$; _ Units
  - Volunteer firefighters _$; _ Units
  - Military fire suppression crews _$; _ Units
  - Incident investigation teams _$; _ Units
  - Special technical fire teams (forest, chemical, etc.) _$; _ Units
  - Fire department HAZMAT teams _$; _ Units
- **Police**
  - Local police departments _$; _ Units
  - Military police units _$; _ Units
  - Federal law enforcement agencies _$; _ Units
  - State police departments _$; _ Units
  - Riot control teams _$; _ Units
  - SWAT teams _$; _ Units
  - K9 teams _$; _ Units
  - Diplomatic protection teams _$; _ Units
- **Bomb Disposal**
  - Police bomb squads _$; _ Units
  - Federal bomb disposal teams _$; _ Units
  - Military explosive ordnance disposal teams _$; _ Units
- **Port Security**
  - Port police _$; _ Units
  - US Coast Guard _$; _ Units
- **Public Health**
  - Toxic/ corrosive agents _$; _ Units
  - Biohazards _$; _ Units
  - Pathogens _$; _ Units
  - Asphyxiates _$; _ Units
  - Radioactive agents _$; _ Units
- **Hospitals**
  - Public/ University hospitals _$; _ Units
  - Private/For Profit hospitals _$; _ Units
- **Transportation**
  - Transit police _$; _ Units
- **Emergency Management**
- **Clinics**
  - Walk-In clinics _$; _ Units
  - Private medical practices _$; _ Units
- **Venue Security**
  - US Park Police _$; _ Units
- **Public works/ Utilities**
  - Public utility protection services _$; _ Units
- **School Security**
  - University public safety teams _$; _ Units
  - University fire departments
- **Response Volunteers**

NOTES

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Appendix J: Requirements Development Guide (April 2008)

Requirements Development Guide

April 2008

Homeland Security

Science and Technology

Preface

This Requirements Development Guide assists the S&T Project/Program Managers, Transition Managers and Division Leaders in the development of detailed requirements to aid in the cost-effective and efficient development and deployment of products and services for our customers – DHS Operating Components and First Responders.

We sincerely believe this guide also provides value to the DHS Operating Components and First Responder communities in developing and articulating their operating requirements and helps to ensure the accurate and timely development and deployment of products and services to aid in the implementation of the mission-critical objectives of the Operating Components and First Responders.

Tom Cellucci
April 2008

Acknowledgement:
I extend my sincerest thanks and appreciation to all those at DHS who contributed in creating this guide. In particular, Sam Francis and Mark Protacio deserve a special thanks for their endless efforts in developing materials for this resource and working not only with others within the Science & Technology Directorate, but also with personnel throughout DHS and with countless input from representatives in the Private Sector. Please give them all the credit for the value this guide brings, while I accept the responsibility for any errors or shortcomings.

Contents

List of Figures

Introduction

This guide introduces the role of requirements in product and system development in S&T and, more broadly, in DHS. The target readership is, principally, S&T project managers. The subject matter relates directly to S&T Transition projects, and only indirectly to Basic Research and Innovation projects.

There is no universally accepted standard vocabulary regarding requirements and specifications. In this document, definitions from DHS management directives by the Project Management Institute (in its *Guide to the Project Management Body of Knowledge*) have been used. The terms “product” and “system” are used interchangeably. Occasionally, the terms “sponsor” and “customer” are used interchangeably, as DHS Acquisition sponsors are S&T’s customers. As always, it is more important to understand the principles than to memorize the vocabulary.

Furthermore, requirements development, in general, is a topic that has received great attention. There exists an incredible volume of books, articles and various other writings on the topic of requirements development. This Requirements Development Guide is just one resource. Please refer to the “Additional Requirements Development Readings” section of this guide for other publications that focus on various aspects of requirements development. Many of these readings are easily accessible on the internet.

Address comments to the Chief Commercialization Officer Tom Cellucci, Ph.D., MBA, at Thomas.Cellucci@dhs.gov.

Quick Overview

Requirements-driven product development is a difficult enterprise, for two fundamental reasons:

- Needs are difficult to articulate, even if users have the breadth of vision to look outside the constraints of their current operational procedures
- Developers tend to jump to preconceived solutions, because of a bias toward a favorite technology or because of a belief that their solution is what the users “should want” or “really need.”

This document presents a brief overview of requirements-driven product development, organized into the following topics:

- **“Why Requirements?”** summarizes the advantages of requirements-driven design and illustrates the pitfalls of its opposite, “technology push.”
- **“The Requirements Hierarchy and Traceability”** summarizes the hierarchy of requirements and specifications, underscoring the important distinction between “defining the problem” and “defining the solution.”
- **“Requirements and the Product Life Cycle”** illustrates the evolution of requirements and specifications through the life cycle of product development.
- **“Characteristics of Good Requirements”** lists the characteristics that distinguish good requirements from bad.

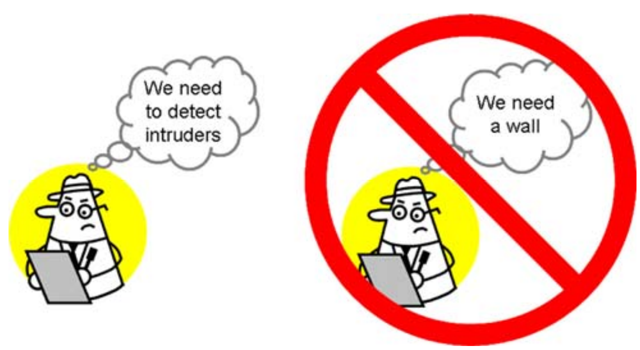
- **"Requirements and Test and Evaluation"** illustrates the close linkage between operational requirements and operational test and evaluation, and the similar linkage between technical requirements and developmental test and evaluation.
- **"Developing Operational Requirements: Customer Input"** lists nine techniques for eliciting user requirements.
- **"Tailored Product Life Cycle: Acquisition"** introduces the concept of a generic product life cycle and shows how it is tailored to DHS' Acquisition life cycle defined in MD1400.
- **"Tailored Product Life Cycle: Commercialization"** shows how the same generic product life cycle can be tailored to govern a Commercialization project.
- **"Tailored Product Life Cycle: Other Project Types"** shows how the same generic product life cycle can be tailored to govern the development of S&T products which are not used by end users in the field.

Why Requirements?

A requirement is an attribute of a product or system necessary to satisfy the needs of a sponsor, customer, end user or other stakeholder. Requirements therefore define "the problem." In contrast, "the solution" is defined by technical specifications, which represent the engineering community's "technical interpretation" of the requirements.

We could save ourselves a lot of work if we jump straight to "the solution" without defining "the problem." Why don't we do that? Because if we take that shortcut we are likely to find that our solution is not the best choice among possible alternatives or, even worse, we're likely to find that our "solution" doesn't even solve the problem!

For example, faced with the problem of potential intruders to a sensitive facility, we might define the requirement as "build a wall" whereas the real requirement is "detect, thwart, and capture intruders." Our wall might "thwart" intruders (or might not, if they're adept at tunneling), but it would not detect them or facilitate their capture. In short, the solution would not solve the problem.



The robust requirement to "detect, thwart, and capture intruders," which includes no preconceived solutions, prompts us to analyze alternative conceptual solutions and choose the best. This analysis is often called an "analysis of alternatives", or AoA, and is an intrinsic part of requirements-driven design.

One way to ensure that we are defining a problem, rather than a solution, is to begin the statement of the requirement with the phrase "we need the capability to …" It's nearly impossible to complete this sentence with a solution ("a wall"), and much easier to complete the sentence with a problem ("capability to detect intruders"). This approach is sometimes called capability-based planning. It is a very simple, yet powerful, concept.

At the other extreme from the "requirements-pull" approach is its opposite: "technology push." Here we start with a solution (perhaps a new technology) and see what problems it might enable us to solve. The danger in this approach is to become enamored of "the solution" and neglect to ensure that it actually solves a problem. With technology push, it is likely that real user requirements will be modified or even ignored to force-fit the desired solution. A historical example was the product known as Picture Phone introduced (and discontinued) in the 1960s, when the advance of telecommunications technology first made possible the transmission and display of video as well as voice. Picture Phone, which allowed telephone users to see each other during a call, was a technological success but a market disaster. It turned out that callers generally don't want to be seen, as a bit of unbiased market analysis would have disclosed.

Technology push should not be ignored, but if the goal is successful transition to the field with acceptable risk, the technology being pushed must be compared with alternative solutions against a real set of user requirements.

Aside from assuring that the "solution" actually solves the "problem," requirements-driven design has a further advantage in that the requirements provide criteria against which the product's successful development can be measured. Specifically, if the product was developed to address a set of quantified operational requirements, then its success is measured by Operational Test and Evaluation (OT&E) to validate that an end-user can use the product and achieve the stated operational goals.

Prior to OT&E, it is common practice to subject products to Developmental Test and Evaluation (DT&E). The purpose of DT&E is to verify that the product meets its technical specifications, which are the engineers' interpretation of the operational requirements. Such DT&E does not obviate the need for OT&E, which validates that the engineers' solution is not only technically successfully but also represents a successful interpretation of the end users' needs, satisfying the original operational requirements (not just the technical specifications) when operated by representative users.

Often requirements are stated in terms of "threshold values" and "objective values," where the "objective value" is the desired performance and the "threshold value" is the minimum acceptable performance. This formalism is useful in allowing stretch goals to be asserted without saddling the system development with unacceptable risk.

The Requirements Hierarchy and Traceability

To reiterate the definitions above, the documents that govern product development include requirements, which define the problem, and specifications, which define the solution. Nevertheless, the hierarchy of requirements and specifications is more complex than that simple dichotomy, as depicted in Figure 1.

The hierarchy is divided into two domains, operational requirements and technical requirements, highlighted in yellow and blue in the figure, representing the "problem space" and the "solution space" respectively. The sponsor (or, from S&T's perspective, the customer), representing the end users in the field (the operators), is responsible for all operational requirements, from the top-level mission requirements to the detailed system-level operational requirements. The system developer is responsible for translating the operational requirements into a system solution, documented in a hierarchy of technical specifications.

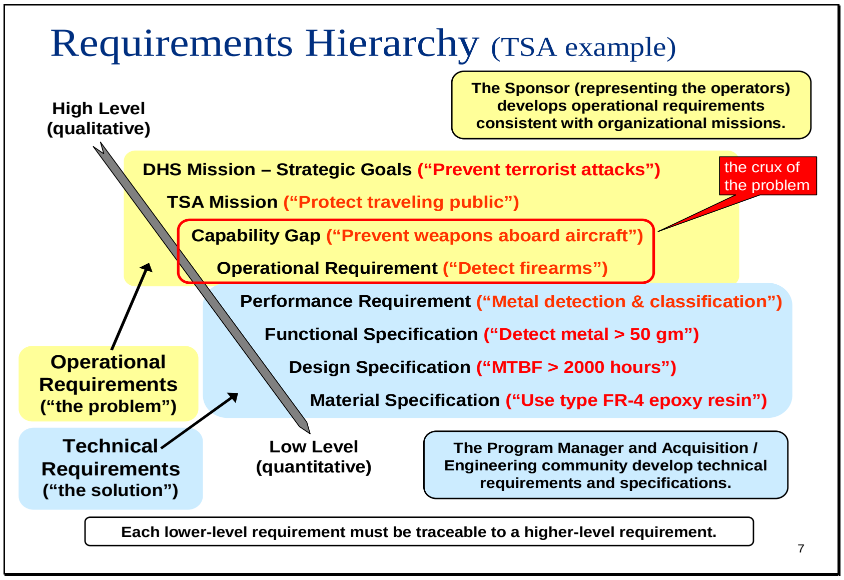


Figure 1. The requirements hierarchy

The highest-level type of technical "specification" is actually called a performance "requirement." A performance requirement actually represents a bridge from operational requirements to the engineering interpretation of those requirements. Put another way, in the course of developing a new system it is necessary to transform the system operational requirements, which are stated from the users' perspective as required outcomes of system action, into a set of system performance requirements, which are stated in terms of engineering characteristics.

The requirements and specifications are described below, first those which define the problem and then those that define the solution:

- **Problem Definition**
  - **Mission Needs Statement (MNS)** is required by the DHS *Investment Review Process* (Management Directive 1400, Appendix G) and is developed by the DHS sponsor (S&T's customer) who represents the end users. The MNS provides a high-level description of the mission need (or, equivalently, capability gap), and is used to justify the initiation of an Acquisition program.
  - **Operational Requirements Document (ORD)** is also required by the DHS *Investment Review Process* and, like the MNS, is developed by the DHS sponsor. The ORD specifies operational requirements and a concept of operations (CONOPS), written from the point of view of the end user. The ORD is independent of any particular implementation, should not refer to any specific technologies, and does not commit the developers to a design.
- **Solution Definition**

- **Performance Requirements** represent a bridge between the operationally oriented view of the system defined in the ORD and an engineering-oriented view required to define the solution. Performance requirements are an interpretation, not a replacement of operational requirements. Performance requirements define the functions that the system *and its subsystems* must perform to achieve the operational objectives and define the performance parameters for each function. These definitions are in engineering rather than operational terms.
- **Functional Specifications** define the system solution functionally, though not physically. Sometimes called the "system specification" or "A-Spec," these specifications define functions at the system, subsystem, *and component level* including:

  - Configuration, organization, and interfaces between system elements
  - Performance characteristics and compatibility requirements
  - Human engineering
  - Security and safety
  - Reliability, maintainability and availability
  - Support requirements such as shipping, handling, storage, training and special facilities

- **Design Specifications** convert the functional specifications of ***what*** the system is to do into a specification of ***how*** the required functions are to be implemented in hardware and software. The design specifications therefore govern the materialization of the system components.
- **Material Specifications** are an example of lower-level supporting specifications which support the higher-level specifications. Material specifications define the required properties of materials and parts used to fabricate the system. Other supporting specifications include **Process Specifications** (defining required properties of fabrication processes such as soldering and welding) and **Product Specifications** (defining required properties of non-developmental items to be procured commercially).

The hierarchy of specifications, which specifies the solution, is often depicted as a specification tree, of which a notional example is shown in Figure 2.

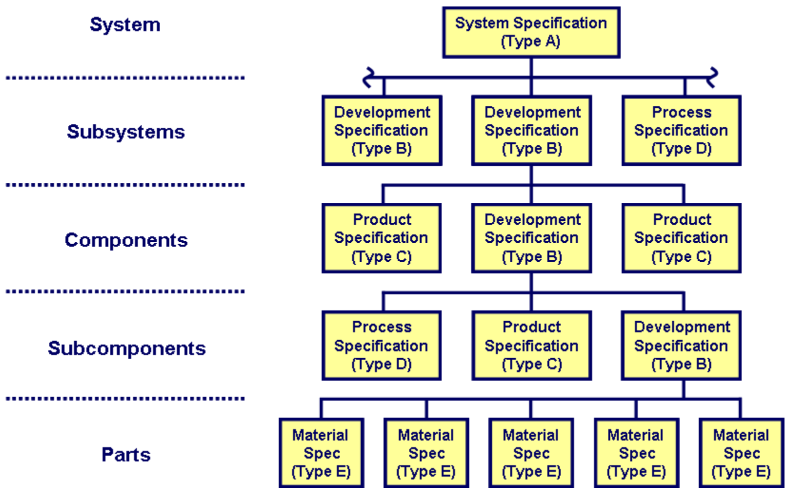


Figure 2. An example of a specification tree

An important feature of a requirements and specification hierarchy is a concept termed *traceability*, which is the thread that weaves this hierarchy into a coherent fabric with no loose ends. Traceability ensures completeness, that all lower-level requirements and acceptance criteria come from higher-level requirements and that all higher-level requirements are allocated to lower-level requirements. Traceability is also used to manage change and provides the basis for test planning, often using a tool called the Requirements Verification Matrix (RVM).

Please refer to Appendix D for more details concerning requirements.

Requirements and the Product Life Cycle

The previous section described the logical flow from high-level requirements to low-level specifications but did not address when these activities happen. To relate requirements development to other project activities, consider the generic product life cycle in Figure 3:

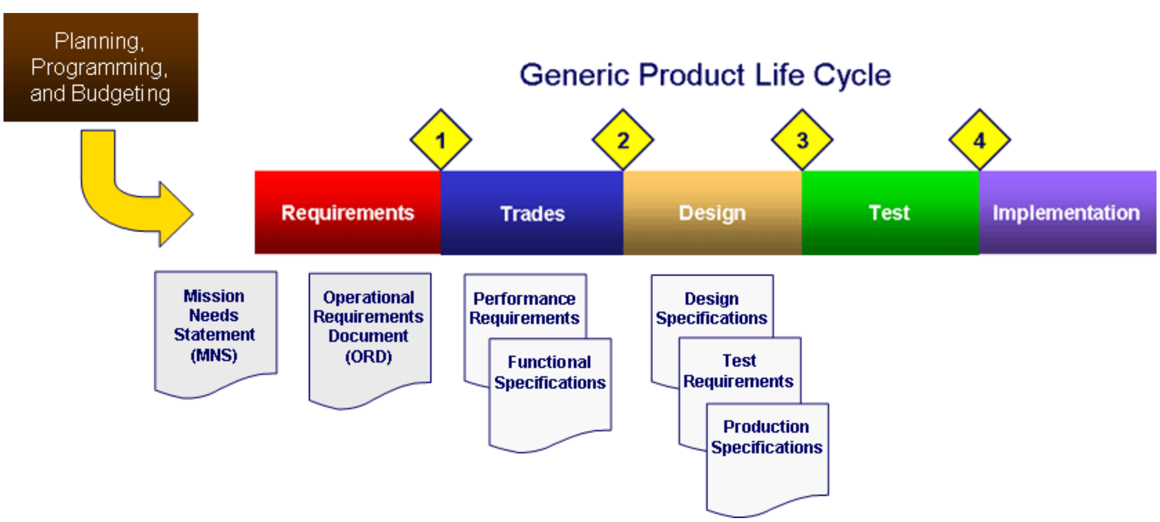


Figure 3. A generic product life cycle

The life cycle is a phase-gate framework, consisting of 5 sequential phases separated by 4 gates allowing the opportunity to assess a given project's progress before it advances to the next phase. Prior to the life cycle is an activity called Planning, Programming, and Budgeting (PP&B) during which preliminary versions of the requirements may be developed along with preliminary system concepts. Because of the time delay in the budget cycle, considerable time elapses between PP&B and project execution, so these preliminary requirements and concepts must be reassessed at project start. The phases include the following activities:

- Planning, Programming, and Budgeting
    - Capstone IPTs identify capability gaps (mission needs) requiring materiel solutions, and convey these capability gaps to S&T. In turn, S&T assesses technology-based solutions to address these gaps and develops rough order-of-magnitude (ROM) estimates of project cost and schedule. To develop these estimates and gain Capstone IPT support for a future project, S&T considers alternative system concepts. This PP&B activity is often informal and quite preliminary.
    - When the intent is to launch an Acquisition program to develop an end-user system, the sponsoring DHS Component documents the capability gap in a Mission Needs Statement.
- Requirements Phase
    - If the purpose of the project is to develop a product or system to be operated by end users, the Mission Needs Statement is updated, refined, and formalized.
    - The operational requirements are developed and documented in an Operational Requirements Document (ORD), providing the detailed quantitative definition of the problem to be solved. (We will later consider the case of other types of projects which do not develop end-user products and which therefore do not require operational requirements.)
    - Preliminary performance requirements may also be defined and documented in this phase, as the first step in defining the engineering solution. The preliminary performance requirements should be independent of any particular implementation, so as not to bias the subsequent analysis of alternatives.
- Trades Phase
    - Alternative system concepts are explored and the system requirements are allocated to subsystems whose performance requirements are defined. After selection of the optimum system concept, the functions necessary for system performance are defined down to the component level and documented as functional specifications. Often the interfaces between system elements are defined in separate documents called Interface Control Documents (ICDs).
- Design Phase
    - With the functional specifications defined, designers proceed to engineer the physical realization of the system and document this design in a set of design specifications and engineering drawings. Test requirements are finalized and preliminary production specifications are developed.

- Test Phase
    - Developmental test and evaluation verifies a representative test item or items against the functional specifications and performance requirements. Operational test and evaluation validates conformance to the Operational Requirements Document (ORD).
- Implementation Phase
    - The tested product is transitioned to its target environment. If the product is an end-user product, implementation consists of transition to production, followed by deployment, field operation, and support. If the product is a technology product not intended for use by end users, implementation consists of transition to a follow-on program (perhaps an Acquisition program) which will integrate the technology product into an end-user system.

Characteristics of Good Requirements

Requirements engineering is difficult and time-consuming, but must be done well if the final product or system is to be judged by the end users as successful. From the International Council of Systems Engineers (INCOSE) Requirements Working Group[1], here are eight attributes of good requirements:

Necessary:	Can the system meet prioritized, real needs without it? If yes, the requirement isn't necessary.
Verifiable:	Can one ensure that the requirement is met in the system? If not, the requirement should be removed or revised.
Unambiguous:	Can the requirement be interpreted in more than one way? If yes, the requirement should be clarified or removed. Ambiguous or poorly worded requirements can lead to serious misunderstandings and needless rework.
Complete:	Are all conditions under which the requirement applies stated? Also, does the specification include all known requirements?
Consistent:	Can the requirement be met without conflicting with any other requirement? If not, the requirement should be revised or removed.
Traceable:	Is the origin (source) of the requirement known, and is there a clear path from the requirement back to its origin?
Concise:	Is the requirement stated simply and clearly?
Standard constructs:	Requirements are stated as imperative needs using "shall." Statements indicating "goals" or using the words "will" or “should” are not imperatives.

Requirements and Test and Evaluation (T&E)

As described in the preceding section, one characteristic of good requirements is that they be verifiable. Accordingly, a project’s test and evaluation strategy must be designed so that all requirements are verified. To assure that the product or system meets all its requirements, a construct known as a Requirements Verification Matrix is often used to map all requirements into specific verification methods such as analysis, inspection,

[1] Kar, Pradip and Bailey, Michelle. Characteristics of Good Requirements. International Council of Systems Engineers, Requirements Working Group. INCOSE Symposium, 1996. Found online: http://www.afis.fr/nav/gt/ie/doc/Articles/CHARACTE.HTM.

demonstration, and test. The distinction between test and demonstration is that a test usually involves some sort of instrumentation and collection of data, whereas a demonstration verifies compliance by mere observation of results.

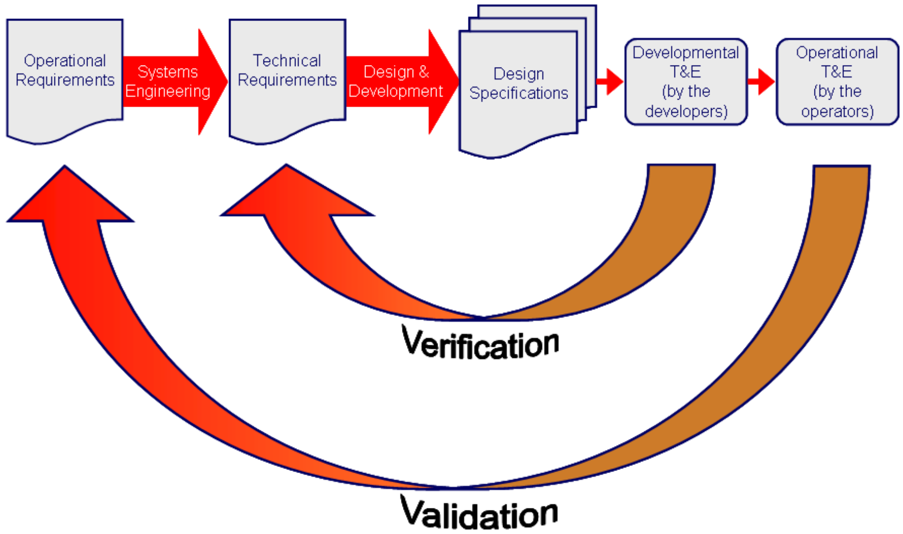


Figure 4. The linkage between requirements and T&E

Figure 4 above illustrates that the purpose of DT&E is to verify that the product or system meets its technical requirements (such as performance requirements and functional specifications). However, since the technical requirements are an engineering interpretation of the operational requirements, it is quite possible that a product or system can satisfy its technical requirements without satisfying its operational requirements. It's for this reason that products and systems also undergo OT&E conducted by an independent test agent, to provide objective validation that the system satisfies its operational requirements when operated by real end users in the most realistic environment available.

The simplified figure above does not depict T&E below the system level. However, as the system is integrated in preparation for system-level DT&E, components are tested prior to integration into subsystems, and subsystems are tested prior to integration into the total operational system. The strategy for testing at the component, subsystem, and system level is documented in a Test and Evaluation Master Plan.

Developing Operational Requirements: Customer Input

So far, we've discussed operational requirements but have not provided any insight into how to develop them. Let's first look at the contents of a typical Operational Requirements Document (ORD) shown in Figure 5 and discussed in more detail in Appendix A.

OPERATIONAL REQUIREMENTS DOCUMENT

1.0 General Description of Operational Capability
- 1.1. Capability Gap
- 1.2. Overall Mission Area Description
- 1.3. Description of the Proposed System
- 1.4. Supporting Analysis
- 1.5. Mission the Proposed System Will Accomplish
- 1.6. Operational and Support Concept
  - 1.6.1. Concept of Operations
  - 1.6.2. Support Concept

2.0 Threat

3.0 Existing System Shortfalls

4.0 Capabilities Required
- 4.1 Operational Performance Parameters
- 4.2 Key Performance Parameters (KPPs)
- 4.3 System Performance.
  - 4.3.1 Mission Scenarios
  - 4.3.2 System Performance Parameters
  - 4.3.3 Interoperability
  - 4.3.4 Human Interface Requirements
  - 4.3.5 Logistics and Readiness
  - 4.3.6 Other System Characteristics

5.0 System Support
- 5.1 Maintenance
- 5.2 Supply
- 5.3 Support Equipment
- 5.4 Training
- 5.5 Transportation and Facilities

6.0 Force Structure

7.0 Schedule

8.0 System Affordability

Appendixes

Glossary

Figure 5. The contents of an Operational Requirements Document

The complexity of the intended system and its operational context will govern the required level of detail in the ORD. The most difficult sections to develop are probably Section 4.0, which describes the capabilities required of the system to be developed, and Section 1.6, which describes the operational and support concepts.

In a perfect world, the operational requirements would be developed by S&T's customer, the sponsoring organization, representing the end users and support personnel in the field. Ideally, the role played by S&T in the development of the ORD would be limited to assessing technical feasibility and risk. However, if the sponsor's organization needs assistance in developing operational requirements, S&T should assist.

In helping DHS customers fill in the blanks, an S&T project manager will almost certainly discover that neither the end users nor their management know what they want in sufficient detail to proceed with product or system development. This barrier is only the first of many challenges to overcome in the development of operational requirements. These challenges may include:

- Users who may not understand precisely what they want or have a clear idea of their requirements. Few users talk about their tasks, needs, and operational environment in neat, concise statements about product requirements.
- Users who don't always understand the distinction between a problem and a solution and may insist on a specific preconceived solution that may be a poor fit to the problem.
- Users who may not commit to a set of written requirements.
- Users who may insist on new requirements throughout project execution, without regard to impact on cost and schedule.
- Poor communication between S&T program managers and due to differing vocabularies. Sometimes users and technologists use the same term to mean different things, leading them to believe they're in agreement when they're not.
- Users who often do not participate in reviews (or are incapable of doing so).
- Users who may be technically unsophisticated and may not understand the development process.
- Requirements discovery may be carried out by technical experts rather than by personnel with the people skills and the domain knowledge to understand user needs properly.

On the other hand, there are several challenges that face S&T program managers throughout the requirements gathering process. S&T program managers must interact with customers to gather and better understand the users' needs.

- Some program managers are not familiar with gathering requirements and communicating with end users.
- Some program managers do not know how to ask users questions to uncover hidden requirements.
- Poor communication between S&T program managers and due to differing vocabularies. Sometimes users and technologists use the same term to mean different things, leading them to believe they're in agreement when they're not.

Please refer to Appendix H for a briefing on "How to Start the Conversation."

There is no silver bullet to solve these potential challenges, but since the issues are universal, there is a wealth of literature that offers approaches to requirements development. As an example, here are nine requirements-elicitation techniques described in the *Business Analyst Body of Knowledge* (from the International Institute of Business Analysis)[2].

[2] International Institute of Business Analysis. *A Guide to the Business Analyst Body of Knowledge*, Release 1.6. 2006. Found online: http://www.theiiba.org/Content/NavigationMenu/Learning/BodyofKnowledge/Version16/BOKV1_6.pdf.

1. Brainstorming
   - Purpose
     - An excellent way of eliciting many creative ideas for an area of interest. Structured brainstorming produces numerous creative ideas.
   - Strengths
     - Able to elicit many ideas in a short time period.
     - Non-judgmental environment enables outside-the-box thinking.
   - Weaknesses
     - Dependent on participants' creativity.
2. Document Analysis
   - Purpose
     - Used if the objective is to gather details of the "As Is" environment such as existing standard procedures or attributes that need to be included in a new system.
   - Strengths
     - Not starting from a blank page.
     - Leveraging existing materials to discover and/or confirm requirements.
     - A means to cross-check requirements from other elicitation techniques such as interviews, job shadowing, surveys or focus groups.
   - Weaknesses
     - Limited to "as-is" perspective.
     - Existing documentation may not be up-to-date or valid.
     - Can be a time-consuming and even tedious process to locate the relevant information.
3. Focus Group
   - Purpose
     - A means to elicit ideas and attitudes about a specific product, service or opportunity in an interactive group environment. The participants share their impressions, preferences and needs, guided by a moderator.
   - Strengths
     - Ability to elicit data from a group of people in a single session saves time and costs as compared to conducting individual interviews with the same number of people.
     - Effective for learning people's attitudes, experiences and desires.
     - Active discussion and the ability to ask others questions creates an environment where participants can consider their personal view in relation to other perspectives.
   - Weaknesses
     - In the group setting, participants may be concerned about issues of trust, or may be unwilling to discuss sensitive or personal topics.
     - Data collected (what people say) may not be consistent with how people actually behave.
     - If the group is too homogenous, the group's responses may not represent the complete set of requirements.
     - A skilled moderator is needed to manage the group interactions and discussions.
     - It may be difficult to schedule the group for the same date and time.
4. Interface Analysis
   - Purpose
     - An interface is a connection between two components. Most systems require one or more interfaces with external parties, systems or devices.

Interface analysis is initiated by project managers and analysts to reach agreement with the stakeholders on what interfaces are needed. Subsequent analysis uncovers the detailed requirements for each interface.

- Strengths
  - The elicitation of the interfaces' functional requirements early in the system life cycle provides valuable details for project management:
    - Impact on delivery date. Knowing what interfaces are needed, their complexity and testing needs enables more accurate project planning and potential savings in time and cost.
    - Collaboration with other systems or projects. If the interface to an existing system, product or device and the interface already exists, it may not be easily changed. If the interface is new, then the ownership, development and testing of the interface needs to be addressed and coordinated in both projects' plan. In either case, eliciting the interface requirements will require negotiation and cooperation between the owning systems.
- Weaknesses
  - Does not provide an understanding of the total system or operational concept since this technique only exposes the inputs, outputs and key data elements related to the interfaces.

5. Interview
   - Purpose
     - A systematic approach to elicit information from a person or group of people in an informal or formal setting by asking relevant questions and documenting the responses.
   - Strengths
     - Encourages participation and establishes rapport with the stakeholder.
     - Simple, direct technique that can be used in varying situations.
     - Allows the interviewer and participant to have full discussions and explanations of the questions and answers.
     - Enables observations of non-verbal behavior.
     - The interviewer can ask follow-up and probing questions to confirm own understanding.
     - Maintain focus through the use of clear objectives for the interview that are agreed upon by all participants and can be met in the time allotted.
   - Weaknesses
     - Interviews are not an ideal means of reaching consensus across a group of stakeholders.
     - Requires considerable commitment and involvement of the participants.
     - Training is required to conduct good interviews. Unstructured interviews, especially, require special skills. Facilitation/virtual facilitation and active listening are a few of them.
     - Depth of follow-on questions may be dependent on the interviewer's knowledge of the operational domain.
     - Transcription and analysis of interview data can be complex and expensive.
     - Resulting documentation is subject to interviewer's interpretation.

6. Observation
    - Purpose
        - A means to elicit requirements by conducting an assessment of the operational environment. This technique is appropriate when documenting details about current operations or if the project intends to enhance or change a current operational concept.
    - Strengths
        - Provides a realistic and practical insight into field operations by getting a hands-on feel for current operations.
        - Elicits details of informal communication and ways people actually work around the system that may not be documented anywhere.
    - Weaknesses
        - Only possible for existing operations.
        - Could be time-consuming.
        - May be disruptive to the person being shadowed.
        - Unusual exceptions and critical situations that happen infrequently may not occur during the observation.
        - May not well work if current operations involve a lot of intellectual work or other work that is not easily observable.
7. Prototyping
    - Purpose
        - Prototyping, when used as an elicitation technique, aims to uncover and visualize user requirements before the system is designed or developed.
    - Strengths
        - Supports users who are more comfortable and effective at articulating their needs by using pictures or hands-on prototypes, as prototyping lets them “see” the future system’s interface.
        - A prototype allows for early user interaction and feedback.
        - A throw-away prototype is an inexpensive means to quickly uncover and confirm user interface requirements.
        - A revolutionary prototype can demonstration what is feasible with existing technology, and where there may be technical gaps.
        - An evolutionary prototype provides a vehicle for designers and developers to learn about the users’ interface needs and to evolve system requirements.
    - Weaknesses
        - Depending on the complexity of the target system, using prototyping to elicit requirements can take considerable time if the process is bogged down by the “how’s” rather than “what’s”.
        - Assumptions about the underlying technology may need to be made in order to present a starting prototype.
        - A prototype may lead users to set unrealistic expectations of the delivered system’s performance, reliability and usability characteristics.
8. Requirements Workshop
    - Purpose
        - A requirements workshop is a structured way to capture requirements. A workshop may be used to scope, discover, define, prioritize and reach closure on requirements for the target system. Well-run workshops are considered one of the most effective ways to deliver high quality requirements quickly. They promote trust, mutual understanding, and

strong communications among the project stakeholders and project team and produce deliverables that structure and guide future analysis.

- Strengths
  - A workshop can be a means to elicit detailed requirements in a relatively short period of time.
  - A workshop provides a means for stakeholders to collaborate, make decisions and gain a mutual understanding of the requirements.
  - Workshop costs are often lower than the cost of performing multiple interviews.
  - A requirements workshop enables the participants to work together to reach consensus which is typically a cheaper and faster approach than doing serial interviews as interviews may yield conflicting requirements and the effort needed to resolve those conflicts across all interviewees can be very costly.
  - Feedback is immediate, if the facilitator's interpretation of requirements is fed back immediately to the stakeholders and confirmed.
- Weaknesses
  - Due to stakeholders availability it may be difficult to schedule the workshop.
  - The success of the workshop is highly dependent on the expertise of the facilitator and knowledge of the participants.
  - Requirements workshops that involve too many participants can slow down the workshop process thus negatively impacting the schedule. Conversely, collecting input from too few participants can lead to overlooking requirements that are important to users, or to specifying requirements that don't represent the needs of the majority of the users.

9. Survey/Questionnaire
   - Purpose
     - A means of eliciting information from many people, anonymously, in a relatively short time. A survey can collect information about customers, products, operational practices and attitudes. A survey is often referred to as a questionnaire.
   - Strengths
     - When using 'closed-ended' questions, effective in obtaining quantitative data for use in statistical analysis.
     - When using open-ended questions, the survey results may yield insights and opinions not easily obtainable through other elicitation techniques.
     - Does not typically require significant time from the responders.
     - Effective and efficient when stakeholders are not located at one place.
     - May result in large number of responses.
     - Quick and relatively inexpensive to administer.
   - Weaknesses
     - Use of open-ended questions requires more analysis.
     - To achieve unbiased-results, specialized skills in statistical sampling methods are needed when the decision has been made to survey a sample subset.
     - Some questions may be left unanswered or answered incorrectly due to their ambiguous nature.
     - May require follow up questions or more survey iterations depending on the answers provided.
     - Not well suited for collecting information on actual behaviors.

Tailored Product Life Cycle: Acquisition

Earlier we considered a generic product life cycle, shown in Figure 6. For present purposes, we will ignore the PP&B phase, which precedes project execution.

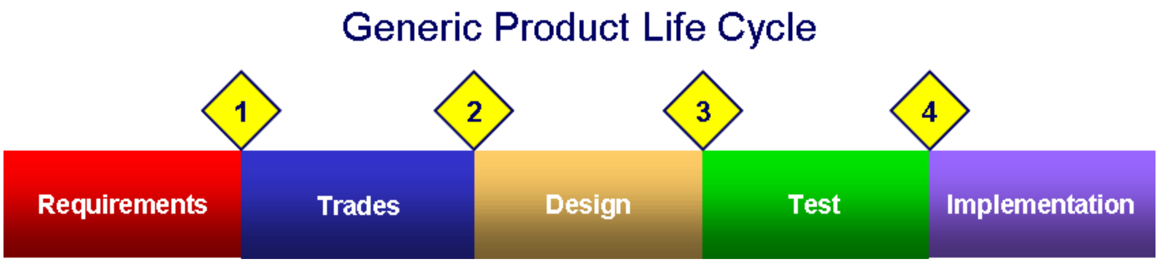


Figure 6. The generic product life cycle (revisited)

It is the nature of such generic management frameworks that they must be adapted ("tailored") to suit the specific needs of each project. For example, DHS has defined an Acquisition life cycle in MD1400 which governs major DHS Acquisitions, and whose structure is depicted in Figure 7.

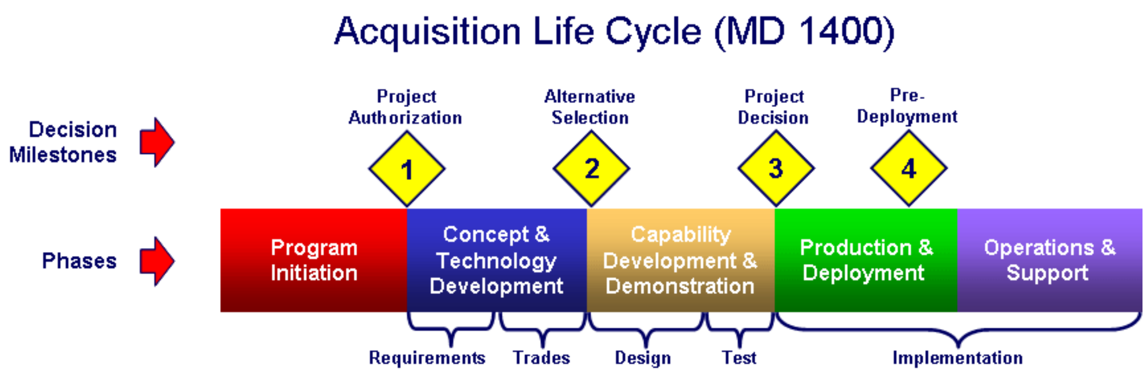


Figure 7. DHS' Acquisition Life Cycle (MD1400)

The mapping of the 5 phases in the generic life cycle model (Requirements, Trades, etc.) is shown. DHS development of end-user systems must use this framework which consists of 5 major phases punctuated by 4 major decision milestones called Key Decision Points. The framework also mandates standard documentation, including the MNS and the ORD.

Since we are focusing on requirements development in this document, we will focus on the Concept and Technology Development phase which, when expanded, can be diagrammed as shown in Figure 8.

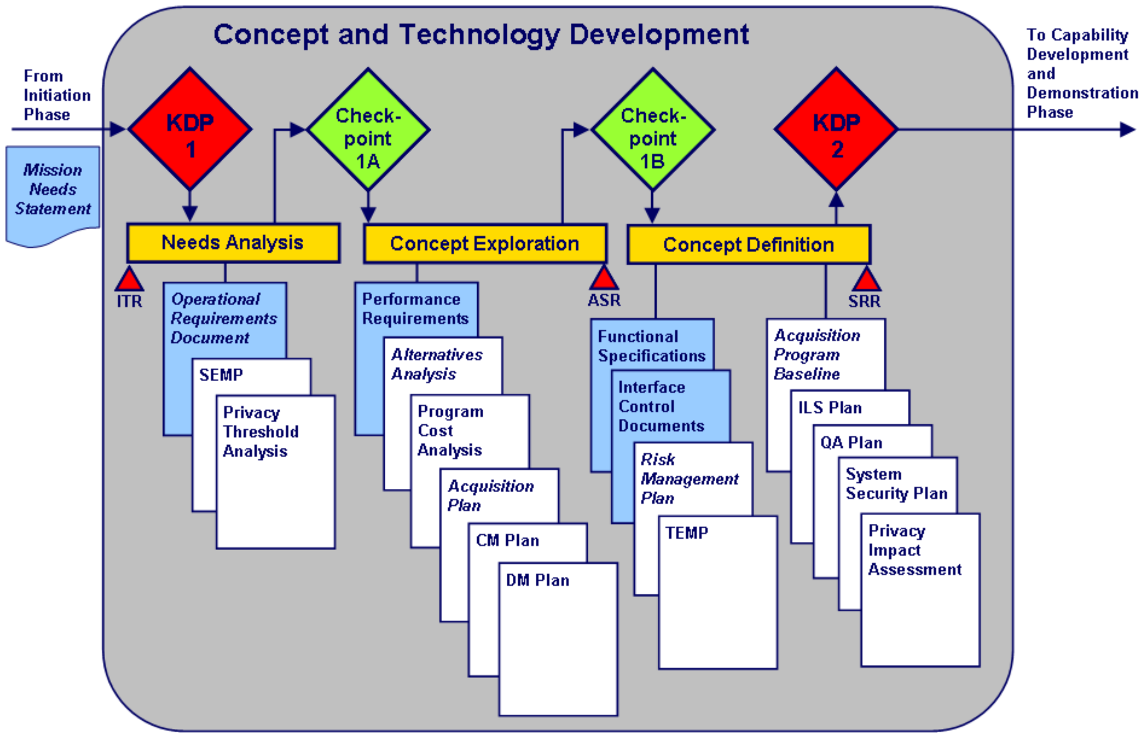


Figure 8. The Concept and Technology Development phase, expanded

The program documentation is depicted with the requirements documents highlighted in blue. Documents whose titles are in italics are mandated by MD1400, with the remaining documents representing industry best practice. Gates depicted as red diamonds are formal Key Decision Points defined in MD1400. Gates depicted as green diamonds are informal checkpoints which may be implemented by the program manager in the interests of program discipline. Technical reviews are depicted as red triangles. The acronyms are defined in the Glossary.

The Mission Needs Statement (MNS) is developed or refined during the Program Initiation Phase and is used to justify the Acquisition program to the appropriate Acquisition authority. The Operational Requirements Document (ORD) is developed during the Needs Analysis sub-phase, and represents a compromise that balances user needs against technological risk. The remaining requirements and specifications, which represent the engineering interpretation of the ORD, are developed later in the program, as depicted.

Further details concerning the Acquisition framework can be found in Appendix G and in MD1400.

The Acquisition framework assumes a conventional Acquisition program in which DHS controls the requirements and funds the system development and production, typically through a contract with a prime contractor. Such a model is appropriate where the end users are Federal employees under the management and control of a DHS Component, and where the product is sufficiently specialized that there is no commercial market. However, for end users in the private sector, such as the first-responder community, this model is unworkable because DHS cannot “deploy” to these users.

Tailored Product Life Cycle: Commercialization

As mentioned above, addressing capability gaps in user communities not under Federal control is impossible using a conventional Acquisition approach. Such users make independent buying decisions and procure commercial off-the-shelf (COTS) products and systems using conventional commercial channels, such as catalog and/or direct sales. In general, the private sector addresses the needs of these users without Government intervention, support, or subsidy. However, there are capability gaps that require Government intervention to cause a new COTS product to be developed and marketed by the private sector. DHS intervention in such cases may involve a combination of requirements development, technology transfers, grants programs, standards development, regulatory activism, and postings on DHS business and marketing vehicles.

It should be noted that the potential market for such new COTS products may be large, and is described in Appendix E which contains a briefing to industry used by S&T's Chief Commercialization Officer. Even when the users are Federal employees and therefore reachable by a conventional Acquisition approach, it may be in the Government's interest to prompt the private sector to address capability gaps by developing products and systems using their own funds, thus avoiding the up-front costs of an Acquisition program.

MD1400 is not relevant in such situations, as it does not apply when the major investments will be made by private-sector entities and by private-sector end users. Accordingly, S&T has developed a Commercialization framework which can be tailored to govern DHS support of product commercialization by the private sector. The phases of the framework are depicted in Figure 9, and the sub-phases are related to the 5 phases of the generic product life cycle (Requirements, Trades, Design, Test, and Implementation).

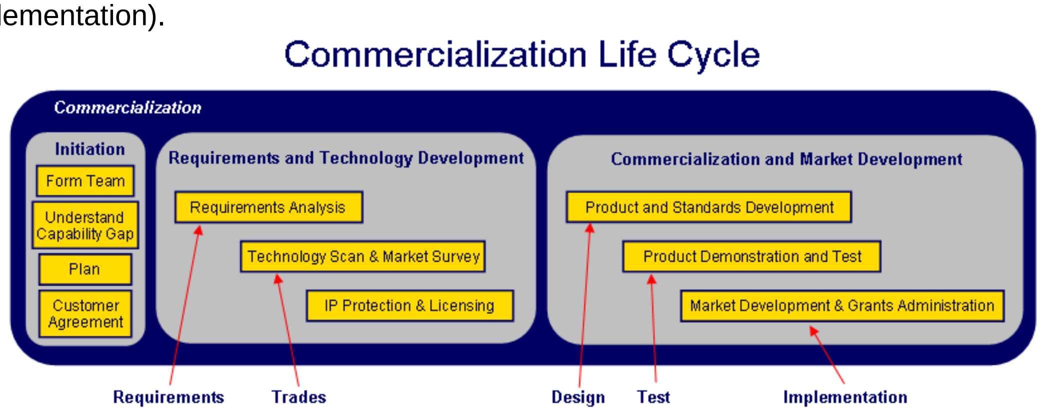


Figure 9. A product life cycle to govern Commercialization

Since our focus in this document is on requirements, we expand the Requirements and Technology Development sub-phase in Figure 10:

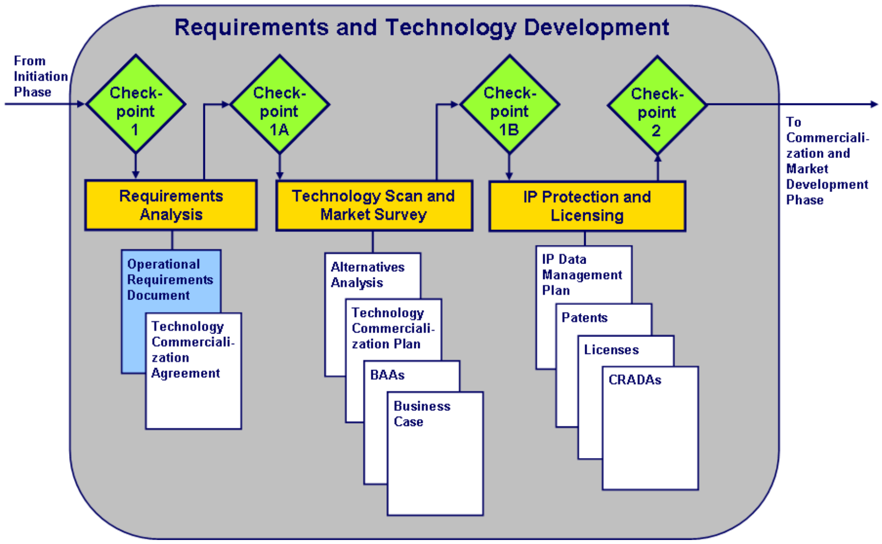


Figure 10. Expansion of the Req'ts and Tech. Development phase

Note that there is only one requirements document in this framework, which is the Operational Requirements Document (ORD) highlighted in blue. There is no required Mission Needs Statement because DHS has not formally acknowledged Commercialization as an alternative to Acquisition (as of this writing), though senior officials at DHS are closely monitoring pilot Commercialization programs. Nor are there downstream requirements and specifications (such as performance requirements and functional specifications) under DHS control, since the product or system development is done independently by a private-sector enterprise using their own funds and their own product realization or new product development process. The development of the ORD, however, proceeds in this framework just as it does in the Acquisition framework.

Another view of the Commercialization framework is depicted in Figure 11. It shows the program flow starting with the identification of a capability gap by a Capstone IPT and ending with the market availability and support of a new COTS product.

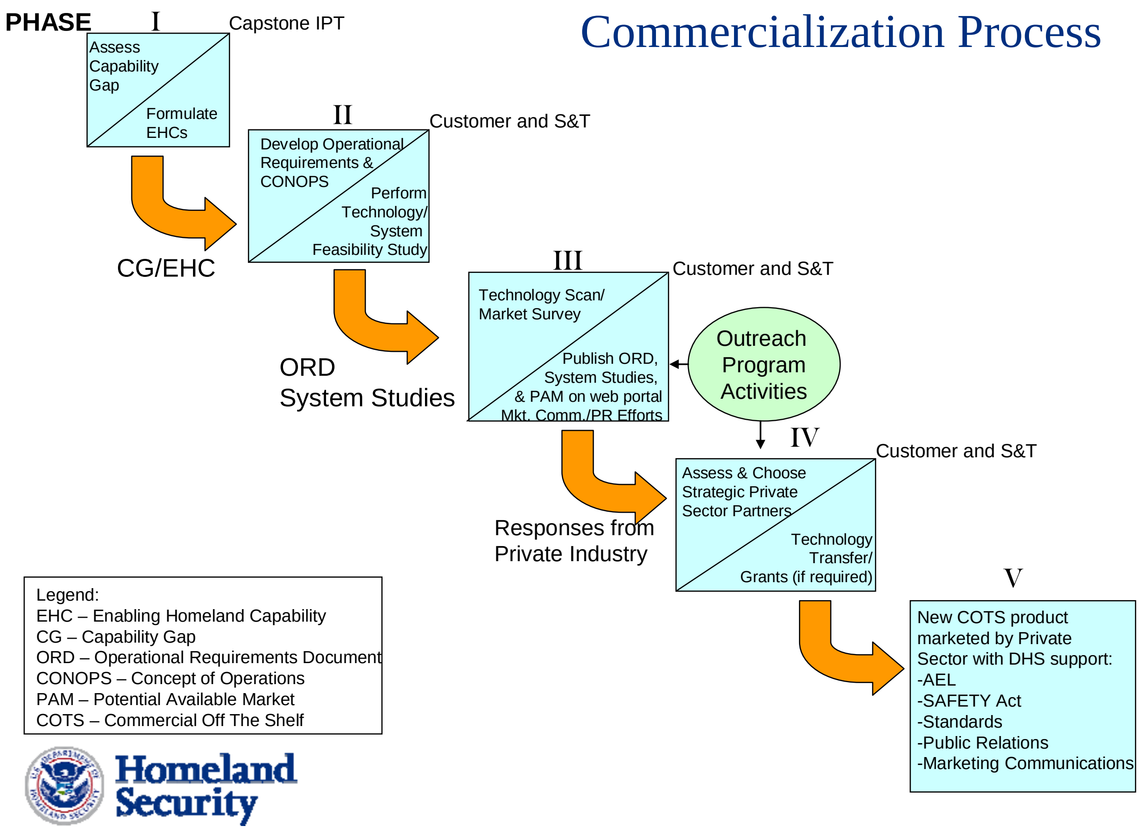


Figure 11. Another view of the Commercialization product life cycle

DHS-S&T has developed the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program that is designed to leverage the skills, productivity and resources of the private sector to develop new technologies, products or services aligned to DHS' customer requirements. The SECURE Program (currently in the Pilot phase) allows private sector entities to develop products that are tailored specifically to address detailed operational requirements of DHS customers, validate T&E on their product, and enables end users to make informed decisions on products that meet their requirements. See Appendix F for the SECURE Program Concept of Operations.

Further details concerning Commercialization are found in Appendix C.

Tailored Product Life Cycle: Other Project Types

If a project's goal is to develop an end-user system, the Acquisition and Commercialization frameworks described in the two preceding sections are relevant. However, in many cases, S&T's customers do not task us to develop an end-user system but instead task us to execute only part of the product life cycle, such as:

- Develop a technology product for subsequent integration into an end-user system. (A "technology product" is not designed to be used by end users, but instead is intended to be integrated into end-user systems by their developers. An example would be a new type of sensor technology.)

- Assess a specific emerging threat as a prerequisite to requirements development for a system to address the threat. (An example of an “emerging threat” would be a new type of explosive undetectable by current screening systems.)
- Develop a standard to govern the testing, evaluation, and/or use of products or systems by end users, or to govern the application of grants programs. (Standards are adopted by industry groups, for example, to facilitate or ensure standardization of product features, interfaces, or test methods. They may also be used by DHS to aid in the implementation of grants programs.)

Each of these project variants has a specific product to be delivered to specific customers. Accordingly, it is appropriate to start project planning by considering the generic product life cycle (shown again below as Figure 12) and tailoring it to the specific product type to be developed.

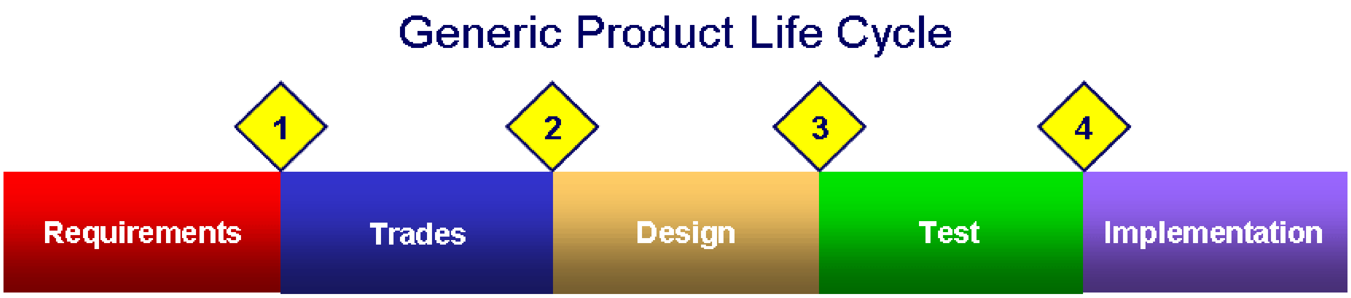


Figure 12. The generic product life cycle (revisited again)

- Requirements Phase
    - Regardless of the type of product, it will have requirements of some sort (though not “operational requirements” if it’s not a product which will be “operated”). These requirements should be elicited, analyzed, and documented in the Requirements Phase. As with operational requirements, these requirements (whatever form they take) are “owned” by S&T’s customer, who should play the principal role in their development.
- Trades Phase
    - Regardless of the type of product, there are likely to be several alternative ways of realizing it. These should be analyzed in the Trades Phase and the optimum approach chosen.
- Design Phase
    - Develop the product
- Test Phase
    - Assess the product’s conformance to its requirements and fitness for use
- Implementation
    - Implementation consists of some form of transition to the customer. Perhaps it’s integration of a technology product into a customer’s Acquisition or Commercialization program, or perhaps it’s simply the delivery of the documented results of a study.

Summary

This document has presented a brief summary of the role of requirements in product and system development, with particular emphasis on operational requirements governing the development of an end-user system. Acknowledging the difficulty of requirements development, it presented nine best practices to elicit requirements from an end-user community and eight criteria to judge the "goodness" of requirements. It also presented a generic product life cycle intended to govern the development of various types of products. It illustrated how this generic life cycle can be tailored in one way to govern an Acquisition program and tailored in another way to govern a Commercialization program. It also considered the development of technology products designed to enable, eventually, a more capable end-user system. Lastly, it considered the development of "knowledge products" such as studies of emerging threats or development of standards, which enables or augments a future Acquisition or Commercialization program.

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Glossary

Alternative Systems Review (ASR). The ASR is a multi-disciplined technical review, conducted at the end of the Concept Exploration phase, to ensure that the Operational Requirements Document agrees with the customers' needs and expectations and that the system under review can proceed into the Concept Definition phase. Generally, this review assesses the alternative systems that have been evaluated during the Concept Exploration phase, and ensures that the preferred system alternative is cost effective, affordable, operationally effective and suitable, and can be developed to provide a timely solution to a need at an acceptable level of risk.

Commercial Off-the-Shelf (COTS) Products are products which are commercially available and which can be procured through retail sales channels.

Concept of Operations (CONOPS). Normally a part of the ORD, the CONOPS is a formal document that identifies the end users, describes their skill levels and environment, and describes how the proposed product or system will be used in the field to accomplish the intended mission. The CONOPS may also include relationships with other systems or entities, information sources and destinations, and other relationships or constraints.

Configuration Management (CM). The discipline of identifying the configuration of a hardware/software system at each life cycle phase for the purpose of controlling changes to the configuration and maintaining the integrity and traceability of the configuration through the entire life cycle.

Data Management (DM). The goals of data management include providing accurate, efficient, and effective information and support for resource management and protection. Resource managers need to know: what data are available, in development, or stored; the quality, timeliness, and uses of the data; how to incorporate this data into resource management decisions; and how the data will be managed over time.

Developmental Test and Evaluation (DT&E). Any engineering test used to verify status of technical development, verify that design risks are minimized, substantiate achievement of technical performance and certify readiness for OT&E. Developmental tests generally require instrumentation and measurements and are accomplished by engineers, technicians, or operators in a controlled environment to facilitate failure analysis. One purpose of DT&E is to verify that the test item conforms to its technical requirements, including performance requirements and functional specifications.

End User. The field operator who will actually use the product or system in an operational environment. Examples include border protection agents, firefighters, and Coast Guard sailors.

Initial Technical Review (ITR). The ITR is a multi-disciplined technical review, conducted at the outset of the Concept and Technology Development phase, to assess the mission needs and conceptual approach of a proposed program and to verify that the requisite research, development, test, engineering, logistics, and programmatic bases for the program reflect the complete spectrum of technical challenges and risks. Additionally, the ITR ensures that historical and prospective drivers of system cost have been quantified to the maximum extent and that the range of uncertainty in these parameters has been captured and reflected in the program cost estimates.

Integrated Logistics Support (ILS). The discipline which plans for and provides the infrastructure and material resources needed to support a system in the field.

Key Decision Point (KDP). Critical milestones throughout the DHS Investment Review Process, defined in MD 1400.

Mission Need Statement (MNS). A core DHS document that provides a high-level description of the mission need, whether from a current or impending gap, based on business-case planning. This document, prepared by the Component, outlines only the concept of the solution to fill the gap and does not provide information on expected Acquisitions. [Source: DHS *Investment Review Process*, DHS MD1400.]

Objective. The desired value for a specific requirement. See also "Threshold," which is the minimum acceptable value.

Operational Requirements Document (ORD). The ORD is a formal document, which describes in detailed quantitative terms what the intended system must be able to do and how it is intended to be used (defined in the CONOPS). The ORD provides a bridge between the high-level operational requirements in the MNS and the detailed system technical specifications. The MNS and ORD are written by the sponsor, whereas the technical specifications are written by the system developer. The ORD establishes absolute minimums ("thresholds") below, which the mission cannot be successfully performed, and sets goals ("objectives") to define an operationally effective system.

Operational Test and Evaluation (OT&E). The field-test, under realistic conditions, of any product, system, or key component for the purpose of determining effectiveness and suitability for use by typical users and the evaluation of the results of such a test. One purpose of OT&E is to validate that the test item conforms to a system's ORD.

Quality Assurance. The discipline used by program management to objectively monitor, control, and gain visibility into the development or maintenance process.

Requirement. A condition or capability that must be met or possessed by a system, product, service, result, or component to satisfy a contract, standard, specification, or other formally imposed documents. Requirements include the quantified and documented needs, wants, and expectations of the sponsor, customer, and other stakeholders. [Source: *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, Third Edition, 2004.]

Specification. A document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a system, component, product, result, or service and, often, the procedures for determining whether these provisions have been satisfied. Examples are: requirement specification, design specification, product specification, and test specification. [Source: *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*, Third Edition, 2004.]

Sponsor. The sponsor represents the operational needs of the Component and, ultimately, the end-users of the required system. The sponsor conducts mission analyses, identifies capability gaps, conducts requirements analyses, and participates in the long-range planning process and the prioritization of needs. The sponsor's final requirements are formally documented in an operational requirements document, and the sponsor participates in all phases of the Acquisition to ensure that the item or system being acquired meets operational requirements. [Source: *Investment Review Process*, DHS MD1400.] Typically, the sponsoring organization is a DHS Component with an operational mission. From the perspective of the S&T Directorate, these DHS Components are the customers for S&T's products, so S&T tends to use the terms "sponsor" and "customer" interchangeably.

System Requirements Review (SRR). The SRR, conducted at the end of the Concept Design phase (and therefore at the end of the Concept and Technology Development phase), assesses progress in defining system technical requirements. This review determines the direction and progress of the systems engineering effort and the degree of convergence upon a balanced and complete configuration.

Systems Engineering Management Plan (SEMP). A formal document that describes a project's process and plan for the technical development of a system. It typically includes sections on planning, requirements analysis, functional analysis and allocation, synthesis, systems analysis and systems control.

Test and Evaluation Master Plan (TEMP). A formal document that identifies a project's test and evaluation tasks and activities so that the entire product or system can be adequately tested to assure a successful implementation.

Threshold. The minimum acceptable value for a specific requirement, below which the product is considered a failure. See also "Objective," which is the desired value.

Appendix A: Operational Requirements Document (ORD) Template

1. General Description of Operational Capability

In this section, summarize the capability gap which the product or system is intended to address, describe the overall mission area, describe the proposed system solution, and provide a summary of any supporting analyses. Additionally, briefly describe the operational and support concepts.

1.1. Capability Gap

Describe the analysis and rationale for acquiring a new product or system, and identify the DHS Component, which contains or represents the end users. Also, name the Capstone IPT, if any, which identified the capability gap.

1.2. Overall Mission Area Description

Define and describe the overall mission area to which the capability gap pertains, including its users and its scope

1.3. Description of the Proposed System

Describe the proposed product or system. Describe how the product or system will provide the capabilities and functional improvements needed to address the capability gap. Do not describe a specific technology or system solution. Instead, describe a conceptual solution for illustrative purposes.

1.4. Supporting Analysis

Describe the analysis that supports the proposed system. *If a formal study was performed, identify the study and briefly provide a summary of results.*

1.5. Mission the Proposed System Will Accomplish

Define the missions that the proposed system will be tasked to accomplish.

1.6. Operational and Support Concept

1.6.1. Concept of Operations

Briefly describe the concept of operations for the system. How will the system be used, and what is its organizational setting? It's appropriate to include a graphic that depicts the system and its operation. Also, describe the system's interoperability requirements with other systems.

1.6.2. Support Concept

Briefly describe the support concept for the system. How will the system (hardware and software) be maintained? Who will maintain it? How, where, and by whom will spare parts be provisioned? How, where, and by whom will operators be trained?

2. Threat

If the system is intended as a countermeasure to a threat, summarize the threat to be countered and the projected threat environment.

3. Existing System Shortfalls

Describe why existing systems cannot meet current or projected requirements. Describe what new capabilities are needed to address the gap between current capabilities and required capabilities.

4. Capabilities Required

4.1. Operational Performance Parameters

Identify operational performance parameters (capabilities and characteristics) required for the proposed system. Articulate the requirements in output-oriented and measurable terms. Use Threshold/Objective format and provide criteria and rationale for each requirement.

4.2. Key Performance Parameters (KPPs)

The KPPs are those attributes or characteristics of a system that are considered critical or essential. Failure to meet a KPP threshold value could be the basis to reject a system solution.

4.3 System Performance.

4.3.1 Mission Scenarios

Describe mission scenarios in terms of mission profiles, employment tactics, and environmental conditions.

4.3.2 System Performance Parameters

Identify system performance parameters. Identify KPPs by placing an asterisk in front of the parameter description.

4.3.3 Interoperability

Identify all requirements for the system to provide data, information, materiel, and services to and accept the same from other systems, and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together.

4.3.4 Human Interface Requirements

Discuss broad cognitive, physical, and sensory requirements for the operators, maintainers, or support personnel that contribute to, or constrain, total system performance. Provide broad staffing constraints for operators, maintainers, and support personnel.

4.3.5 Logistics and Readiness

Describe the requirements for the system to be supportable and available for operations. Provide performance parameters for availability, reliability, system maintainability, and software maintainability.

4.3.6 Other System Characteristics
Characteristics that tend to be design, cost, and risk drivers.

5. System Support
Establish support objectives for initial and full operational capability. Discuss interfacing systems, transportation and facilities, and standardization and interoperability. Describe the support approach including configuration management, repair, scheduled maintenance, support operations, software support, and user support (such as training and help desk).

5.1 Maintenance
Identify the types of maintenance to be performed and who will perform the maintenance. Describe methods for upgrades and technology insertions. Also address post-development software support requirements.

5.2 Supply
Describe the approach to supplying field operators and maintenance technicians with necessary tools, spares, diagnostic equipment, and manuals.

5.3 Support Equipment
Define the standard support equipment to be used by the system. Discuss any need for special test equipment or software development environment

5.4 Training
Describe how the training will ensure that users are certified as capable of operating and using the proposed system.

5.5 Transportation and Facilities
Describe how the system will be transported to the field, identifying any lift constraints. Identify facilities needed for staging and training.

6. Force Structure
Estimate the number of systems or subsystems needed, including spares and training units. Identify organizations and units that will employ the systems being developed and procured, estimating the number of users in each organization or unit.

7. Schedule
To the degree that schedule is a requirement, define target dates for system availability. If a distinction is made between Initial Capability and Full Operational Capability, clarify the difference between the two in terms of system capability and/or numbers of fielded systems.

8. System Affordability
Identify a threshold/objective target price to the user at full-rate production. If price is a KPP, include it in the section on KPPs above.

Signatures

Sponsor's Acquisition Program Manager [print and sign] Date

Sponsor's Representative [print and sign] Date

S&T Project Manager [print and sign] Date

S&T Division Head [print and sign] Date

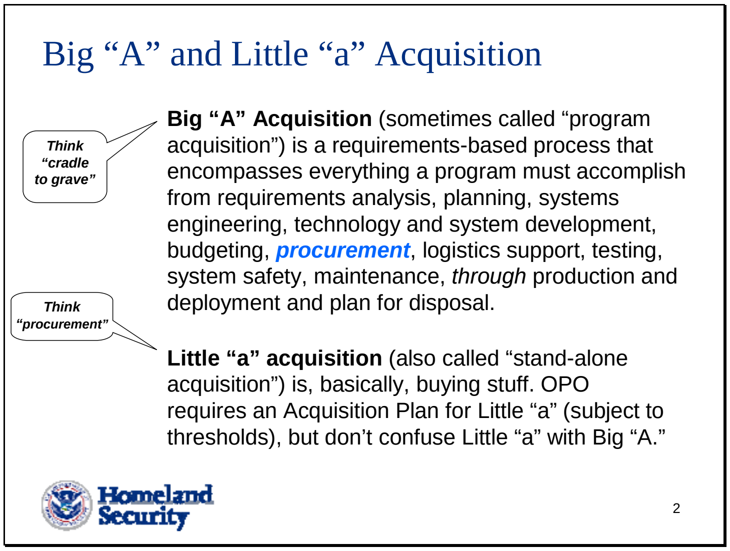
Appendix B: Acquisition Mini-Course

The following pages include the slides and slide notes used in teaching the S&T hour-long mini-course on Acquisition.

Slide 1

This mini-course is one of a series of about a dozen, sponsored by the S&T Office of Strategy, Planning, and Integration.
The briefing takes an hour, and will start and stop on time, so make sure any questions are for general clarification. The speaker will remain for 30 minutes after the end for discussion, if desired.
Hard copies of the slides will be handed out. The slides are also available from the RDT&E web site (click on Training and follow your nose). To browse the RDT&E web site, double-click on “Shared\RDT&E Process Website\index.htm” (then bookmark).
Please sign the sign-in sheet.
Today we’ll be talking about Acquisition, which is one of two principal methods by which S&T’s technologies can find their way to the user. (The other method is via COTS, enabled by technology transfer, which we’ll talk about in another session.)
Acquisition can be confusing because the word is used to mean different things and is often confused with procurement. The next slide addresses this confusion.

Slide 2



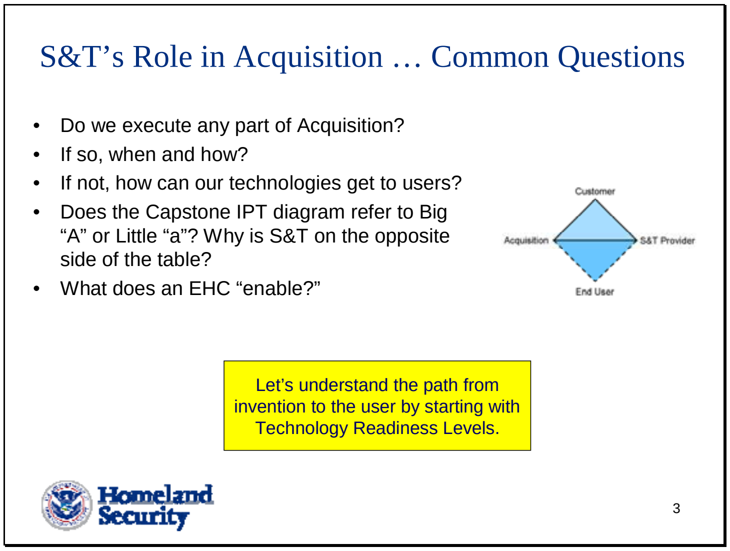
“Acquisition” is one of those words, like “research”, “transition,” “program,” and “project” which are in the common vernacular and used by different people to mean different things. Where precision is useful, these words have to be defined more precisely. So let’s avoid some confusion be defining the two contexts in which the word “acquisition” is used.

Little “a” acquisition is basically a procurement action to buy existing products or services. OPO requires documentation (e.g., an acquisition plan and/or an alternatives analysis) to demonstrate that you’ve thought through what you’re buying and are making good choices, but it’s a relatively straightforward and low-risk procurement.

Big “A” acquisition is a process to acquire a product or system which must be developed to a set of requirements. It’s much higher-risk than Little “a” acquisition, and requires disciplined program management to manage the risk and assure the outcome.

In short, Little “a” acquisition is buying stuff that exists, and Big “A” acquisition is buying stuff that doesn’t yet exist.

Slide 3



There are exceptions to all blanket statements regarding RDT&E (which is why the unofficial motto of the Defense Acquisition University is "it depends").

But, here's a blanket statement... Except for COTS, Acquisition is the only path for technology to get to the users. So if we don't execute any part of Acquisition, the only way for our technology to reach the users is through someone else's Acquisition program. Hence, it's critical that S&T be effective in transitioning to Acquisition. Without transition, we cannot influence Homeland Security in any significant way.

It's also critical that our customers become expert at Acquisition. If the customer has no effective Acquisition program, there's nothing for S&T to transition to.

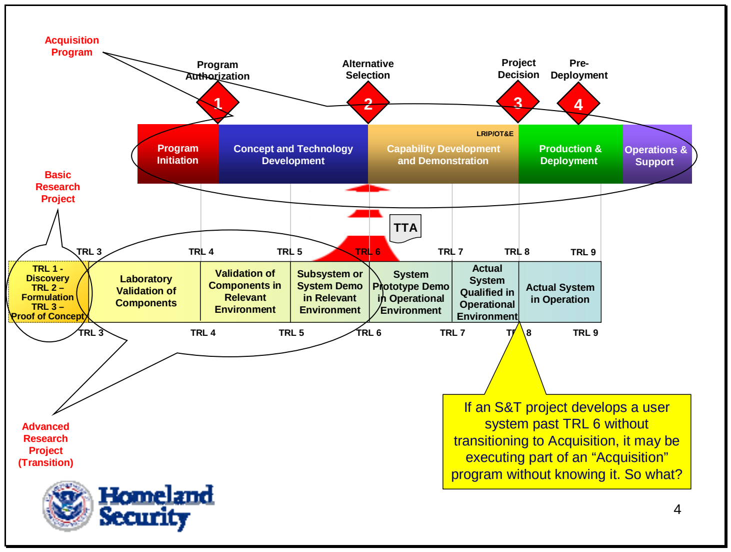
Even if we aren't executing any part of an Acquisition program, we need to understand Acquisition so we can interface with it (or even know when a customer's Acquisition program doesn't exist or isn't viable).

And, by the way, just who does sit in that seat labeled "Acquisition" on the other side of the table?

By the end of this hour, we'll come back to these questions and see if we have answers.

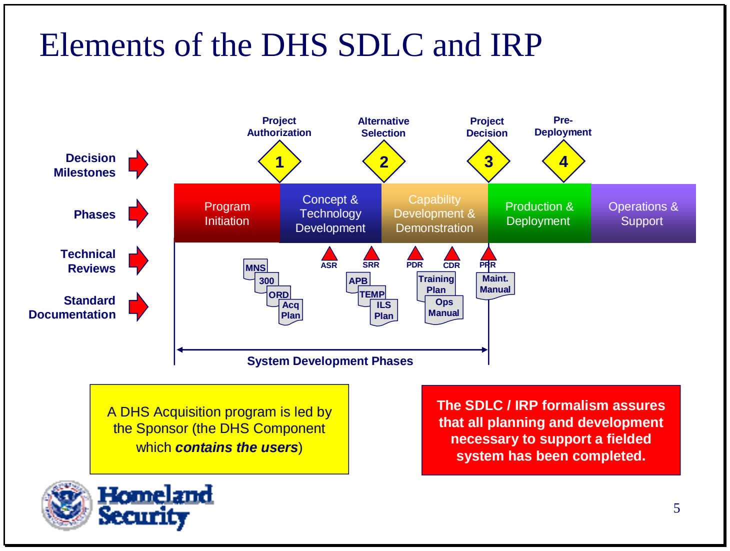
The next slide will allow us to take a look at the path that technology takes from invention to the users, and note where it leaves the S&T track and enters the Acquisition track.

Slide 4



This slide builds, so it is best viewed in PowerPoint's "slide-show mode."
TRL is a 9-point scale measuring technology maturity. For example, a modern cell phone is at TRL 9. In 1975, the prototype cell phone (at TRL 2) was a Ford van with a minicomputer inside and an antenna on top. Mobile phone technology matured through proof of concept (TRL 3), laboratory analyses and experiments, field experiments, etc., to the mature product you use today. There is no way, at TRL 2, to create a program plan through TRL 8 or 9, because there's too much uncertainty. So you take it a step at a time (Basic Research, then Applied Research, then Acquisition). It's all about risk reduction.
In interpreting this diagram, don't forget the unofficial motto of DAU – "It depends." For example, the TRL at transition could be earlier than TRL 6 if the benefit is worth the added risk.
You transition to Acquisition at TRL 6 (roughly) because (a) the risk is low enough, and (b) you haven't started final system design yet. When you're doing final system design, you need the planning and controls that the SDLC and IRP include. At TRL 7, by definition, you've demonstrated a prototype near or at planned operational system, in an operational environment. If you're that far along, the system development should be inside the Acquisition program.
Note that there's "technology development" in the Acquisition program (CTD) phase and also in the Advanced Research project. How do they relate? "It depends." How does the new technology enter the Alternatives Analysis in CTD? Or does it? "It depends." Perhaps the technology development by S&T outside the Acquisition program is not on the critical path, and not necessary for the Acquisition (so that if it fails, the Acquisition still proceeds).
Sponsors are responsible for Acquisition programs because 85% of the life-cycle costs are in their domain (Production, Deployment, Operations, and Support). If the Sponsor doesn't need the system badly enough to pay for these large out-year costs, there's no point in developing a system.
You don't develop a production-ready user system without entering the SDLC, and thereby submitting yourself to the IRP. Otherwise, you might end up with a system ready to ship but without any logistics system in the field. No maintenance techs, no spare parts, no manuals, no troubleshooting equipment, no user training. Also no environmental requirements. Even worse, no life-cycle funding! In other words, an Applied Research project developing a "production-ready design" of an operational system is a sneak path to the field, which is generally a bad idea (though, of course, "it depends").

Slide 5



This chart shows the 4 elements of the SDLC/IRP: decision milestones, phases, technical reviews, and documentation. It's a good example of a phase-gate process (just like DoD 5000, after which it's modeled).

The Sponsor is responsible for Production, Deployment, Operations, Support, since the Sponsor is the DHS Component which contains (or represents) the end users. S&T is almost never the Acquisition Sponsor, because we don't operate systems in the field, and therefore don't fund the big-dollar phases (P&D and O&S). Generally the only Acquisitions for which S&T would be the Sponsor would be acquisition of facilities (such as NBAF, which is to replace Plum Island Animal Disease Center).

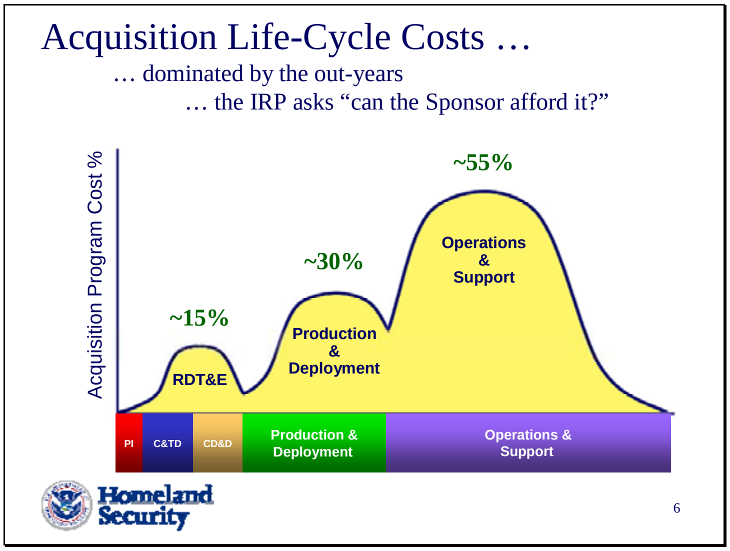
We may execute the "System Development Phases" (shown), if the Sponsor asks us to manage that part of the life cycle. But we do that as a "subcontractor" to the Sponsor, who is responsible for the requirements and the out-year funding (even if we budget for design and development).

The importance of executing system development INSIDE AN ACQUISITION PROGRAM is that the formalism forces certain best practices, such as operational requirements development, out-year funding, logistics planning, etc. If a system prototype is developed by S&T without linkage to an Acquisition program, the likely outcome is an unsupportable system which also may not be compliant with the users' operational requirements.

This is a good time to reflect on the concept of "tailoring." There are almost no hard-and-fast rules in RDT&E management. The caveat to almost every rule or guideline is "it depends." R&D processes are not like manufacturing processes, designed to produce the same output over and over again. On the production line, innovation is anathema, since production processes must be tightly controlled. But R&D is different. Unlike a production process, which must produce the same thing many times, an R&D process must produce the same thing ONCE. Thus, there aren't really R&D processes, which dictate what you must do, but R&D management frameworks, providing guidelines within which projects are planned and executed. The framework provides a structure, a common vocabulary, checklists, templates, and best practices, but it's not intended to be prescriptive. The project manager must is expected to have the wisdom and experience to decide what elements of the framework are appropriate for his/her project. For example, if the project doesn't require configuration management (CM), then tailor out the CM Plan, but be prepared to defend that decision. Or if an alternatives analysis isn't felt to be necessary, then tailor out the concept exploration phase, and be prepared to defend *that* decision when someone asks "why didn't you consider this alternative approach?"

Acronyms: ASR = Alternative Systems Review, SRR = System Requirements Review, PDR = Preliminary Requirements Review, CDR = Critical Design Review, PRR = Production Readiness Review

Slide 6

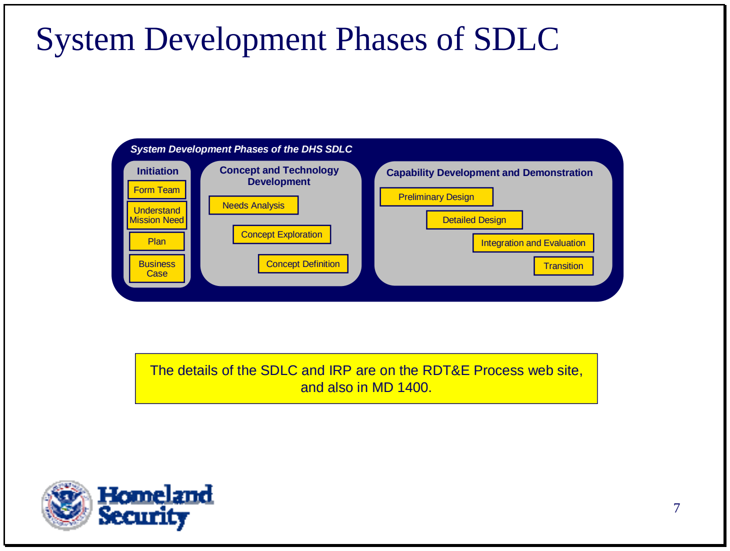


There's little point doing RDT&E to develop a system if the Sponsor can't afford the life-cycle costs. For most systems the majority of cost is incurred in O&S.

In Program Initiation, the IRP requires the Sponsor to create a Business Case (typically, an Exhibit 300), forcing the Sponsor to consider the entire life cycle. If S&T is responsible for the RDT&E phases, the Sponsor needs S&T's help in estimating the life-cycle costs.

The DHS system development life cycle doesn't explicitly include disposal costs, but they may be sizeable and should not be ignored.

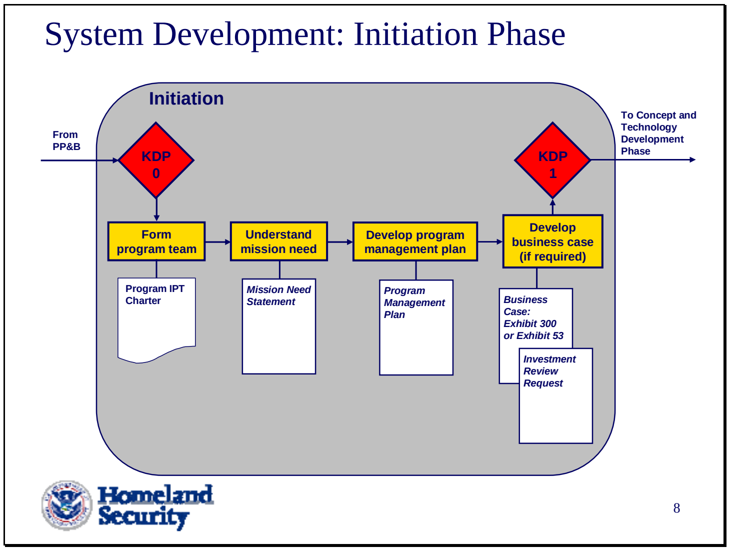
Slide 7



This slide is the first one to show a graphic from the RDT&E web site, and therefore is a good segue to the site. Note that the three phases shown here ("Initiation," etc.) are the first three phases of SDLC shown on the previous slide, and that on the web site you find more explanation and detail by drilling down. Down to a certain level of detail, the web site simply provides a user-friendly version of the DHS SDLC and MD 1400, "Investment Review Process". Below that level of detail, standard systems engineering best practices are included. (For example, the three sub-phases of C&TD – "Needs Analysis" etc. – are not part of the SDLC but are simply textbook systems engineering, integrated with the SDLC.)

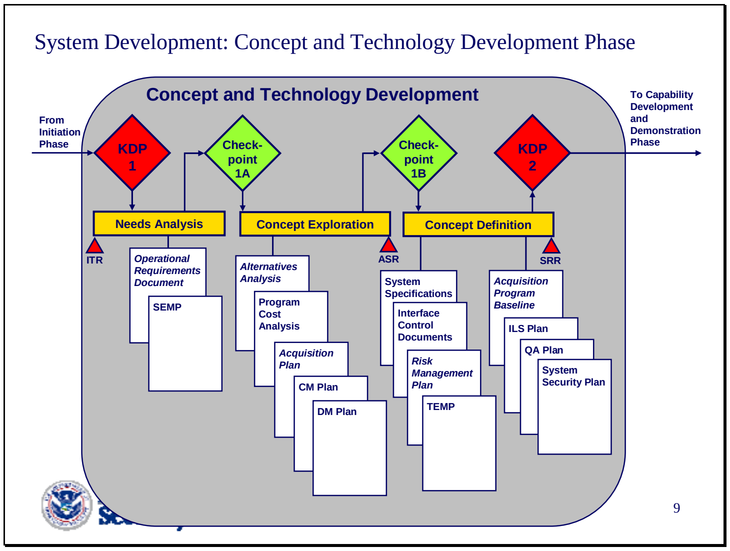
Much of the textbook systems engineering on the web site is taken from Kossiakoff and Sweet, *Systems Engineering Principles and Practice*, but any good systems engineering text will serve, if more details are desired. Another standard text is Blanchard and Fabrycky, *Systems Engineering and Analysis*.

Slide 8



This graphic will be discussed when viewing it on the web site. “Initiation” is the first phase of system development. The red diamonds are the IRP’s decision milestones, called “Key Decision Points.” The identification of the decision authority depends on the size (i.e., Level) of the investment. Show the table which defines the levels, by clicking on the “Acquisition” link and scrolling down.
The program team is really an IPT, representing all important functional disciplines and stakeholders (including, as appropriate, representation from program management, engineering, T&E, users, contracting, procurement, production, logistics, etc.). Obviously, representatives from industry join the IPT after award.
The top-level statement of the need is in a Mission Need Statement, for which a template is provided.
A business case is required for large investments, typically an Exhibit 300 generated by the Sponsor (with support from S&T if involved in system development). Then, at KDP 1, triggered by an Investment Review Request, the milestone decision authority reviews the business case to verify the need for the system as well as the availability of out-year funding for the life-cycle costs.

Slide 9



This graphic will be discussed when viewing it on the web site. C&TD consists (in S&T's version) of three sub-phases:

Needs Analysis develops an Operational Requirements Document (including a CONOPS) and assesses the feasibility of developing a compliant system. Titles in italics are required by the IRP; other titles (e.g., SEMP) have been added by S&T and are optional. The program manager tailors the phases, reviews, and documentation to suit the size, importance, and risk of the program.

Concept Exploration explores alternative concepts and chooses the best one, documented in an Alternatives Analysis. Typically, system concepts are defined only down to the subsystem level during Concept Exploration. An Acquisition Plan is developed, documenting the acquisition strategy.

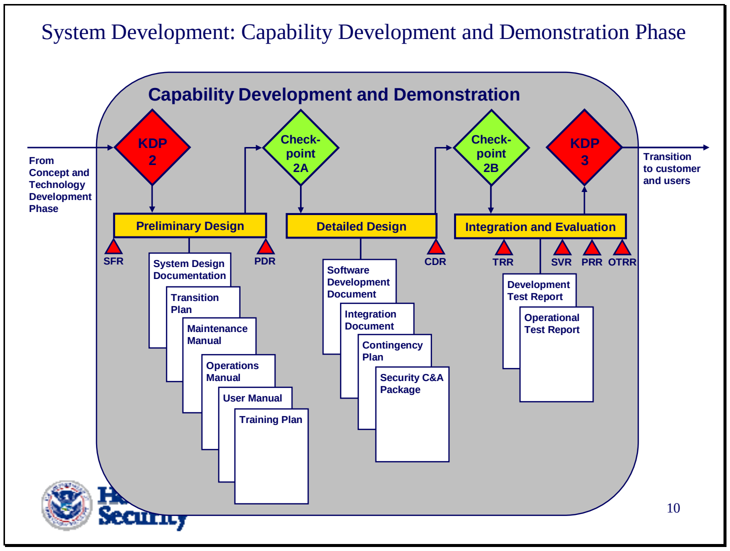
Concept Definition accomplishes the systems engineering necessary to define subsystems and components, flow down functional requirements, and define interface requirements. Test planning is started (in the form of a draft TEMP) and logistics planning (in the form of a draft ILS Plan).

Note the green diamonds between sub-phases, called "checkpoints." These are milestones at which the project/program manager looks back and looks ahead. Looking back, he/she verifies, by means of checklist reviews, that all necessary activities and documentation have been completed in the preceding sub-phase. Looking ahead, he/she reviews the plans, activities, and deliverables during the next phase to ensure that these are planned and understood, and that there are adequate resources (funding, facilities, and people) to execute.

The C&TD phase ends at Key Decision Point 2, at which the milestone decision authority verifies that the program team has accomplished and documented the necessary activities and produced the necessary work products. The milestone decision authority ensures that any process tailoring done by the program team has not increased program risk unduly. (For example, did the program team "tailor out" the concept exploration and alternatives analysis? If so, why?)

Acronyms ITR = Initial Technical Review, ASR = Alternative Systems Review, SRR = System Requirements Review

Slide 10



This graphic will be discussed when viewing it on the web site. CD&D consists of three sub-phases:

Preliminary Design (sometimes called "Advanced Development"), is that part of the SDLC in which the great majority of the uncertainties inherent in the selected system concept are resolved through analysis, simulation, development, and prototyping. Its goal is to develop and validate a sound technical approach and demonstrate it during PDR to those who must authorize the full-scale development of the system. System requirements are flowed down through subsystems, components, and sub-components, and functional allocation is adjusted as the capabilities of the system elements are proven (or not).

Detailed Design (sometimes called "Engineering Design") is that part of the SDLC in which all the component parts of the system are designed so that they will fit together as an operating whole that satisfies the ORD. Detailed internal and external interfaces are established and confirmed, and the design is first fully implemented in hardware and software. This phase culminates in a CDR.

Integration and Evaluation is that part of the SDLC in which the engineered components of the new system are assembled and integrated into an effectively operating whole, which undergoes DT&E (to verify compliance with technical specifications) and OT&E (to verify compliance with the operational specifications in the ORD when the system is operated in the field by its intended users). During this phase, Low-Rate Initial Production (LRIP) may be authorized, so that the OT&E is conducted on a production unit (often the first article). OT&E should be conducted by a testing agent independent of the development team.

At the end of this phase, the milestone decision authority at KDP 3 authorizes the release of the design to full production, after verifying successful DT&E and OT&E by reviewing test plans and test reports.

Acronyms SFR = System Functional Review, PDR = Preliminary Design Review, CDR = Critical Design Review, TRR = Test Readiness Review, SVR = System Verification Review, PRR = Production Readiness Review, OTRR = Operational Test Readiness Review

Slide 11

Recapping the Process

- Simply stated, system development for an Acquisition program is a 6-step process:
  - Requirements
  - Concept exploration
  - Concept selection and refinement
  - Preliminary design
  - Detailed design
  - Test and evaluate
- Generically, almost every R&D project executes these steps in some form
  - More formal in Acquisition programs (higher TRLs), to reduce risk
  - Less formal for early TRLs, to provide flexibility

Homeland Security

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Having shown and discussed details of the system development phases of an Acquisition program, we'll step back and recap.

System development consists of 6 steps, which actually aren't specific to Acquisition but are executed in one form or another in almost all R&D.

Define the requirements. There are requirements, of a sort, in almost all projects, even as early as TRL 1. For example, the Wright brothers' requirements were twofold: It has to be heavier than air, and it has to get off the ground.

Explore alternative concepts, to make sure that you aren't jumping to a preconceived solution and missing a better one.

Choose the favored concept (best balance of cost, schedule, risk, performance) and, if appropriate, do the system design (identify subsystems and components, and flow down requirements).

Execute preliminary design, emphasizing the immature technologies to reduce risk.

Execute detailed (final) design.

Integrate and test against the requirements, making sure that the relationship between the developers and the testers isn't cozy.

Slide 12

Review of Earlier Questions

Question	Answer
Does S&T execute any part of Big "A" Acquisition? If so, when and how?	Commonly, no, but occasionally, yes, we may manage the system development (the C&TD and CD&D phases) if requested to do so by the Sponsor, subject to the availability of adequate funding. In such cases, we follow DHS's SDLC, and the Sponsor is responsible for compliance with the IRP.
If we don't execute Acquisition, how can our technologies get to users?	By executing an Advanced Research project and transitioning the product to a customer's Acquisition program, subject to a Technology Transition Agreement. To create a good TTA we must understand the Acquisition process in general and the customer's Acquisition program in particular.
Does the Capstone IPT diagram refer to Big "A" or Little "a"?	Big "A" (because if it were Little "a," the customer would simply execute a procurement without the need for S&T involvement).
Why is S&T on the opposite side of the table from Acquisition?	Because Acquisition is the Sponsor's responsibility, not S&T's. At most, S&T executes the system development phases of Acquisition, if requested.
What does an EHC "enable?"	An EHC, consisting of one or more technology products from S&T Applied Research projects, "enables" the customer's Acquisition program to produce a more capable system.

Homeland Security

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These are the questions first posed on slide 3. Below are some amplifying comments for each Q&A (numbered 1 to 5 to correspond with the 5 questions).

Since the only way that technology can get to the user, it's critical that effective Acquisition programs be executed (by somebody). However, since Big "A" Acquisition is expensive, S&T's budget typically is inadequate to fund a full-fledged system development leading to a fully sustainable and production-ready design. This is an issue which must be addressed case by case, realizing that if an effective Acquisition program is not executed, no technology can improve Homeland Security.

The transition of our product to a customer's Acquisition program is very difficult, and requires us to understand the customer's program and what they need, in depth. What are the complete requirements (not just functionality, but also interface requirements, environmental requirements, and ilities)? Do they need a production-ready design? If so, how will production-readiness be demonstrated? Do they need S&T to develop a supplier who can be integrated into their Acquisition program? Or will the product be handed off to a system prime by S&T's supplier, in which case can it be effectively integrated and manufactured?

This one is pretty self-explanatory, once you understand Big "A" Acquisition.

So is this one.

The subtleties of EHCs will be addressed in another mini-course. Suffice it to say that the term "enabling" is intended to imply that S&T's product augments the customer's system development some important way, providing an important increment of capability which would be otherwise unachievable. It's important to understand whether S&T's technology development is on the customer's critical path (in which case "enable" may mean that the EHC makes the customer's system development possible) or whether S&T's technology development is supplementary (in which case S&T's technology development will allow the customer's system to be more capable than it otherwise would be, but if S&T's development fails or is late, the customer's system development will still proceed, resulting in less capability but still providing a useful performance increment).

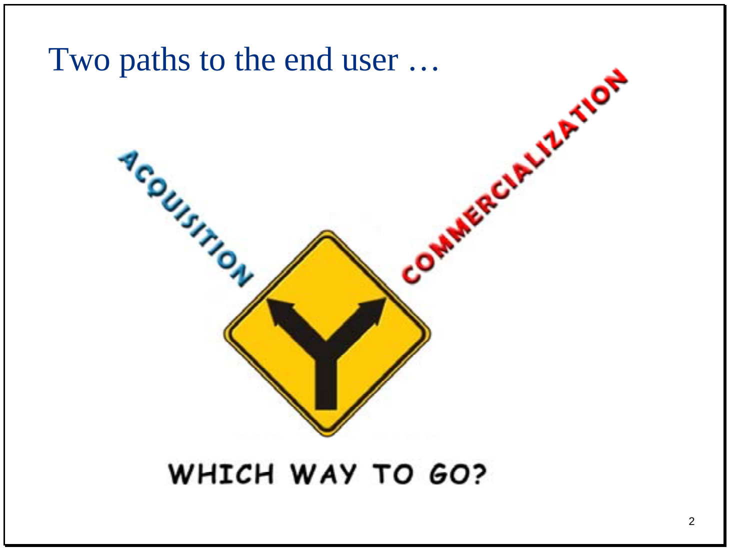
Appendix C: Commercialization Mini-Course

The following pages include the slides and slide notes used in teaching the S&T hour-long mini-course on Technology Commercialization.

Slide 1

This mini-course is one of a series of 14, sponsored by the S&T Office of Strategy, Planning, and Integration (Mitch Crosswait, Director).
The briefing takes an hour, and will start and stop on time, so make sure any questions are for general clarification. The speaker will remain for 30 minutes after the end for discussion, if desired.
Hard copies of the slides will be handed out. The slides are also available from the RDT&E web site. To reach this web site, browse to the S&T Shared drive, find the folder “RDT&E Process Website,” then double-click on the filename index.htm to browse the home page. To find the slides for all of the mini-courses in this series, click on Training in the bottom navigation bar and follow your nose.
Please sign the sign-in sheet. Also, fill out and leave behind the feedback form.
Today we’ll be talking technology commercialization, which is one of two methods by which new products and systems can be put into the hands of users. (The other method is Acquisition.)

Slide 2



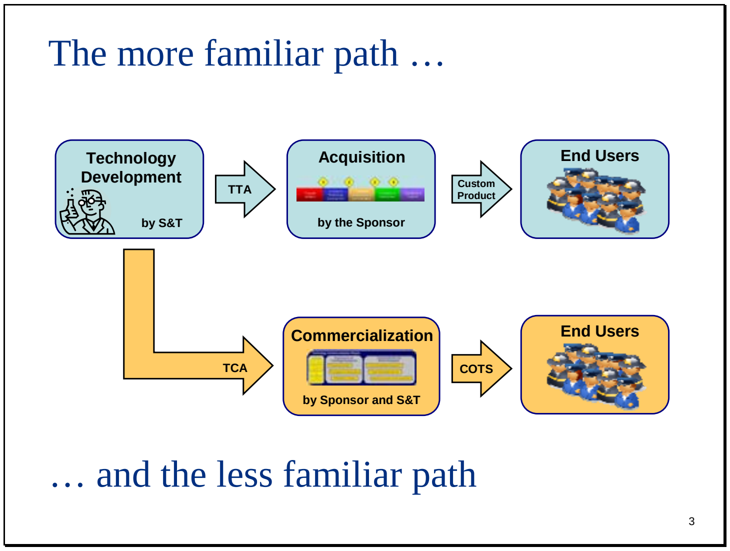
Acquisition and Commercialization are very distinct processes. Accordingly, the project manager reaches a fork in the road right at the beginning of the project. Which way to go?

Acquisition and Commercialization aren't mutually exclusive, of course, in the sense that elements of each can be blended, depending on the needs of the project. However, they are distinctly different models, and therefore it's important to understand both models before you try to combine elements of each.

In this mini-course, whenever we mention "Acquisition," we're talking "big 'A' Acquisition, not "little 'a' acquisition." In other words, we're talking about acquiring products which don't exist, rather than procuring or purchasing products which do exist. Those who are unfamiliar with the distinction between big 'A' Acquisition and little 'a' acquisition are referred to two other mini-courses in this series: "Acquisition" and "Procurement Requisitions."

We will also use the terms "product" and "system" interchangeably.

Slide 3



This slide depicts the two alternative paths to the end users.

The blue path, Acquisition, is the methodology which seems most familiar to S&T project managers, for two reasons:

It is the only methodology which is used by most other major Federal Government agencies, such as the Department of Defense and NASA, because of their high-technology requirements and limited market size. Thus, it is the only methodology with which S&T project managers with Government experience are likely to be familiar.

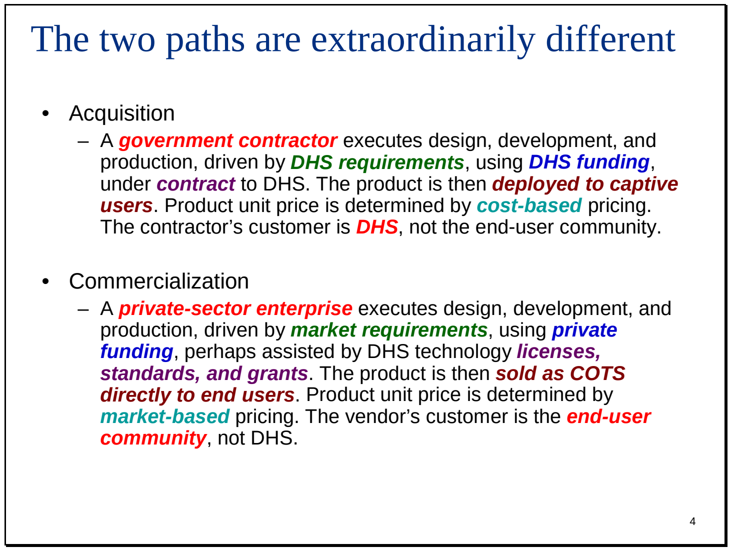
It is the methodology which has been emphasized by the S&T Under Secretary and the Director of Transition, in their implementation of the Capstone IPT approach to engaging our internal DHS customers. The emphasis on “transition to Acquisition” governed by “Technology Transition Agreements” (TTAs) is, by now, familiar across S&T.

In contrast, the beige-colored path, Commercialization, is much less familiar to most S&T project managers, for two reasons:

This methodology has no close analog widely used in any other Government agency. Consequently, there is no proven management framework for this methodology, as there is for Acquisition. True, our National Laboratories have a commercialization process which is executed by their Offices of Research and Technology Application (ORTAs) in compliance with technology transfer statutes, but this process lacks important features needed by S&T. Specifically, the ORTA’s process is not driven by capability gaps of government end users, nor does it make provision for the use of grants and standards.

The purpose of this mini-course is to familiarize you with the beige-colored path by describing a methodology which S&T has put forward for executing Commercialization projects. This methodology cannot be said to be proven, since it has not been applied widely. However, it has benefited from adoption of the best practices of the ORTAs, where they apply, and it’s a good starting place for the project manager who is wondering what to do next.

Slide 4



Although the two paths are extraordinarily different, they are often confused. Let's highlight the differences.

Who develops the product?

In Acquisition, the developer is a government contractor (often called a prime contractor or a system integrator to make clear their responsibility for the total product or system.)

In Commercialization, the developer is a private-sector enterprise.

Where do the requirements come from?

In Acquisition, the government specifies the requirements, based on information from its captive end users.

In Commercialization, the developer determines the requirements from the marketplace. The government may assert that it knows the marketplace requirements, but the developer is unlikely to invest scarce resources until they have at least validated those requirements.

Where does the funding come from?

In Acquisition, from the government.

In Commercialization, from the developer.

What are the formal, legal agreements between the Government and the developer?

In Acquisition, the relationship is governed by contracts.

In Commercialization, the relationship may require no legal agreements, or it may require licenses, CRADAs (Cooperative R&D Agreements), or Memoranda of Understanding.

(continued in the slide notes on the next page)

Slide 5

Highlighting the differences …

Typically …

	Acquisition	*Commercialization*
Product type	Custom	COTS
Users	Federal agency	State, local, private sector
Channel to users	Deployment	Sales
Designer & manufacturer	Gov't contractor	Private sector
Formal agreements	Contracts	Licenses, CRADAs, or none
Developer's customer	DHS	Marketplace
Design funder and owner	DHS	Private sector
Pricing	Cost-based	Market-based
Standards development	Possible	Likely
Grants	None	If needed
The bottom line …		
DHS relationship to developer	**Control**	**Influence**

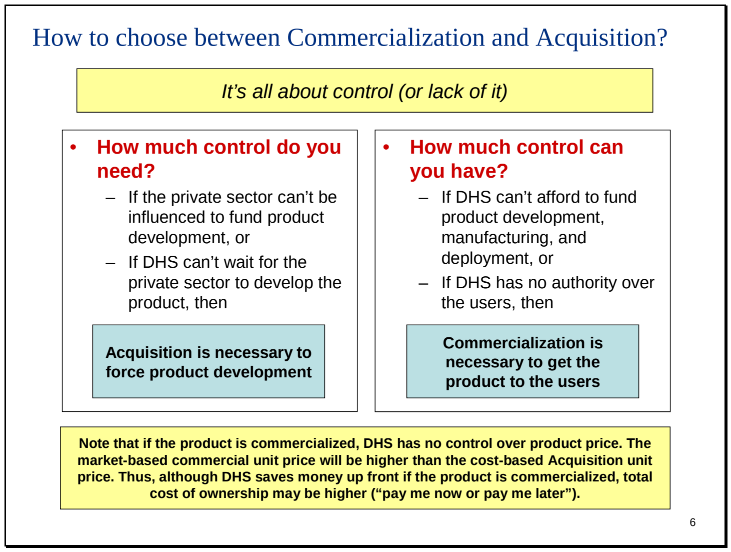
5

(notes continued from previous page)

What are the channels by which the products reach the end users?
In Acquisition, by deployment to captive end users.
In Commercialization, by sales channels such as catalog sales, e-commerce, or direct sales. The product is referred to as COTS (Commercial Off-the-Shelf), implying that it is readily available for sale.
How is the unit price determined?
In Acquisition, by a cost-type contract specifying a price determined by the cost of goods sold marked up by a fixed percentage.
In Commercialization, by price-based pricing, sometimes called market-based pricing, which means that the vendor charges what the market will bear. The market price is conventionally determined by a combination of a product's value, its manufacturing cost, and the competitive situation.
Who does the developer consider to be their customer?
In Acquisition, the developer's customer is the government agency with which they have contracted.
In Commercialization, the developer's customer is the marketplace.

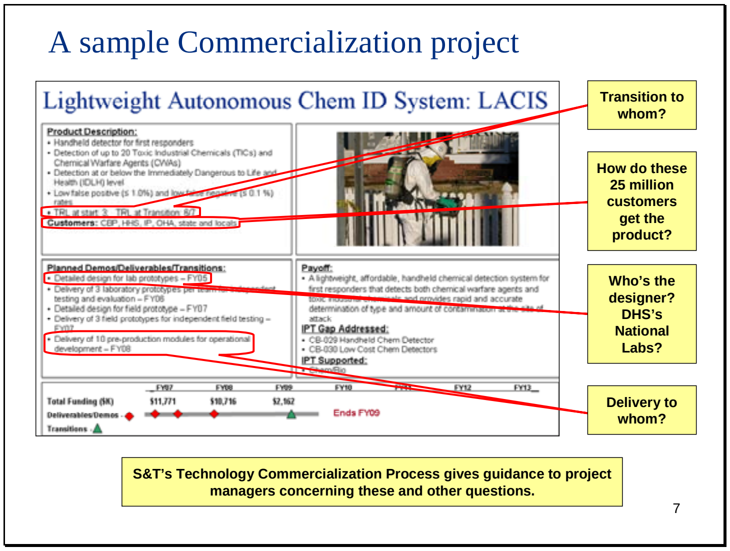
The fundamental difference between the two approaches is the question of who has control. Acquisition allows total control by the government, because the government is paying the bills. In contrast, the best the government can hope for in Commercialization is to influence the private sector, by informing them of the market and perhaps by judicious use of standards and grants programs.

Slide 6



The choice between Acquisition and Commercialization may boil down to two questions of control:
How much control is needed? (Perhaps none, if the private sector can be influenced to commercialize the product in a timely manner.)
How much control is achievable? (Perhaps none, if the end users are not under the authority of a DHS agency, and therefore make their own buying decisions.)
Note that the ultimate unit price of the product will be price-based if commercialized and cost-based if acquired under contract. One can expect that market-based pricing will be higher than a cost-based pricing, because the vendor will recover the R&D costs in the market-based price of the product.
So if the ultimate users are in a DHS agency, the choice may very well be between (a) a higher up-front cost and a lower unit purchase price (in an Acquisition program), or (b) a lower up-front cost and a higher purchase price (in a Commercialization program).
In short, if the users are in a DHS agency, the choice may be "Pay me now or pay me later." If indeed both the Acquisition and Commercialization paths are feasible for the desired product, total cost of ownership should be considered as a significant factor in the decision.

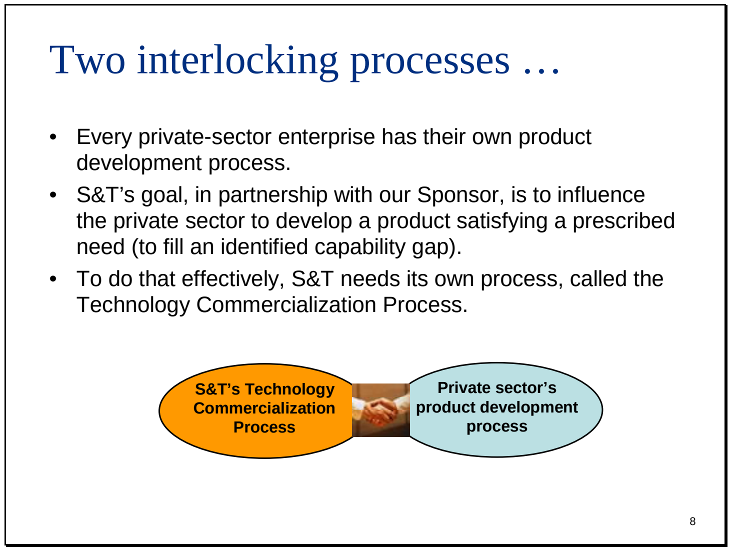
Slide 7



Here is a sample Commercialization project quad chart, chosen at random from the many S&T projects whose goal is to put a commercial product into the hands of users over whom DHS has no authority.
The call-outs ask questions which might be prompted by any S&T quad chart for a Commercialization project. Specifically:
This is a Transition project, in that it is part of the portfolio of S&T's Transition Office. But to whom will it transition?
The customers include some DHS agencies with authority over end users (such as border-protection agents), but other agencies over which DHS has no authority (such as State and local agencies). How will all these end users have access to the product?
The quad chart asserts that the first major milestone is detailed design of a laboratory prototype. But what Laboratory will do the design? If the manufacturing will ultimately be done in the private sector, shouldn't the designing Laboratory be the R&D Division of the enterprise whose factory will ultimately manufacture the product? After all, their profits will depend on whether the product can be produced in ***their*** factory at a cost consistent with a competitive price point?
But perhaps the private sector doesn't have the technology? This is where licensing may enter the picture.
The quad chart describes the last milestone as "delivery of pre-production modules for operational development." Delivery to whom? Does "pre-production" imply that there is or is not yet a production-ready design? If there is a production-ready design, whose factory has it been designed for, and by whom?

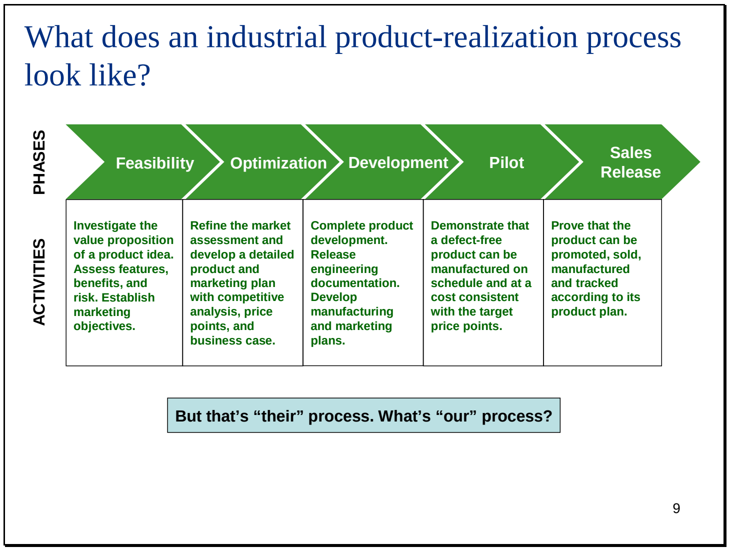
Of course, the quad chart format is not designed to answer detailed questions such as these. Presumably the project's documentation, such as its Project Management Plan and its Transition Plan, have specified answers to these questions.

Slide 8



Let's be clear that we're talking about two interlocking processes here:
Each private sector enterprise has its own product development process. Of course, S&T does not execute ***this*** process, and cannot specify it or control it, but needs to understand it in order to influence its outcome.
S&T has its own Technology Commercialization process. The private sector will not execute any part of ***our*** process, but will need to understand certain aspects of it in order for S&T to be able to influence the private sector. For example, if S&T asserts that there is a strong market for a new product satisfying certain requirements, the credibility of this assertion may depend on the private sector's visibility into how the market size and the requirements were determined.
This mini-course will not go into detail concerning the private sector's product development process. We will touch on it, but spend most of our time talking about ***our*** process.

Slide 9

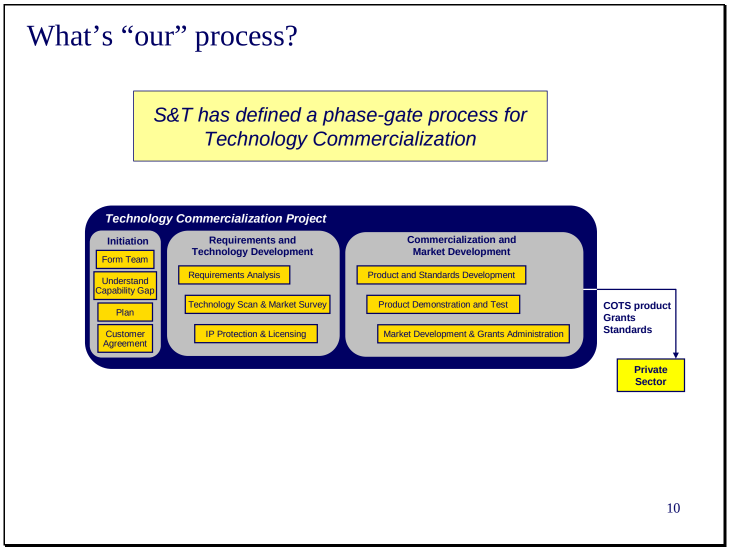


Most industrial product-development processes are structured as phase-gate frameworks, since the phase-gate paradigm is the best way to organize a series of activities with periodic event-driven management reviews.

The product-development process depicted here is a top-level description of a detailed product-development process used by S&T's Chief Commercialization Officer, Tom Cellucci, when he was a CEO and later a management consultant in the private sector. This phase-gate process uses a different vocabulary than any of S&T's processes, including terms such as "value proposition," "marketing," "competitive analysis," "price points," and "sales." One difficulty faced by S&T project managers of Commercialization projects is bridging the communications gap between the typical S&T technology-focused terms and the private sector's product-focused terms.

S&T's technology focus reveals itself in the use of terms (such as Technology Readiness Levels) which are generally unknown in the private sector. If you plan to partner with the commercial sector, you've got to learn their language, because (unlike government contractors) they won't learn yours.

Slide 10



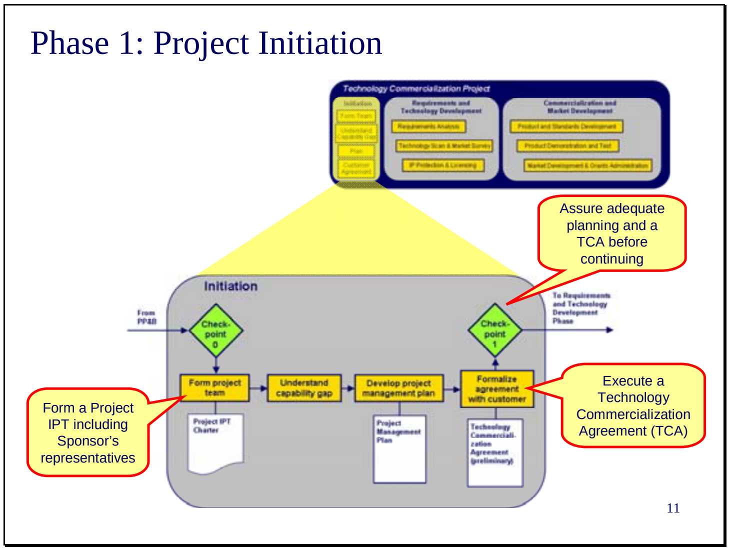
S&T has developed a phase-gate process to govern Technology Commercialization, as a way of providing guidance to project managers as they navigate unfamiliar waters. S&T has discovered no analogous process anywhere else, because no other government agency have a proven requirements-driven process to influence the private sector to develop a new product for a specific set of users.

This process contains elements of the commercialization process used by the Offices of Research and Technology Application (ORTAs) in DHS’s National Laboratories to manage technology transfer to the private sector. However, the goal of the ORTAs is simply to transfer the technology to private-sector partners for whatever commercial purpose the private sector chooses, regardless of any connection with the Laboratory’s mission. In contrast, the purpose of S&T’s Technology Commercialization process is mission-driven, specifically to fill capability gaps relating to homeland security. This objective is much more difficult.

Accordingly, this process cannot be said to be proven, but is offered as a prototype process to be used and improved.

The process is documented on S&T’s RDT&E web site, a disk-based web on the S&T Shared drive. Find the file “index.htm” in the folder “RDT&E Process Website” and double-click it to reach the home page. Then click on “Transition” in the main graphic, and then on “Technology Commercialization,” and you’ll see the phase-gate graphic reproduced in this slide.

Slide 11



Form project team

Name the project manager, who will lead the formation of a project integrated product team (IPT) whose members include all important skill sets and constituencies, including the Sponsor, who is S&T's customer internal to DHS who will represent the interests of the end users.

Understand capability gap

Establish knowledge of and rapport with the Sponsor and, through him, the end-user community. Define precisely the capability gap to be filled, and validate this requirement with the Sponsor and, through him, the end-user community.

Develop project management plan

Revisit and validate the initial decision to address the capability gap via Commercialization versus Acquisition.

Develop a specific commercialization strategy for this project, to be executed jointly by the S&T project team and the Sponsor's organization.

Document the project plan, defining the project team, project schedule, project budget, major milestones, and major reviews and checkpoints, all of which are consistent with the project's commercialization strategy.

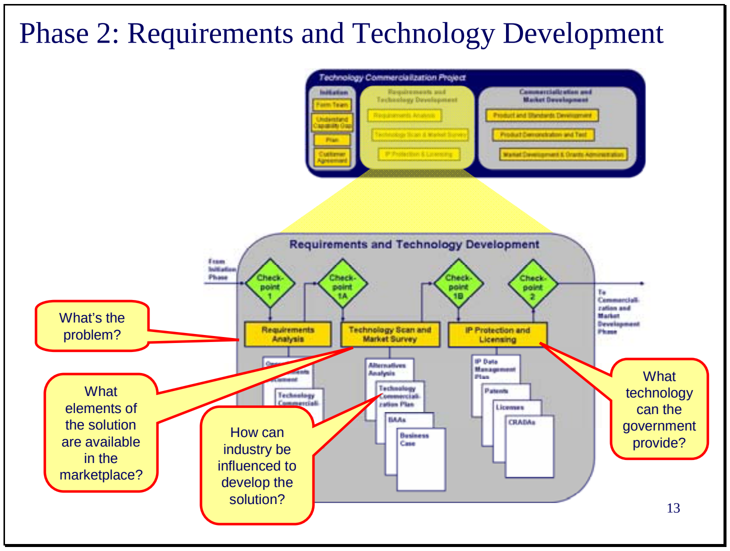
Formalize agreement with the customer

Execute a Technology Commercialization Agreement (TCA) with the Sponsor. See the next slide for details.

Slide 12

It is fundamental principle of S&T project management that all Transition projects must have written agreements with their internal DHS customers, documenting mutual expectations and signed by both parties. If a project can't reach a written agreement with its DHS customer (its Sponsor), then it probably doesn't have a real customer at all.
For Advanced Research projects, which develop technology and transition it to an Acquisition program, the form of the agreement is the by-now familiar Technology Transition Agreement (TTA).
For Technology Commercialization projects, the TTA template is inappropriate, and it is replaced by a template for a Technology Commercialization Agreement.
The TCA specifies what responsibilities will be fulfilled by S&T (generally those that require technology expertise), and what responsibilities will be fulfilled by the Sponsor (generally those requiring familiarity with the end users and their operations). Funding by both parties is also specified. Specifically, if the Sponsor is expected to develop and administer a grants program, this fact is documented in the TCA.

Slide 13



Requirements Analysis

Develop a set of operational requirements to govern subsequent product development
Make an initial assessment of technological feasibility

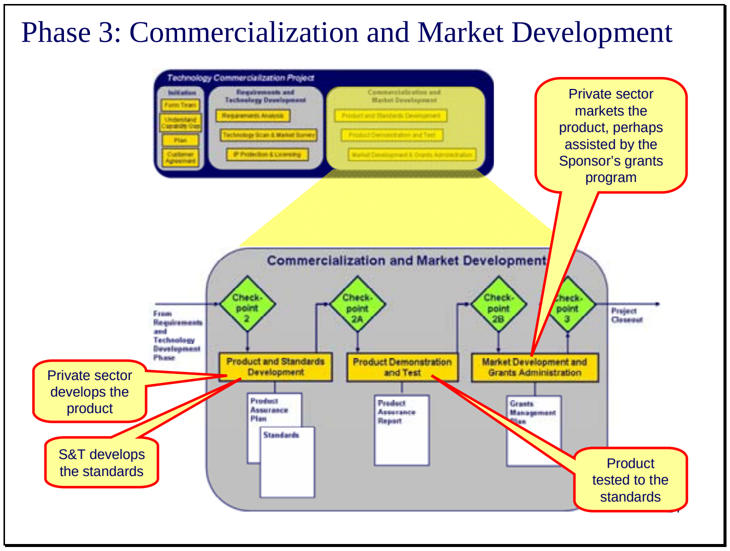
Technology Scan and Market Survey

Conduct a technology scan, spanning all potential sources of technology (private sector, DHS laboratories, national laboratories, and other Government agencies such as the Department of Defense).
The purpose of the scan is to assess whether there exist technologies and/or products which address the documented operational requirements, and to identify the preferred technology or product.
Conduct a market survey, to nsure that no products exist which address the capability gap addressed in the ORD, and to identify which vendors are best positioned to reach the target marketplace with a new product based on the identified technology
Conduct a commercialization assessment, to assess the potential of the identified technology for successful commercialization and marketing

IP Protection and Licensing

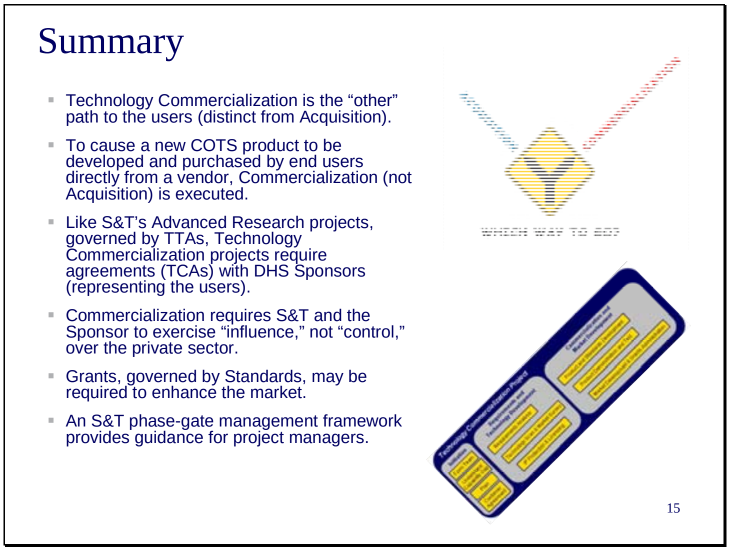
Develop the technology, if necessary, to the point of reduction to practice and therefore patentability
Ensure that the Government's intellectual property rights are secured
Identify the best partner in the private sector for commercialization of the technology
Enterr into an appropriate licensing agreement with a chosen partner in the private sector
Manage the license during its effective term

Slide 14



Product and Standards Development
Follow and, if appropriate, oversee the product development by the licensee
Develop any necessary new standards to govern the product under development
Product Demonstration and Test
Ensure that the commercial product, if successfully marketed, will meet the original requirements documented in the ORD.
Influence the test and certification plan to ensure that a properly conducted test program will validate the product's performance against the original operational requirements document (ORD).
Assure that tests and certifications are conducted properly, to the degree possible under the terms of the license and consistent with any standards which apply.
Market Development and Grants Administration
Add the product, once certified, to the authorized equipment list on the website Grants.gov.
Administer the grants program (as defined in the Technology Commercialization Plan and subsequently amended) to help develop the market for the product

Slide 15



This slide summarizes the main points of this mini-course.

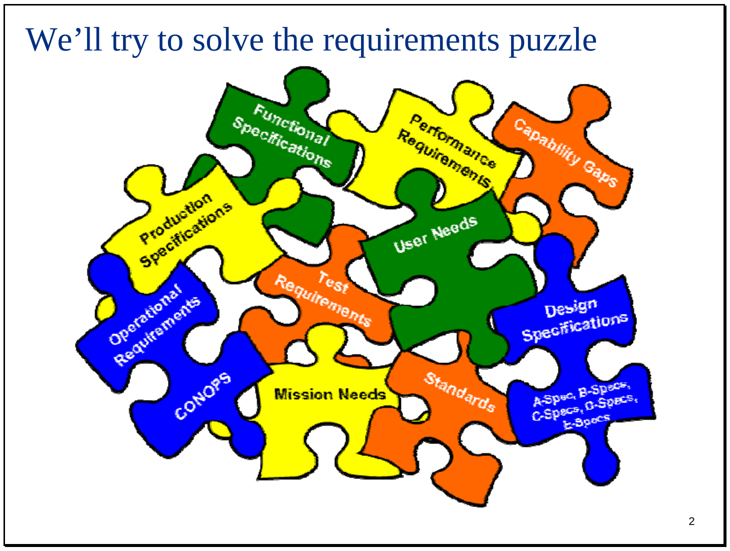
Appendix D: Requirements Mini-Course

The following pages include the slides and slide notes used in teaching the S&T two-hour mini-course on Requirements.

Slide 1

This mini-course is one of a series of more than a dozen, sponsored by the S&T Office of Strategy, Planning, and Integration.
The briefing takes an hour, and will start and stop on time, so make sure any questions are for general clarification. The speaker will remain for 30 minutes after the end for discussion, if desired.
Hard copies of the slides will be handed out. The slides are also available from the RDT&E web site. It's on the S&T Shared drive, in the folder "RDT&E Process Website." Double-click the filename index.htm and you'll be browsing the home page. Click on Training in the links at the bottom of any page and you'll be able to find the slides.
Please sign the sign-in sheet.
Today we'll be talking about Requirements, which is a critical topic for S&T if we hope to satisfy our customers.

Slide 2



The vocabulary relating to requirements is broad and not standardized. Different communities use different definitions.

The Project Management Institute, in its bible titled *Project Management Book of Knowledge*, includes the following definitions:

Requirement: A condition or capability that must be met or possessed by a system, product, service, result, or component to satisfy a contract, standard, specification, or other formally imposed documents. Requirements include the quantified and documented needs, wants, and expectations of the sponsor, customer, and other stakeholders.

Specification: A document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a system, component, product, result, or service and, often, the procedures for determining whether these provisions have been satisfied. Examples are: requirement specification, design specification, product specification, and test specification.

Other communities use the term "requirement" to refer to a definition of the problem, and "specification" to refer to a definition of the solution. For example, Kossiakoff and Sweet (Systems Engineering Principles and Practice) define:

Requirement: (1) A characteristic that identifies the accomplishment levels needed to achieve specific objectives under a given set of conditions; (2) A binding statement in a document or in a contract.

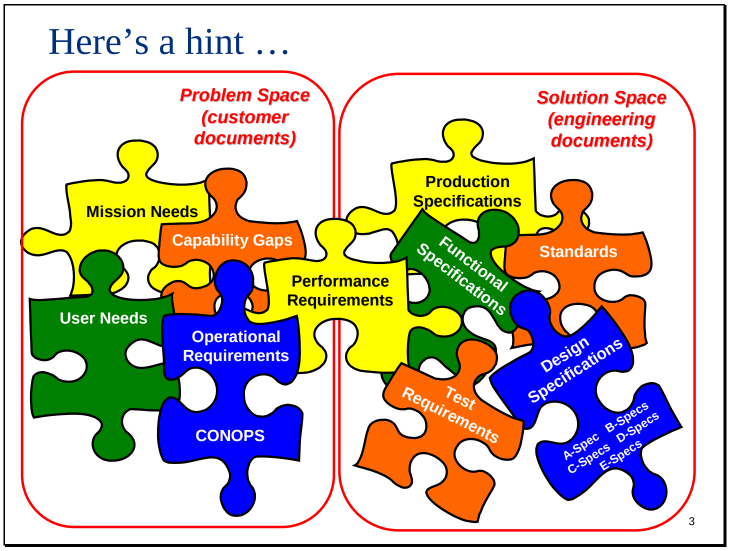
Specification: A document intended primarily for use in procurement, which clearly and accurately describes the essential technical requirements for items, materials, and services including the procedures by which it will be determined that the requirements have been met.

Nor does DHS have a standard vocabulary, with the exception of "mission need" and "operational requirement" (two terms inherited from DoD by way of the Coast Guard).

This mini-course will use the terms carefully, adopting a set of definitions which should be clear by the end, but don't assume that these terms mean the same to everyone. You will have to negotiate a common vocabulary with each of your customers (or suppliers) to be sure of your terms.

By the way, the acronym CONOPS stands for Concept of Operations.

Slide 3



In systems engineering, an "operational requirement" is generally a description of *what* a system must do. It is generally written in the language of the operator (the end user), not the engineer.

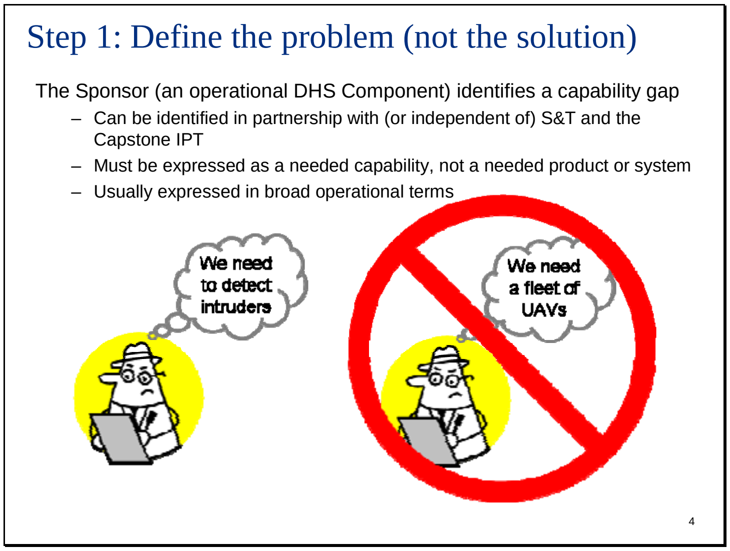
In contrast, a "performance requirement" specifies something about the system itself, and how well it performs its functions. It is generally written in the language of the engineer. Performance requirements are a bridge from the operational world to the engineering world. Examples of performance requirements include availability, testability, maintainability, and ease-of-use. Other system-specific performance requirements include detection probability, false-alarm probability, and similar technical performance measures (TPMs).

A "good" list of requirements generally avoids saying *how* the system should implement the requirements, leaving such decisions to the system designer.

Once the system designer has decided how the system implements the requirements, this solution is documented in the design specifications.

In short, "requirements" can be thought of as statement of the problem, and "specifications" are a statement of the solution.

Slide 4



We'll start by describing how requirements of various types relate to a standard product or system development. Then we'll be in a position to understand how they relate to an S&T technology development or a commercialization project.

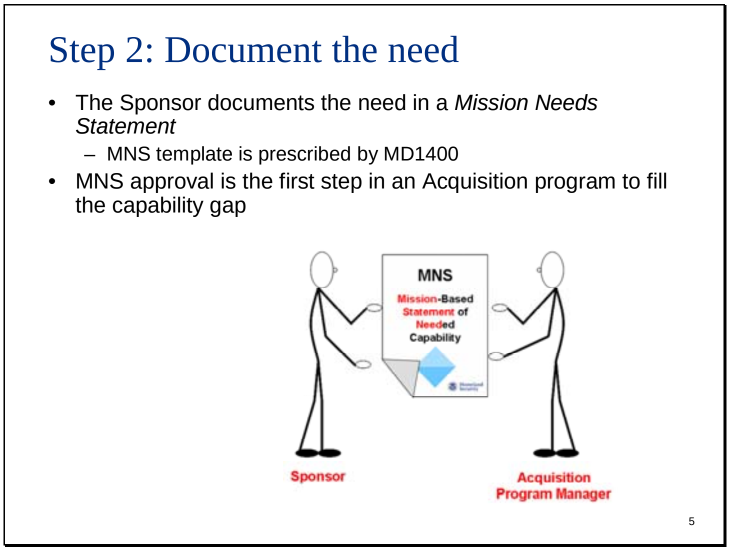
In DHS, a product or system development is conventionally accomplished by an Acquisition program, led by a Sponsor.

The term "Sponsor" is formally defined by DHS's Investment Review Process, documented in MD1400. The Sponsor is a designated executive in the DHS Component which contains or represents the end users (the "boots on the ground") who need the capability. It is the Sponsor's responsibility to ensure that the end users have the capabilities they need.

At this early stage, there is an almost irresistible temptation to specify the solution rather than the problem. However, it's important to resist that temptation so as not to preclude possible solutions which may be optimal but haven't been considered. Force the problem statement to be a need for a "capability to be able to do something" rather than a "need to have something." This is called capabilities-based planning.

To identify the capability need seems basic or self-evident. However, a design project is often initiated as a result of a personal interest or a political whim, without first having adequately defined the requirement. Defining the problem is the most difficult part of the system engineering process. This objective is most likely to succeed if the ultimate users are involved in the process from the beginning.

Slide 5



Note that, so far, all these activities have taken place in the Sponsor's organization, not in the S&T Directorate. The only role played by S&T so far is, perhaps, to act as a catalyst in identifying the capability gap (through S&T's sponsorship of the Capstone IPTs).

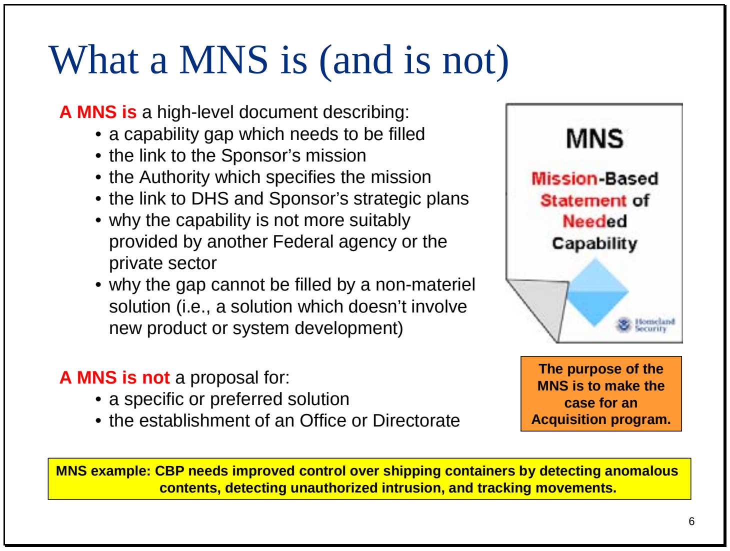
Said another way, the S&T Directorate plays little role in identifying the problem. S&T's role begins (if asked) when it comes time to identify the solution.

As an aside, the *Mission Need Statement* was initially used in the Department of Defense, but was subsequently changed in DoD to the *Initial Capability Document* to emphasize capability-based planning (i.e., identify the problem, not the solution). DHS also emphasizes capability-based planning, but has not changed the title of the document.

To originate a program, the Sponsor documents the mission need in an MNS, stating the operational needs (i.e., capability gaps) written in broad operational terms and not in terms specific to any system or system concept. For example, a checked-baggage mission need could be that a new type of explosive must be detected during airport baggage handling, or that an increase in air travel requires that baggage throughput be doubled within 5 years.

It's not uncommon for the creation of the MNS to be delegated to an Acquisition program manager, but this practice violates the principle that the solution developer should not be the same as the problem specifier. It's very tempting for solution developers to solve problems that they prefer, rather than solving problems of importance to operators.

Slide 6



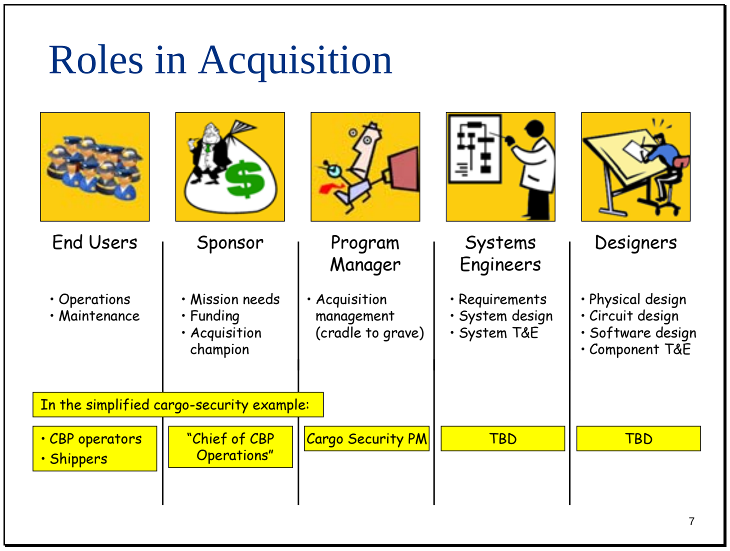
The purpose of the Mission Need Statement (MNS) is to synopsize at a high level (i.e., two to five pages) specific functional capabilities required to accomplish the DHS mission and objectives. MNS submissions that go beyond the scope of this guidance and include detailed costs or solution-based requirements normally contained in other planning documents will be rejected. The MNS is a qualitative communication vehicle both within a program and between the program and DHS HQ to provide a strategic framework for Acquisition planning and development.

Approval of the MNS provides formal DHS executive-level acknowledgment of a justified and supported need for allocation of scarce resources to resolve a mission deficiency with a material solution. In the broader view of the investment lifecycle, it represents the initiation of formal acquisition program management and the beginning of the investment process.

The MNS should describe specific functional and architectural capabilities required to perform the DHS mission, concisely but in sufficient detail for reviewers to understand the need for the investment within the context of the DHS portfolio. It should provide critical insight into mission capabilities and should provide the basis on which the reviewers can render an investment decision with an initial authorization to proceed within an acquisition project. Later documents, such as the Operational Requirements Document, will take the concepts outlined in the MNS and begin decomposing the gap requirements in detail.

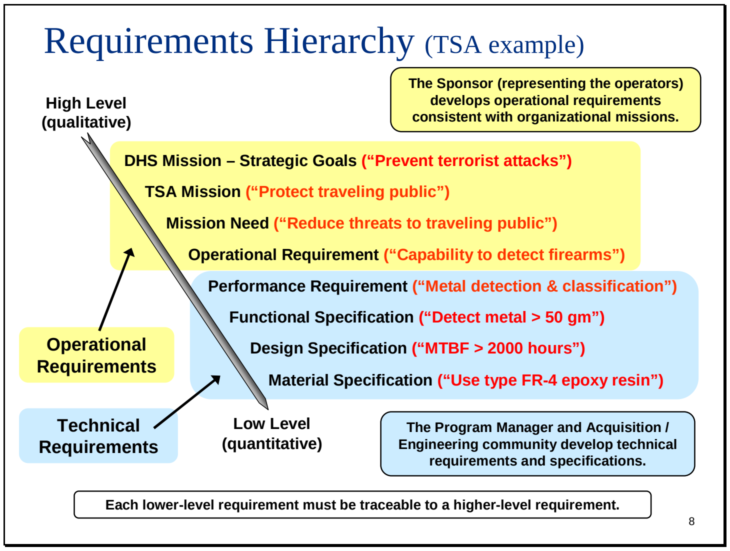
The MNS requires approval by the Milestone Decision Authority, depending upon the level of the investment (see the MD 1400, Investment Review Process, for a description of the levels), before the investment can proceed.

Slide 7



The goal of Acquisition is to provide a material system or product to the end users to enhance Homeland Security.
Any product development by S&T is useless unless, sooner or later, it finds its way to the end users through the Acquisition process (or the Commercialization process).
It's important that S&T managers understand where they fit in and what responsibilities are fulfilled by others. Their impact on the end users may be direct or indirect, depending on where their products fit in the value chain.
For example, if the role of a particular S&T project is to transition a product to Acquisition, but the Acquisition program does not exist or is not viable, S&T will have no impact on Homeland Security.
The roles and responsibilities may be articulated as follows:
The End Users have the responsibility to operate and maintain the systems in the field. They have no responsibility to identify capability gaps or requirements.
The Sponsor is an executive in DHS agency which contains or represents the end users. The Sponsor's responsibility is to identify mission needs (or, equivalently, capability gaps), perhaps inside the Capstone IPT process; to be a champion for Acquisition programs to address the mission needs; and to provide funding and other resources to facilitate the success of such Acquisition programs.
The Acquisition Program Manager is responsible for managing the Acquisition from beginning to end, from needs assessment at the front end to system deployment, operation, maintenance, and ultimately disposal at the back end.
The Systems Engineers guide the engineering of the system, from requirements development to test and evaluation, including the development of the system architecture.
The Design Engineers design and develop the components of the system.

Slide 8



The requirements hierarchy is naturally divided into two domains, operational and technical. The Sponsor, representing the operators, is responsible for all operational requirements. The technical system developer is responsible for all technical requirements.

The Mission Needs Statement is the entry point to Acquisition.

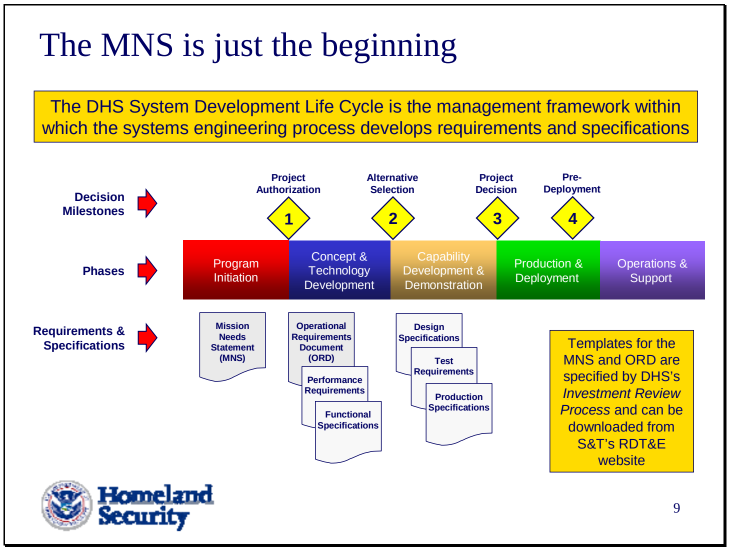
During an Acquisition program, requirements and specifications of increasing detail will ultimately specify the materiel solution. All lower-level requirements must be traceable to higher-level requirements. If not, why are they required?

The development of these requirements and specifications is governed by the systems engineering process.

Attention to detail, and disciplined adherence to process, is required for a successful Acquisition program. Counter-examples are legion.

Incidentally, the acronym MTBF signifies Mean Time Between Failures, a principal measure of reliability.

Slide 9



The System Development Life Cycle (SDLC) is DHS's management framework to provide structure and discipline for Acquisition programs. Its 5 phases are a relatively standard structure for a system life cycle.

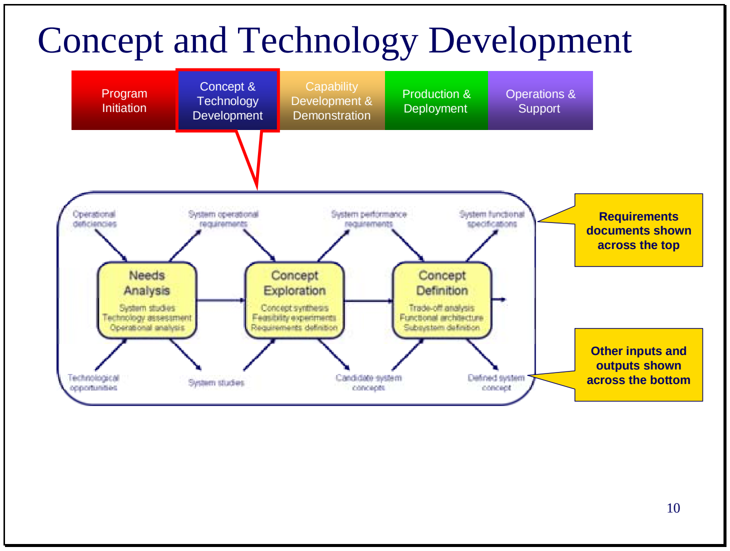
DHS mandates the use of MNSs and ORDs, and provides templates for these documents. However, the downstream requirements and specification documents are not prescribed.

The decision milestones, known as Key Decision Points and numbered from 1 to 4, are the gates in the phase-gate process at which the program is reviewed by its Acquisition Authority (whose level depends on the size of the Acquisition, as prescribed in MD1400).

We will use the SDLC to provide the context in which requirements and specifications evolve as a new system goes through design and development.

More details can be found on S&T's RDT&E website. Browse to the "RDT&E Process Website" folder on S&T's Shared drive, then open index.htm in your browser.

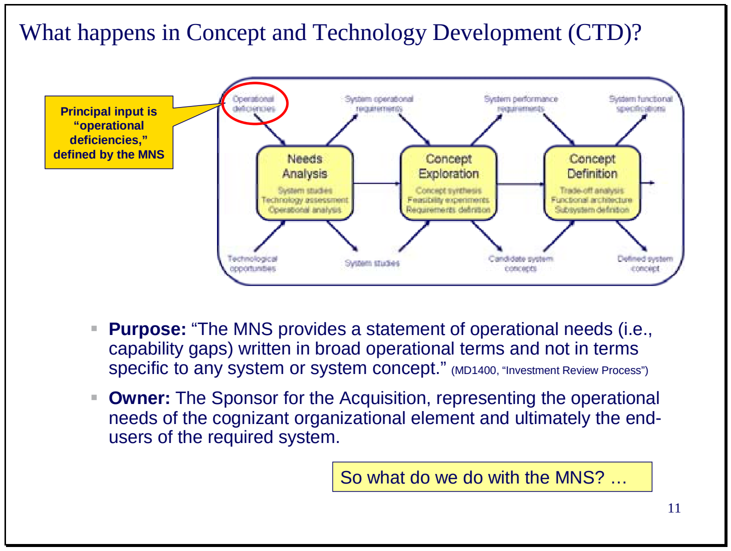
Slide 10



We will expand the SDLC's second phase (Concept and Technology Development) and its third phase (Capability Development and Demonstration) into three sub-phases each, to describe the activities within each phase and the resulting requirements and specifications.

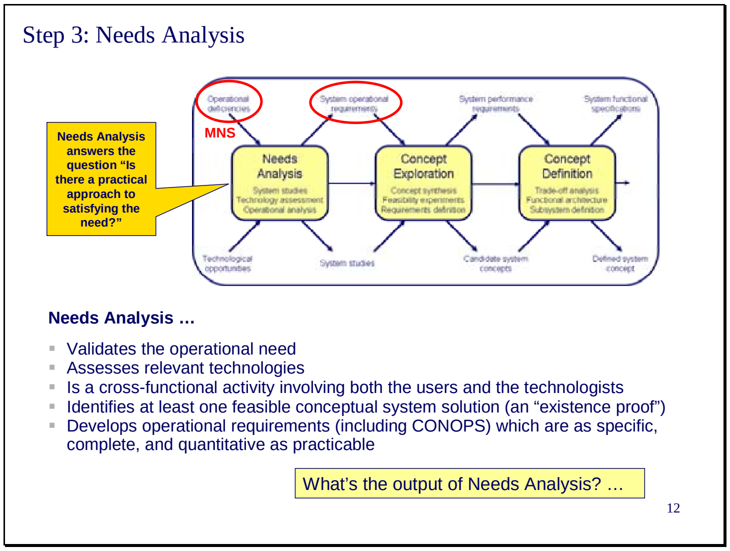
This expansion derives from relatively standard textbook expositions of systems engineering. Reference may be had to *Systems Engineering: Principles and Practice* by Kossiakoff and Sweet, or to any standard systems engineering text.

Slide 11



The entry criteria for Concept and Technology Development are:
An approved Mission Needs Statement, stating operational deficiencies
An approved preliminary business plan, typically in the form of an Exhibit 300
A successful completion of Key Decision Point 1
The next step (on the next slide) is Needs Analysis.

Slide 12

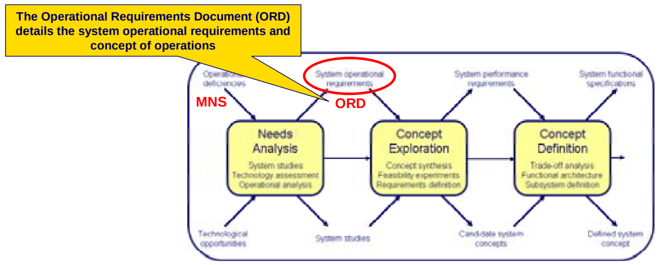


Needs Analysis consists of the following activities:

Conduct Operations Analysis
Analyze projected needs (Identify deficiencies in current systems)
Define operational approach (CONOPS) and operational objectives
Conduct Functional Analysis
Translate into functions, analyzing functional capabilities necessary for the system to perform the desired operational actions.
Allocate functions to subsystems and identify all interactions and interfaces
Establish Feasibility
Envision subsystem technology
Define feasible concept
Validate Needs
Design an operational effectiveness model, including "measures of effectiveness," to assess the degree to which a given system concept may be expected to meet a postulated need.
Validate feasibility and needs
Develop System Operational Requirements
Develop operational scenarios spanning the expected range of operational situations
Develop operational requirements statements (described in terms of operational outcomes rather than system performance). They must not be stated in terms of implementation, nor biased toward a particular conceptual approach.
All requirements should be expressed in measurable (testable) terms. The rationale for all requirements must be stated or referenced, so that the systems engineers can understand the requirements in terms of user needs.

Slide 13

Here’s where the ORD comes in …



- The ORD defines the essential capabilities, associated requirements, and performance measures of a system, as well as the concept of operations which will govern its use.
- The ORD establishes the reference against which the subsequent system development will be judged and ultimately tested (in operational test and evaluation).
- Requirements must be clear, complete, consistent, feasible of accomplishment, and measurable (testable).
- Like the MNS, the ORD specifies the problem, not the solution. It is not written in terms specific to any system concept or technological realization.
- The Sponsor, representing the users, owns the ORD.

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After needs analysis and the selection of a feasible technical approach (though not, at this point, necessarily the optimum one), one is ready to project the relevant information to derive anticipated operational requirements. These requirements include the following considerations:

Operational distribution or deployment – the number of customer sites where the system will be used, the geographical distribution and deployment schedule, and the type and number of system components at each location. This responds to the question: where is the system to be used?

Mission profile or scenario – identification of the prime mission for the system, and its alternative or secondary missions. What is the system to accomplish and what functions must be performed in responding to the need? This may be defined through a series of operational profiles, illustrating the “dynamic” aspects required in accomplishing a mission. An aircraft flight path between two cities, an automobile or a shipping route, and the number of products to be produced in a factory are examples.

Performance and related parameters – definition of the basic operating characteristics or functions of the system. This refers to parameters, such as range, accuracy, rate, capacity, throughput, power output, size, and weight. What are the critical system performance parameters needed to accomplish the mission at the various sites? How do these parameters relate to the mission profile(s)?

Utilization requirements – anticipated usage of the system (and its components), in accomplishing the mission. This refers to hours of equipment operation per day, the duty cycle, on-off cycles per months, percentage of total capacity used, facility loading, and so forth. To what extent will the various system components be used? This leads to a determination of some of the stresses imposed on the system by the operator.

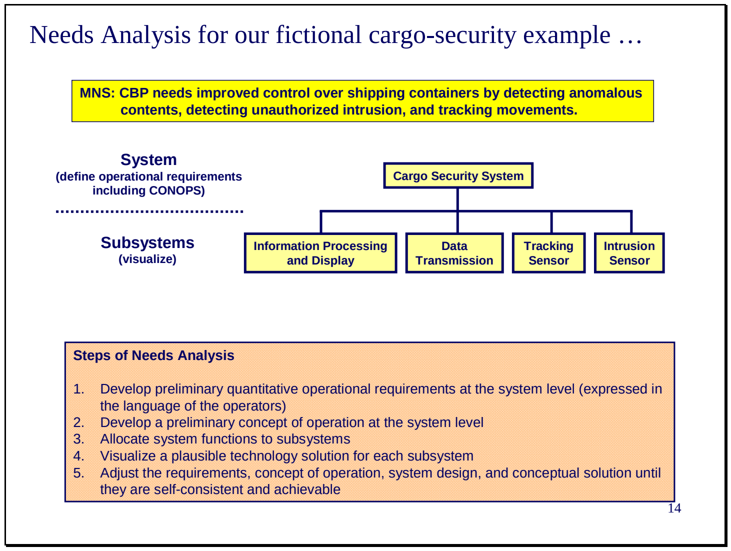
Effectiveness requirements – system requirements (specified quantitatively as applicable) to include cost/system effectiveness, operational availability, dependability, reliability mean time between failure (MTBF), failure rate, readiness rate, maintenance downtime, mean time between maintenance (MTBM), facility use (percentage), personnel quantities and skill levels, cost, and so on. Given that the system will perform, how effective or efficient must it be?

Operational life cycle (horizon) – the anticipated time duration that the system will be operational. How long will the system be in use by the consumer? What is the total inventory profile for units of the system and its components, and where is this inventory to be located? One needs to define the system life cycle. Although this may change (i.e., the life cycle of a system may be extended or reduced), a “baseline” needs to be established at the beginning.

Environment – definition of the environment in which the system is expected to operate in an effective manner. Examples are temperature, shock and vibration, noise, humidity, arctic or tropics, mountainous or flat terrain, airborne, ground, and shipboard. Following a set of mission profiles may result in specifying a range of values. To what will the system be subjected during its operational use and for how long? In addition to system operations, environmental considerations should address transportation, handling, and storage modes. It is possible that the system (or some of its components) will be subjected to a more rigorous environment when being transported than during operation.

The establishment of operational requirements forms the basis for system design. Be careful not to presuppose a specific technical solution. For example, if an operational requirement is that a vehicle be capable of traveling 600 miles on a tank of gas, such a requirement might be met by a larger gas tank, a lighter vehicle, or a more efficient engine. Thus, the ORD would specify the 600 miles/tank requirement, but be silent on tank size, vehicle weight, and engine efficiency, each of which presupposes a specific technical approach to solving the problem.

Slide 14



Start by writing down draft operational requirements at the system level. For example (to cite some made-up requirements for pedagogical purposes):

If a shipping container is tampered with, CBP shall know within 24 hours if at sea or on arrival at the port of entry.

CBP shall be able to determine the geographical position of each shipping container on demand, to an accuracy of one nautical mile.

CBP's ability to monitor each container shall commence when the container leaves its port of departure.

If a shipping container at sea is bound for a U.S. port which is not a port of entry, CBP shall have at least one day's notice of this fact.

CBP shall know within one day when its ability to monitor a particular shipping container is compromised.

Also write down a CONOPS.

CBP shall maintain an operations center where shipping container status is monitored. (Or, alternatively, each port of entry shall maintain such an operations center.)

When tampering is detected on a container at sea, CBP will …

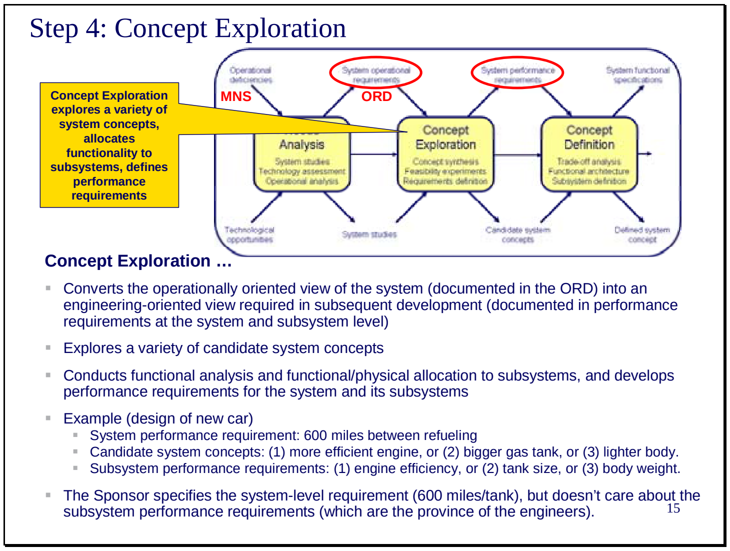
When a shipping container is bound for a U.S. port which is not a port of entry, CBP will …

If CBP loses the ability to monitor a particular shipping container, CBP will …

Visualize a potential system decomposition into subsystems and visualize how the functionality of the system is distributed among the subsystems. Is there a plausible technology solution for each subsystem?

For example, is the signal processing done in the sensor (of which there may be 100,000) or the Info Processing and Display subsystem (of which there may be one)? If in the sensor, the sensor may become unaffordable for the shippers to purchase. If centralized in the Info Processing and Display subsystem, great demands are placed on the Data Transmission subsystem and the Info Processing subsystem.

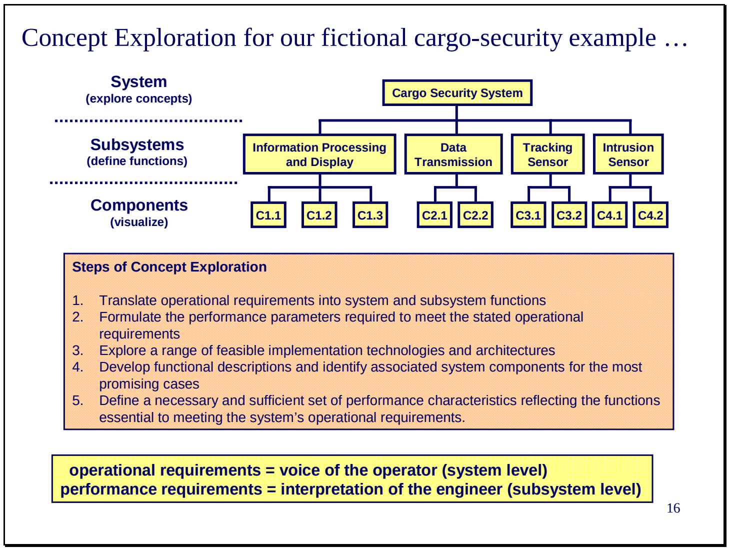
Slide 15



Concept Exploration consists of the following activities:

Operational Requirements Analysis
Define and analyze at least 3 alternative concepts, starting with an existing (predecessor) system as a baseline, if possible, and varying one or more subsystems or considering modified architectures
Develop a CONOPS, expressing the customer's expectation for system use. The CONOPS is a constraint on the system concept and therefore is, effectively, an addition to the operational requirements.
Performance Requirements Formulation
Derive subsystem functions
Formulate performance parameters
Implementation Concept Exploration
Explore alternative technologies and architectures
Define performance characteristics of each candidate system concept
Performance Requirements Validation
Integrate performance characteristics, selecting those characteristics of the different system concepts that are necessary and sufficient to define a system possessing the essential operational characteristics
Validate performance requirements against operational requirements, and create the performance-requirements document. These requirements define:
What the system must do, and how well, but not how the system should do it.
Characteristics in engineering terms that can be verified by analytical means or experimental tests.

Slide 16



Now we define the functionality of the subsystems and visualize the components necessary to implement these subsystems. We do this for a range of feasible implementation technologies and architectures.

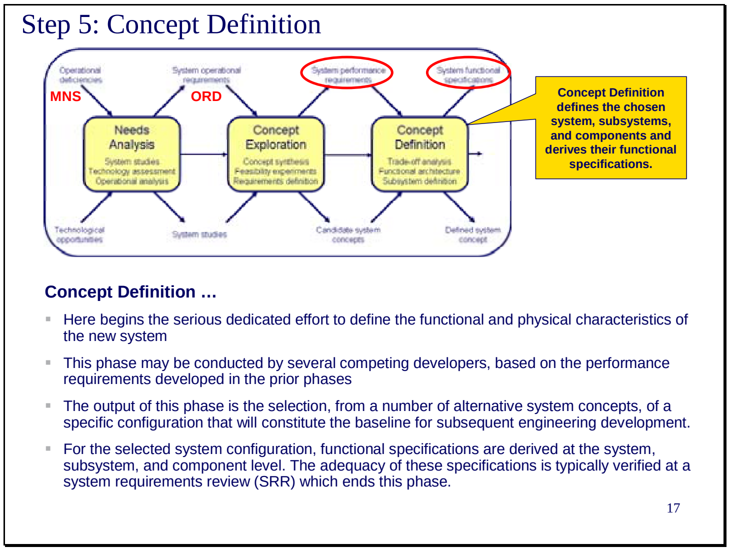
For example, two competing concepts might be to implement signal processing in the Intrusion Sensor subsystem or to centralize signal processing in Info Processing and Display subsystem. We would visualize the components necessary to implement each of these approaches, and compare the system performance, cost, schedule, and risk for the competing approaches.

We then define a necessary and sufficient set of performance characteristics reflecting the functions necessary to meet the operational requirements.

These performance characteristics, derived for the system and subsystem levels, are called “performance requirements” and are the engineer’s interpretation of the operational requirements. Examples of performance requirements for this system might include “probability of detection of an intrusion,” “probability of false alarm,” “system availability,” “system geographical coverage.” These are performance requirements at the system level. Requirements at the subsystem level might include the bandwidth of the Data Transmission system, shock and vibration resistance of the Intrusion Sensor subsystem, or the accuracy of the Tracking Sensor subsystem.

To tell whether a particular requirement is an operational requirement or a performance requirement, ask yourself whether the operator could (a) articulate the requirement, and (b) measure compliance with the requirement during an operational test at the system level.

Slide 17



Concept Definition consists of the following activities:

Performance Requirements Analysis
Analyze performance requirements
Each phase of development must begin with a detailed analysis of all of the requirements on which the ensuing program is to be predicated. Even though the previous phase may have been thoroughly carried out, the derivation of a set of performance requirements for a complex system is necessarily an imprecise and often subjective process. It is therefore essential that both the basis for the requirements and their underlying assumptions be clearly understood.
Refine performance requirements as necessary
Functional Analysis and Formulation
Define component functions, by allocating subsystem functions to the component level
Formulate functional requirements for each assigned function
Concept Selection
Synthesize alternative technological approaches and component configurations designed to meet the system performance requirements
Select preferred concept after trade-off studies
Concept Validation
Conduct system simulation using system effectiveness models. Conduct critical experiments where necessary to demonstrate feasibility where modeling is inadequate.
Validate selected concept (Does it meet requirements? Is it the superior alternative?)

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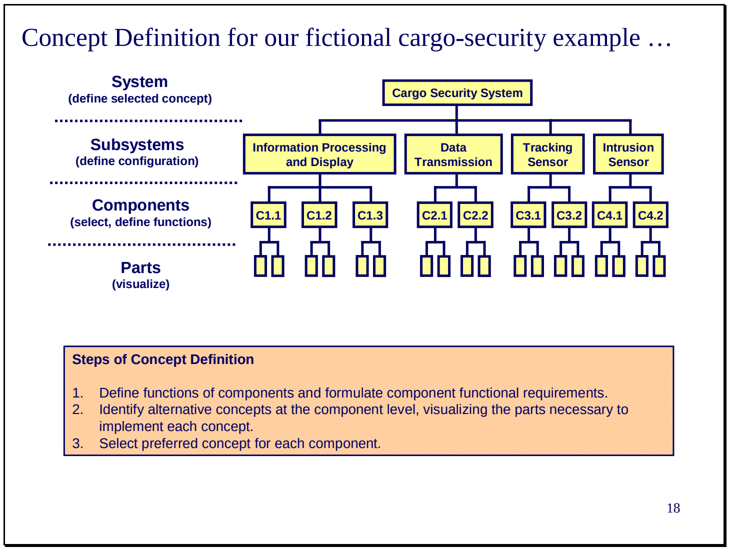
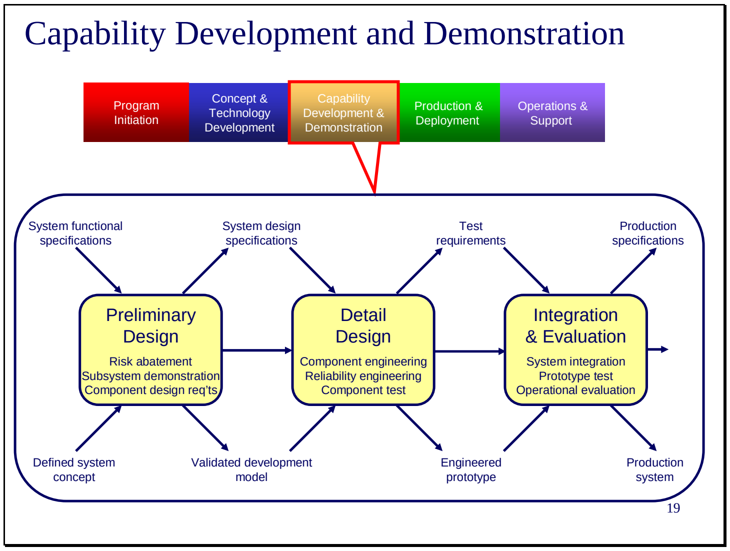


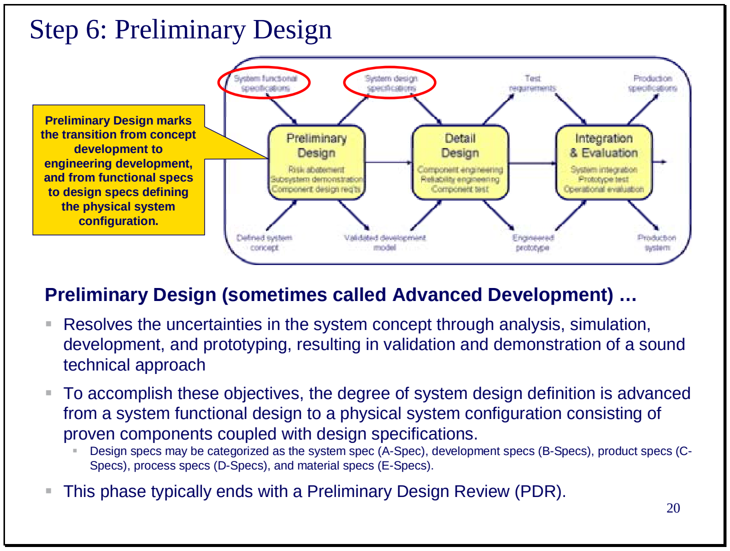
After the optimum system concept has been selected in the Analysis of Alternatives (AoA), complete the system design by flowing down functional requirements from the subsystem level to the component level, and visualizing the implementation of these components using standard parts.
Select a preferred concept for each component (a sort of mini-AoA).

Slide 19



We expand the System Development Life Cycle's third phase (Capability Development and Demonstration) into three sub-phases, to describe the activities within this phase and the resulting requirements and specifications, listed across the top.
This expansion derives from relatively standard textbook expositions of systems engineering. Reference may be had to *Systems Engineering: Principles and Practice* by Kossiakoff and Sweet, or to any standard systems engineering text.

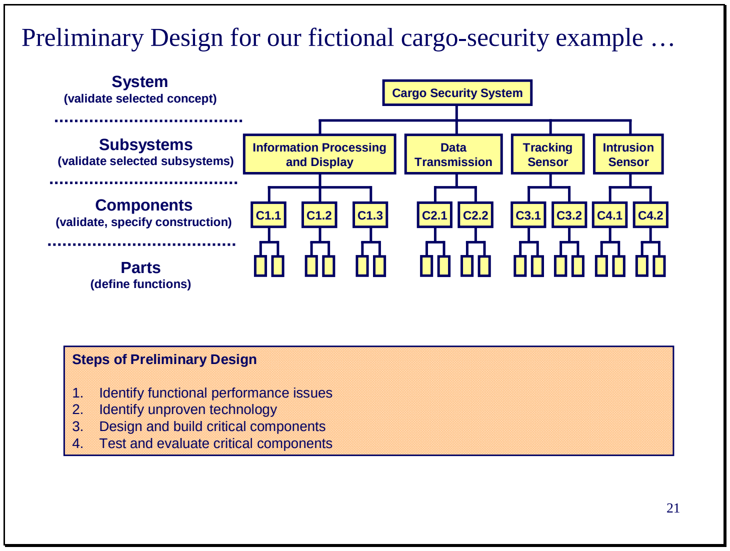
Slide 20



Preliminary Design consists of the following activities:

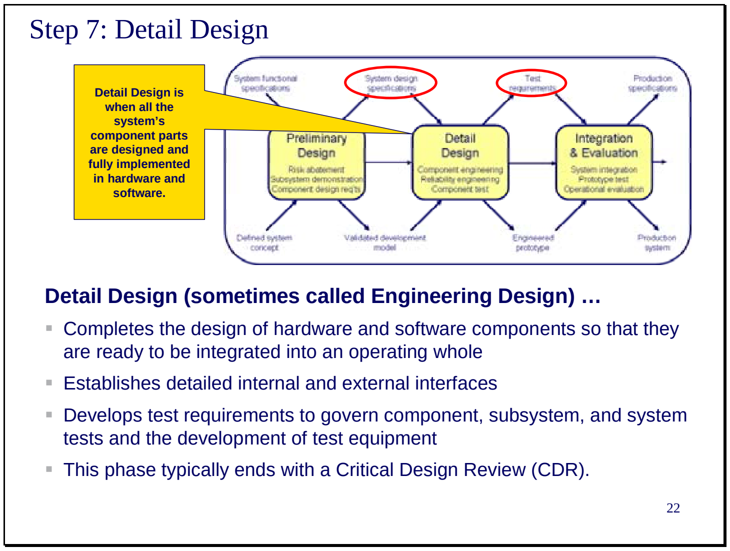
Requirements Analysis
Analyze system functional specs, validating their traceability to operational and performance requirements and the validity of their translation into subsystem and component functional requirements
Identify immature components requiring development
Functional Analysis and Design
Identify functional performance issues
Resolve issues (by analyses and simulations), design software
Prototype Development
Identify unproven technology
Design and build critical components (hardware and software)
Development Testing
Build test set-up, conduct tests of critical components
Evaluate test results and feed back design deficiencies or excessively stringent requirements as necessary for correction.
Perform preliminary product design
Create mockups, models, and breadboards as necessary.
Create design and interface specifications (B specs)
Conduct a PDR

Slide 21



Note that, in Preliminary Design, functional requirements are flowed down to the Parts level, and critical components using unproven technology are designed, built, and tested.

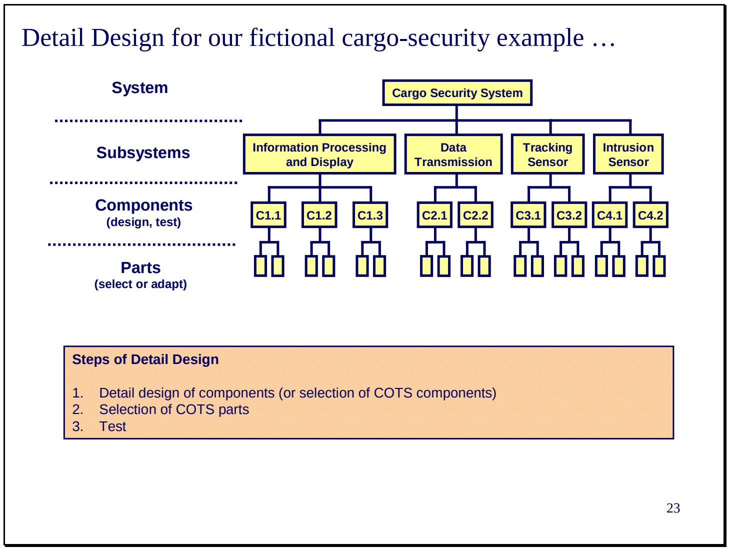
Slide 22



Detail Design consists of the following activities:

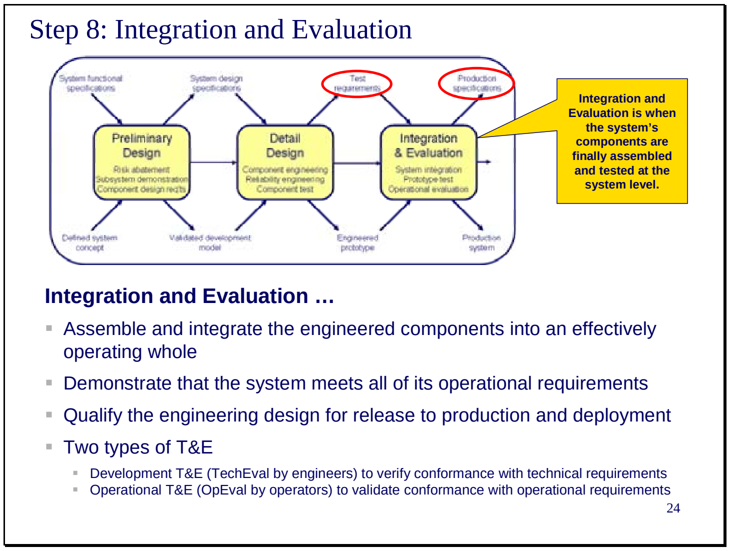
Requirements Analysis
Analyze system design requirements for relevance, completeness, and consistency
Identify and analyze external interface requirements
Since the whole system has not been physically assembled in previous phases, it is likely that the design of its external interfaces has not been rigorous.
Functional Analysis and Design
Analyze component interactions (which may not have been done rigorously in preliminary design)
Maximize system modularity, by definitizing the interactions of components with one another and with the system environment to maximize their mutual independence
Execute detailed design of components
Produce a complete description (the product baseline) of the end items constituting the total system, including specifications (C, D, E), interface control drawings, detailed engineering drawings, configuration control plan, detailed test plans and procedures, QA plans, ILS plans, and other documentation
Produce prototype hardware and software
Conduct a CDR
Design Validation
Design and build test equipment
Test components to validate design, correcting design discrepancies if necessary

Slide 23



In detail design we complete the design down to the Parts level, by selecting or adapting existing COTS parts which can be used with acceptable risk to implement the functionality at the Component level.

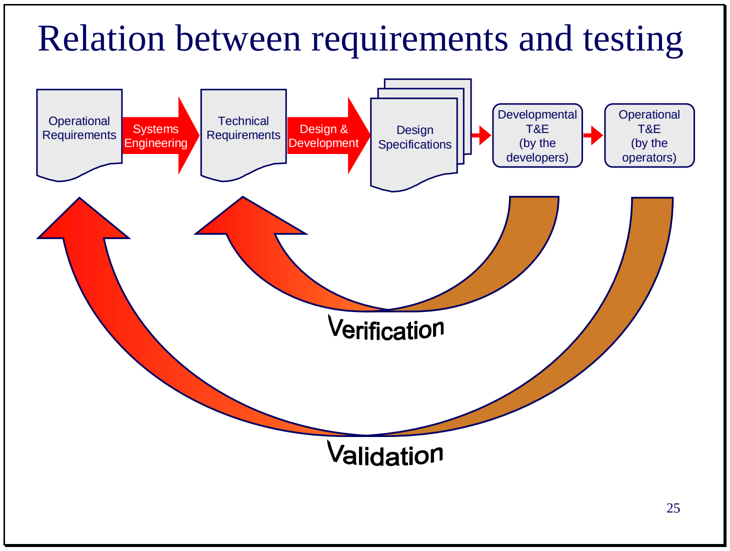
Slide 24



Integration and Evaluation phase consists of the following activities:

Test Planning and Preparation
Review system requirements to ensure that no changes have occurred during the engineering design phase which may impact the system T&E process.
Define test requirements for integration testing and performance testing
Design/build system/subsystem test equipment (including capability to stimulate the element under test and measure system response)
System Integration
Integrate tested components into subsystems
Test subsystems
Integrate tested subsystems into an operational system
Developmental System Testing
Perform system-level tests
Eliminate all performance deficiencies
Operational Test and Evaluation
Test system performance with real users, under the cognizance of an independent test agent
Compare test results to the operational requirements themselves, rather than to their translation into performance requirements.
Evaluate system readiness for transition to the Production and Deployment Phase

Slide 25



T&E comes in two flavors: Developmental T&E and Operational T&E.
Developmental T&E is sometimes called Technical Evaluation (or TechEval) or, in the software world, alpha testing.
Operational T&E is sometimes called OpEval or, in the software world, beta testing.
DT&E serves the purpose of verifying that the final system design conforms to its technical requirements.
OT&E serves the purpose of validating that the final system design satisfies its operational requirements ***when operated by its intended users***.
Involving the system designers in OT&E represents a conflict of interest, since the designers have a vested interest in proving that the system satisfies its operational requirements. This consideration motivates the requirement for an independent test agent when conducting OT&E.

Slide 26

What makes a good requirement?

Criterion	*Description*
Necessary	Can the system meet prioritized, real needs without it? If yes, the requirement isn't necessary.
Verifiable	Can one ensure that the requirement is met in the system? If not, the requirement should be removed or revised.
Unambiguous	Can the requirement be interpreted in more than one way? If yes, the requirement should be clarified or removed. Ambiguous or poorly worded requirements can lead to serious misunderstandings and needless rework.
Complete	Are all conditions under which the requirement applies stated? Also, does the specification include all known requirements?
Consistent	Can the requirement be met without conflicting with any other requirement? If not, the requirement should be revised or removed.
Traceable	Is the origin (source) of the requirement known, and is there a clear path from the requirement back to its origin?
Concise	Is the requirement stated simply and clearly?
Standard constructs	Requirements are stated as imperative needs using "shall." Statements indicating "goals" or using the words "will" or “should” are not imperatives.

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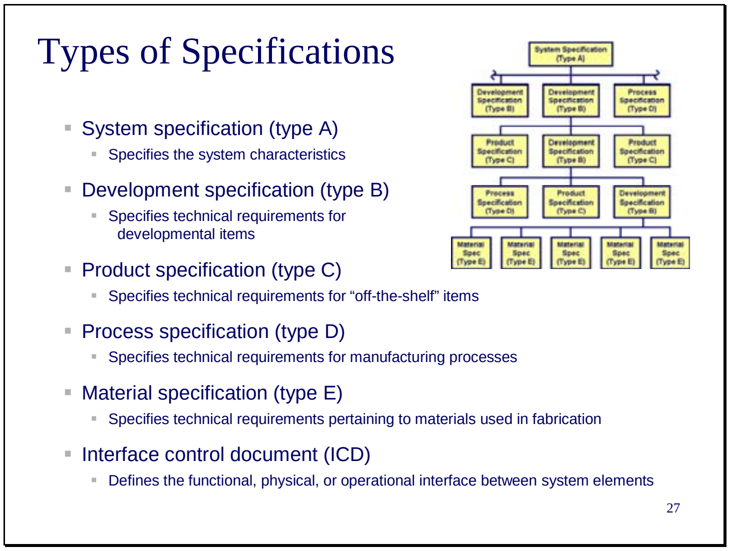
This list of criteria for good requirements was taken from a publication of INCOSE, the International Committee on Systems Engineering. It is pretty much self-explanatory.

Slide 27



System specification (type A)
Includes the technical, performance, operational and support characteristics for the system as an entity. It includes the allocation of requirements of functional areas, and it defines the various functional-area interfaces. The information derived from the feasibility analysis, operational requirements, maintenance concept, and the functional analysis is covered.

Development specification (type B)
Includes the technical requirements for any item below the system level where research, design, and development are accomplished. This may cover an equipment item, assembly, computer program, facility, critical item of support, and so on. Each specification must include the performance, effectiveness, and support characteristics that are required in the evolving of design from the system level and down.

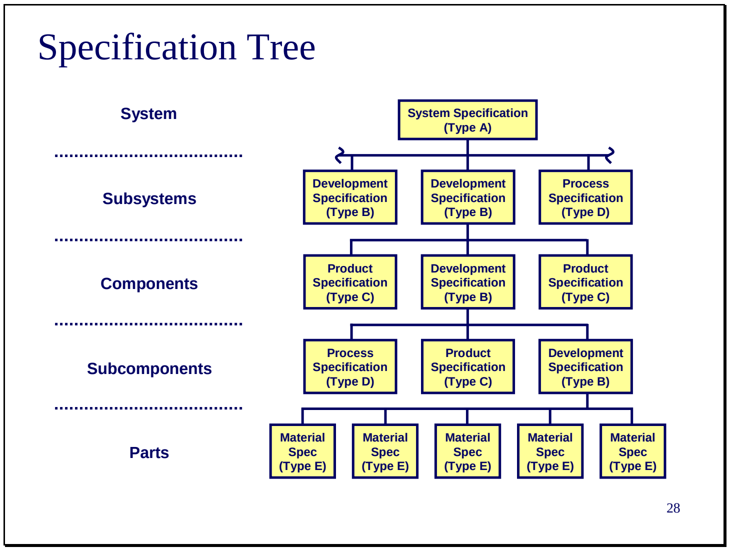
Product specification (type C)
Includes the technical requirements for any item below the top system level that is currently in the inventory and can be procured “off the shelf.” This may cover standard system components (equipment, assemblies, units, cables), a specific computer program, a spare part, a tool, and so on. These are sometimes called “non-developmental items,” or NDIs.

Process specification (type D)
Includes the technical requirements that cover a service that is performed on any component of the system (e.g., machining, bending, welding, plating, heat treating, sanding, marking, packing, and processing).

Material specification (type E)
Includes the technical requirements that pertain to raw materials, mixtures (e.g., paints, chemical compounds), or semi-fabricated materials (e.g., electrical cable, piping) that are used in the fabrication of a product.

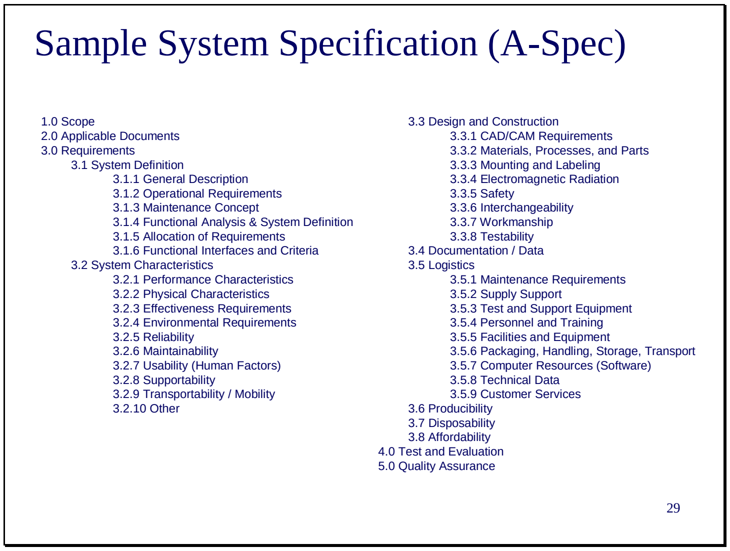
Interface control document
Describes the complete interface protocol from the lowest physical elements (e.g., the mating plugs, the electrical signal voltage levels) to the highest logical levels (e.g., the level 7 application layer of the ISO model), or some subset thereof. The purpose of the ICD is to communicate all possible inputs to and all potential outputs from a system element.

Slide 28



The specification tree shows the relationships among all the system's specifications, related to the system/subsystem/component hierarchy.
At the highest level is the system spec. Any path down through the hierarchy must end in a product or material that can be procured "off the shelf."
The system integrator, normally a prime contractor, is responsible for the system specification and for integrating the subsystems.
The subsystems themselves might be developed by the integrator, by a subcontractor to the integrator, or by separately contracted developers providing the subsystems as Government-furnished equipment (GFE).
S&T's engagement with this specification tree depends on whether S&T is responsible for delivering a system, a subsystem, or a component. If delivering a subsystem or component, S&T would execute to a development specification (type B).

Slide 29



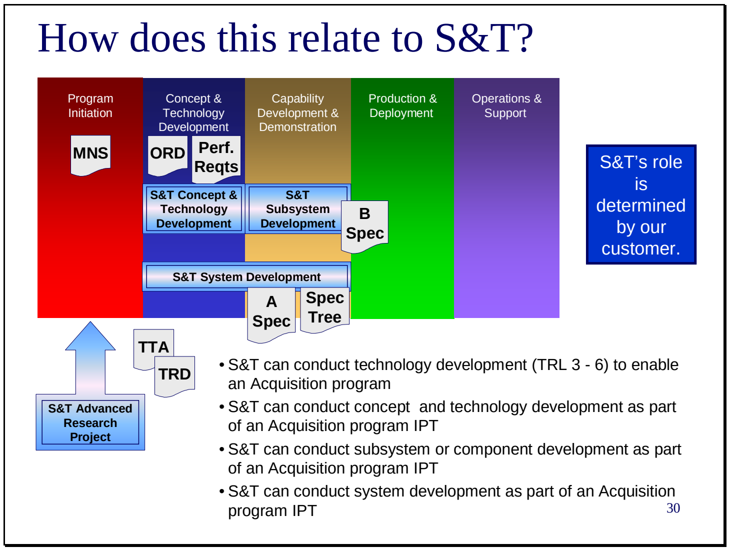
This sample system specification is intended to illustrate the range of requirements which govern a system development (and, by extension, the development of subsystems or technologies).

Engineers tend to focus on functionality, but only a subset of the requirements relates to the functionality of the system (which of course is of direct interest to the operators).

Other requirements address logistical concerns, such as maintainability, supportability, producibility, and affordability.

B-Specs and C-Specs are similar in nature to A-Specs, though with more emphasis on interface requirements and less emphasis (if any) on operational requirements (since subsystems and components are generally not “operated” in the same sense that systems are operated).

Slide 30



We've shown how the world of requirements relates to the world of Acquisition. But in almost all cases the S&T Directorate is not the Acquisition Sponsor and may not play a direct role in the Acquisition program. So how does all of this relate to S&T? There are several alternative roles for S&T.

S&T can execute an Advanced Research project intended to provide an Enabling Homeland Capability (EHC) to an Acquisition program. The EHC may in fact be necessary to make the Acquisition program possible, in which case it would execute before the initiation of Acquisition. Or the EHC may provide an enhancement to an existing Acquisition program, in which case it may transition its technology product into the Concept and Technology Development phase, to be included as part of the Alternatives Analysis.

OR

S&T can be tasked by an Acquisition program manager to conduct the technical aspects of the Concept and Technology Development phase.

OR

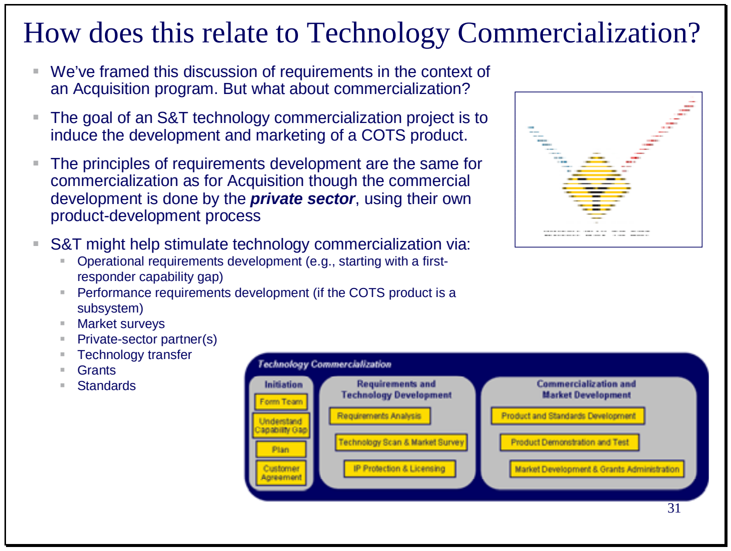
S&T can be tasked by an Acquisition program manager to execute the preliminary and detail design of a subsystem or component, as part of the Capability Development and Demonstration phase.

OR

S&T can be tasked by an Acquisition program manager to execute the technical aspects of the entire system development.

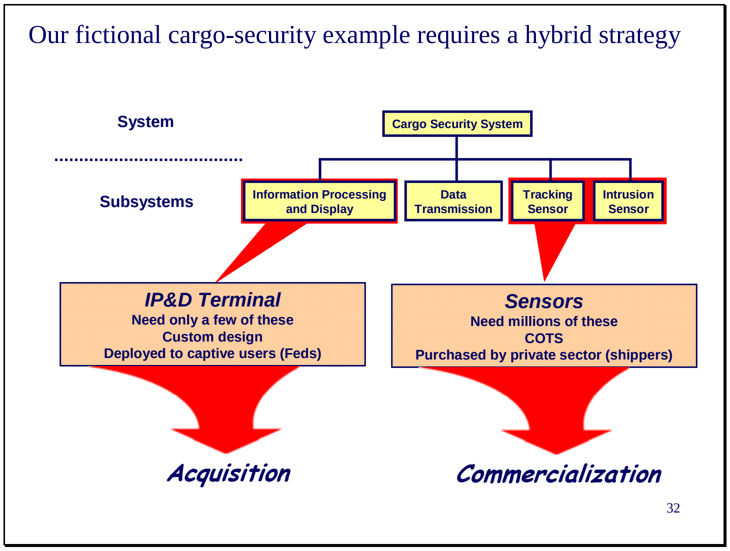
In the last three alternatives, where S&T is executing inside the Acquisition program, S&T would be a full member of the Acquisition program's Integrated Product Team (IPT).

Slide 31



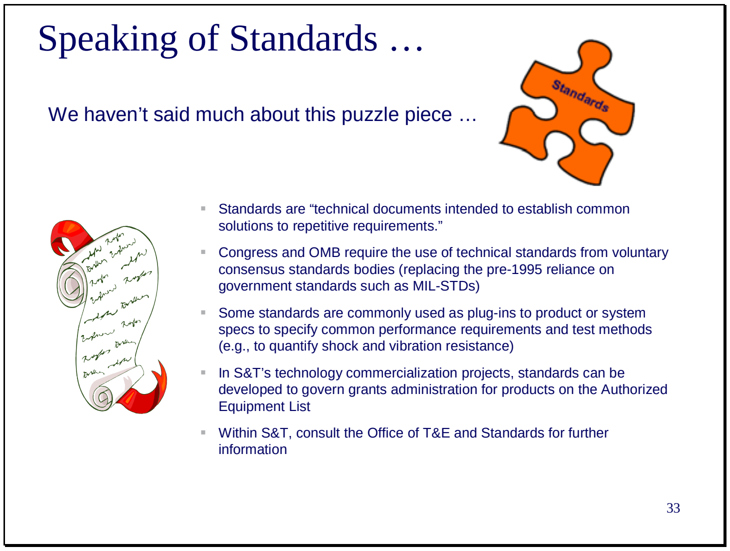
A DHS Acquisition program typically results in a DHS-funded DHS-owned product or system, manufactured and integrated by a prime contractor and deployed to a DHS workforce. But what if the goal is the realization of a Commercial Off-the-Shelf (COTS) product, to be made available to non-DHS users (State, local, and/or private sector) via normal commercial channels (such as catalog sales)?
Such a product development is not governed by DHS's System Development Life Cycle, but instead by S&T's Technology Commercialization framework (described in other mini-courses in this series).
How is the world of requirements different in this case?
The principles are the same, though very little of the product-realization process is under the direct control of DHS. Instead, the product or system is developed by the private sector, using their product-realization process. DHS's requirements role is limited to the development of operational requirements to address a capability gap (e.g., pertaining to first responders), and to the development of standards to govern the acceptance of the resulting product.

Slide 32



Our fictional cargo-security system has an awkward aspect when it comes to Acquisition. It is a distributed system whose sensors must be procured and installed by the private sector.
Thus, the development, deployment, operations, and support of its Information Processing and Display Terminal can be accomplished by a classical Acquisition program. But the implementation and distribution of its distributed sensors cannot be managed in that way, because the users of the sensors are not under CBP control, and therefore CBP cannot "deploy" to them.
The implementation of a commercialization program to create the necessary COTS sensors must address the following questions, among others:
What private-sector enterprise will develop and market the product?
What are the performance requirements which the product must satisfy, and how will compliance with these requirements be assured? (Note that "operational requirements" are not relevant here, since the sensors are subsystems which are not "operated".)
Is there government-owned intellectual property which must be transferred to the private sector?
What will cause shippers to purchase and install the sensors? Grants? Regulation? Dual use? If dual use, how will the shippers interrogate the sensors?
Are new standards required?
How are the answers to these questions documented in an agreement with S&T's DHS customers, and who must be party to the agreement? CBP, certainly, but also Policy (to address regulation) and FEMA (to address grants)?

Slide 33



Most organizations use the generic term "standard" to refer to a wide variety of technical documents intended to establish common solutions to repetitive requirements. OMB Circular A-119 defines a standard as "common and repeated use of rules, conditions, guidelines, or characteristics for products or related processes and production methods and for related management systems practices." According to OMB, a standard can be "definition of terms; classification of components; delineation of procedures; specification of dimensions, materials, performance, designs, or operations; measurement of quality or quantity in describing materials, processes, products, systems, services, or practices; test methods and sampling procedures; or descriptions of fit and measurements of size or strength."

Congress passed the National Technology Transfer and Advancement Act of 1995 to promote the commercialization of technology and industrial innovation. The Act requires all federal agencies and departments to use technical standards that are developed or adopted by voluntary consensus standards bodies, unless such use is impractical or inconsistent with law.

The use of technical standards as plug-ins to product or system specifications is a powerful labor-saving tactic for developers. Why develop your own environmental requirements, for example, if someone else has already done it for you?

The use of product performance standards is a powerful incentive to private-sector product developers to develop products to conform to homeland-security needs as perceived by DHS, in cases where product marketing relies on DHS acceptance (as with the use of grants programs coupled with the Authorized Equipment List).

Slide 34

Summary: Requirements Evolution

time

		Concept and Technology Development			Capability Development and Demonstration		
Phase		Needs Analysis	Concept Exploration	Concept Definition	Preliminary Design	Detail Design	Integration and Evaluation
Requirements output		Operational requirements	Performance requirements	Functional specs	Design specs (A, B, C, D, E)	Test requirements	Production specs
Level	System	Define operational objectives	Explore concepts	Define selected concept	Validate concept		Test and evaluate
	Subsystem	Visualize	Define functions	Define configuration	Validate selected subsystems		Integrate and test
	Component		Visualize	Select and define functions	Validate and specify construction	Design and test	Integrate
	Sub-component			Visualize	Define functions	Design	
	Part				Visualize	Select or adapt	

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This slide summarizes the parallel evolution of requirements and designs to deeper and deeper levels in the system/subsystem/component hierarchy as time progresses and the design matures. The framework is DHS's System Development Life Cycle.

Technical requirements are derived from operational requirements, and lower-level requirements from higher-level requirements, always maintaining traceability so that systems engineers and design engineers don't lose sight of why a lower-level requirement is important to the customer.

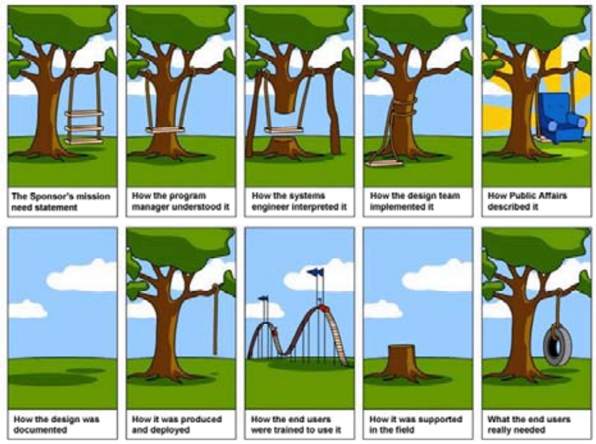
At each phase and sub-phase, the higher-level requirements are re-validated before lower-level requirements are developed, to ensure that the link to customer needs is never broken.

The final design is verified against its technical requirements, to ensure that it conforms to all specifications. Then it is validated against operational requirements, to ensure that it addresses all customer needs.

The details of this requirements development differ depending on whether the development is a DHS Acquisition program or an S&T Technology Commercialization project, and the level of DHS control is radically different in these two types of product or system development. But the principles are the same.

Slide 35

How the process ***really*** works



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Appendix E: Commercialization Briefing to Industry

The following pages include the slides used in briefing the private sector on business opportunities in DHS and ancillary markets.

Slide 1

Opportunities for the Private Sector

Thomas A. Cellucci, Ph.D., MBA
Chief Commercialization Officer
Department of Homeland Security
Science and Technology
Email: Thomas.Cellucci@dhs.gov

Slide 2

Discussion Guide

- Overview of Department of Homeland Security
- Commercialization initiatives at DHS
- Capstone Integrated Product Teams (IPTs)
- Market Potential is Catalyst for Rapid New Product Development
- Getting on the Same Page
- SECURE Program
- Safety Act Protection
- Tech Clearing House
- SBIR Opportunities
- Getting Involved
- Summary

Homeland Security

Slide 3

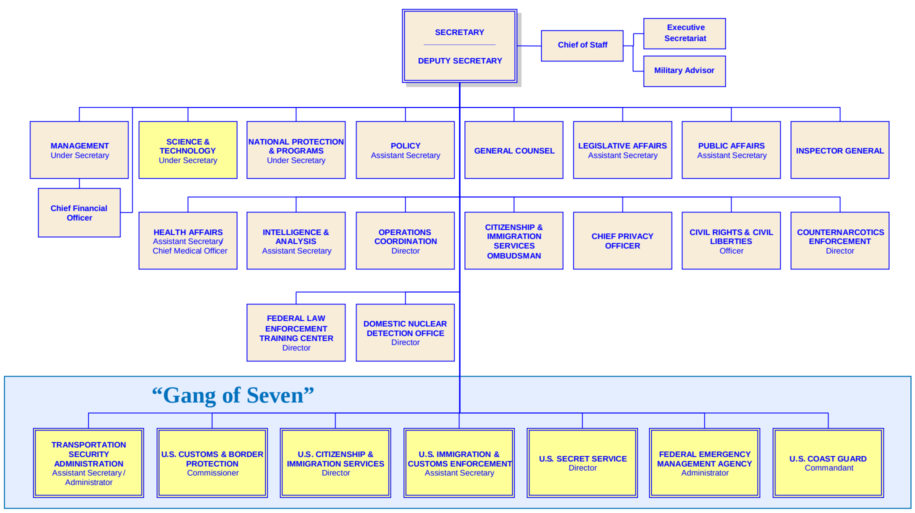
Homeland Security Mission

- Lead Unified National Effort to Secure America
- Prevent Terrorist Attacks Within the U.S.
- Respond to Threats and Hazards to the Nation
- Ensure Safe and Secure Borders
- Welcome Lawful Immigrants and Visitors
- Promote Free Flow of Commerce

Homeland Security

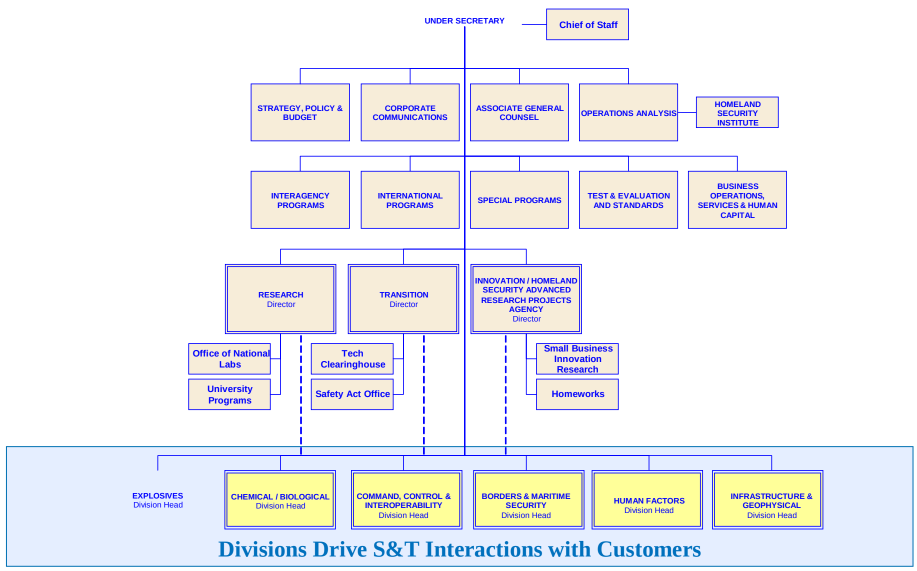
Slide 4

U.S. Department of Homeland Security



Slide 5

Office of the Under Secretary for Science and Technology



Slide 6

S&T Goals

Consistent with the Homeland Security Act of 2002

- **Accelerate the delivery of enhanced technological capabilities** to meet the requirements and fill capability gaps to support DHS agencies in accomplishing their mission.
- Establish a lean and agile world-class S&T management team to deliver the technological advantage necessary to ensure DHS Agency mission success and prevent technological surprise.
- Provide leadership, research and educational opportunities and resources to develop the necessary intellectual basis to enable a national S&T workforce to secure the homeland.

Homeland Security

Slide 7

DHS S&T Investment Portfolio

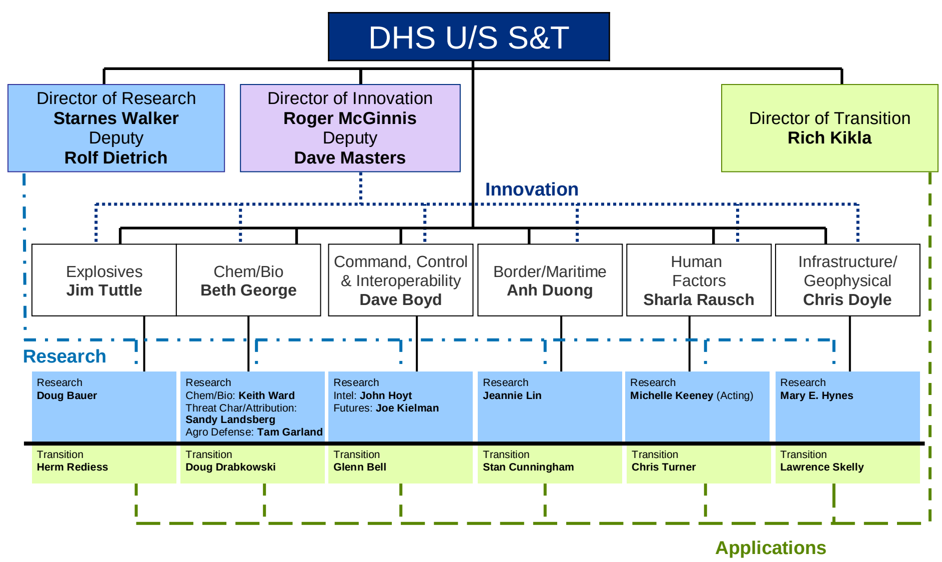
Balance of Risk, Cost, Impact, and Time to Delivery

Product Transition (0-3 yrs) • Focused on delivering near-term products/enhancements to acquisition • Customer IPT controlled • Cost, schedule, capability metrics	**Innovative Capabilities (1-5 yrs)** • High-risk/High payoff • “Game changer/Leap ahead” • Prototype, Test and Deploy • HSARPA
Basic Research (>8 yrs) • Enables future paradigm changes • University fundamental research • Gov’t lab discovery and invention	**Other (0-8+ yrs)** • Test & Evaluation and Standards • Laboratory Operations & Construction • Required by Administration (HSPDs) • Congressional direction/law

Customer Focused, Output Oriented

Slide 8

S&T Organization



Slide 9

Commercialization Office: Major Activities

Commercialization Office

Requirements Development Initiative	Commercialization Process	SECURE Program	Private Sector Outreach
•Requirements Development Book(s) •Operational Requirements Document Template •Training for end users and engineers	•"Hybrid" Commercialization Model •Product Realization Chart •Commercialization Framework and "Mindset"	•Concept of Operations •Website Development •Internal processes developed and socialized •Requirements and Conservative Potential Market Available Estimates Communicated	•Invited Speeches •Meetings with business executives •Numerous articles written and published regarding observations and programs in practice. •Repository of currently available products, services and/or technologies in the private sector aligned to Capstone IPT Capability Gaps

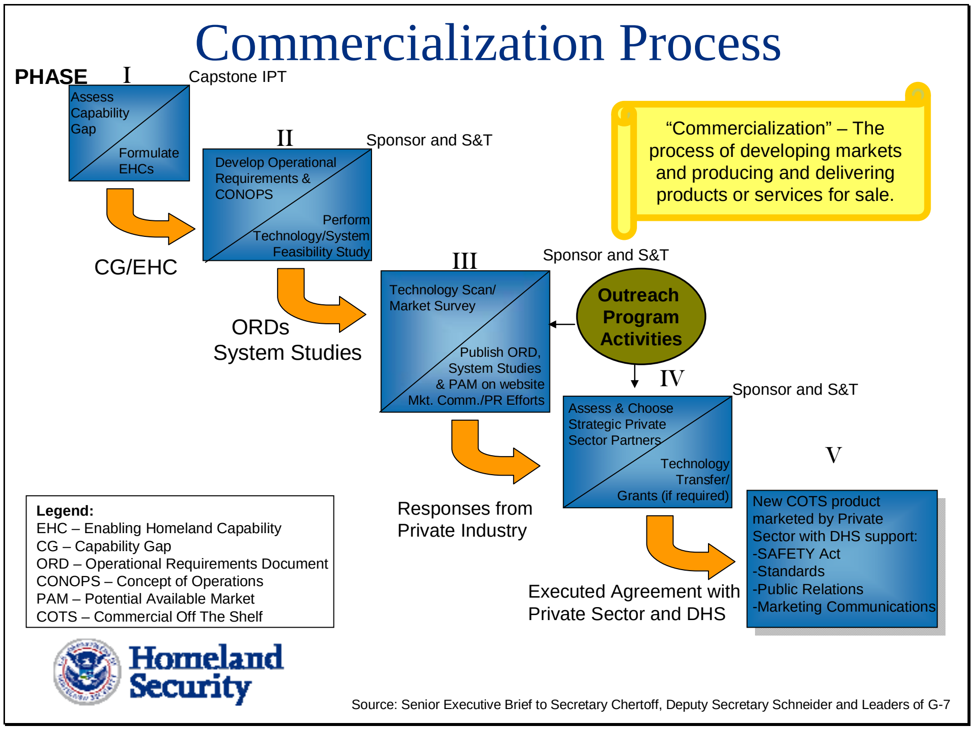
Homeland Security

Slide 10

Three Step Approach:
Keep it Simple and Make it Easy

1. Develop Detailed Requirements And Relay Conservative Market Potential
2. Establish Strategic Partnerships
   - Business Case Information
   - Open Competition
   - Detailed Mutual Responsibilities
3. Deliver Products!

Slide 11



Slide 12

10 Reasons to Partner with DHS Science & Technology

Reasons Color Legend:

Economics-based

Public Relations-based

Business Development-based

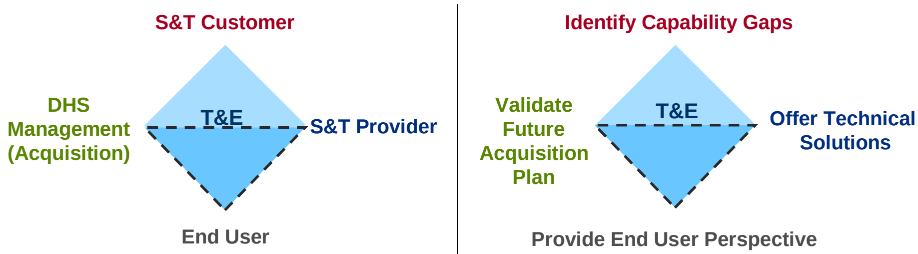
Strategic Marketing-based

Technical Resources-based

1. Access to Sizeable DHS Market and Ancillary Markets
2. Leverage the Financial Strength/Stability of DHS and off-set R&D costs through participation in mutually beneficial cost-sharing Programs
3. Utilize the SAFETY Act to gain liability protection and access DHS' array of PR and Market Communications services
4. Effectively reach the First Responders Market through FEMA-sponsored grant programs, the AEL (Approved Equipment List), other sponsored equipment lists and fast-track programs
5. Team with Science & Technology Personnel to leverage a vast Network of Laboratory Facilities for Technology and Product Development
6. Gain access to Test and Evaluation (T&E) Facilities for Product Development and actively participate in the generation of Standards, T&E methods and Regulations used at the tribal, local, state, and federal levels
7. Meet and establish Partnerships with others in the University, Business, and National Lab Communities
8. Potentially generate Licensing revenue and capture potential Derivative Product revenue
9. Leverage SBIRs, HITS and HIPS to gain experience with homeland security applications
10. Make a Real Difference by Developing Products to Defend the Homeland for Generations to come as well as gain recognition as a Corporate Citizen contributing to the Security of our Homeland

Slide 13

S&T Transition Capstone IPTs Members and Function



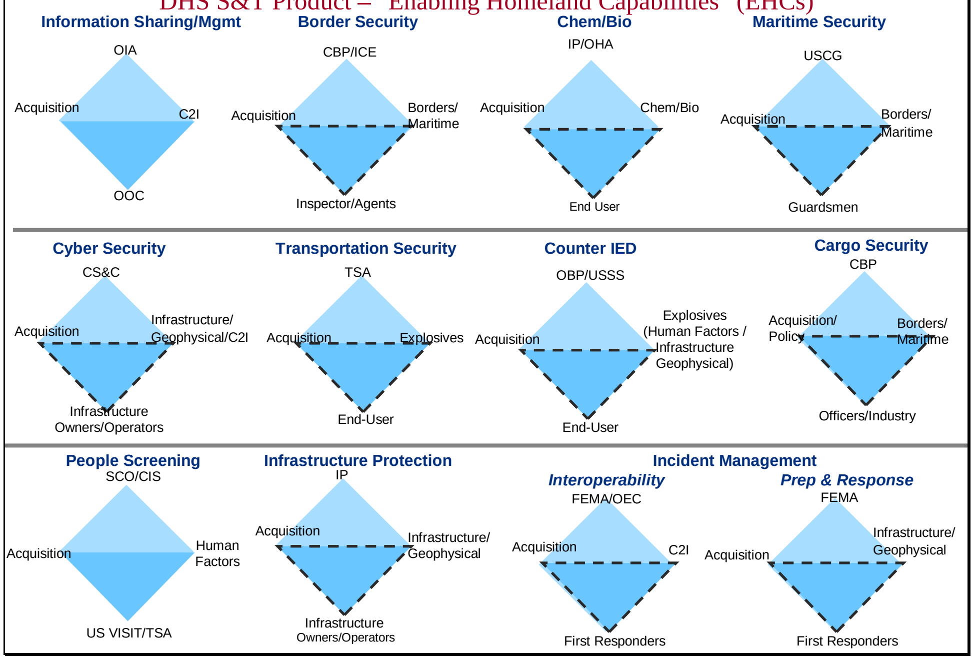
- Industry Board of Directors Model
- Consensus-driven Process

End Result :
Prioritized Investments in S&T

Slide 14

DHS Requirements/Capability Capstone IPTs

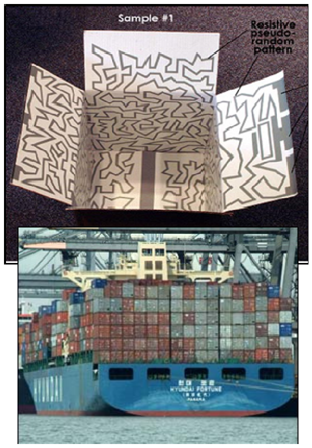
DHS S&T Product – "Enabling Homeland Capabilities" (EHCs)



Slide 15

Cargo Security

Representative Technology Needs



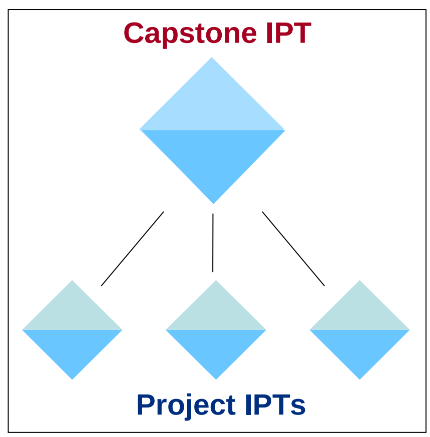
- Enhanced screening and examination by non-intrusive inspection
- Increased information fusion, anomaly detection, Automatic Target Recognition capability
- Detect and identify WMD materials and contraband
- Capability to screen 100% of air cargo
- Test the feasibility of seal security; detection of intrusion
- Track domestic high-threat cargo
- Harden air cargo conveyances and containers
- Positive ID of cargo and detection of intrusion or unauthorized access

Source: S&T High Priority Technology Needs, May 2007

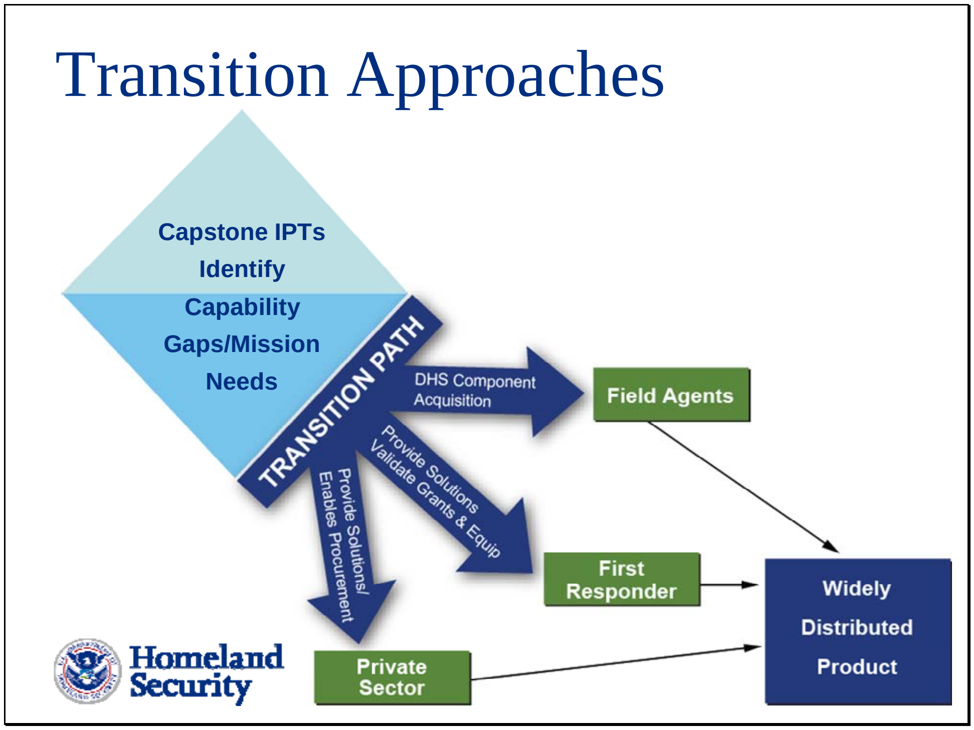
Slide 16

Establishment of Project IPTs: Detailed Specifications/Requirements

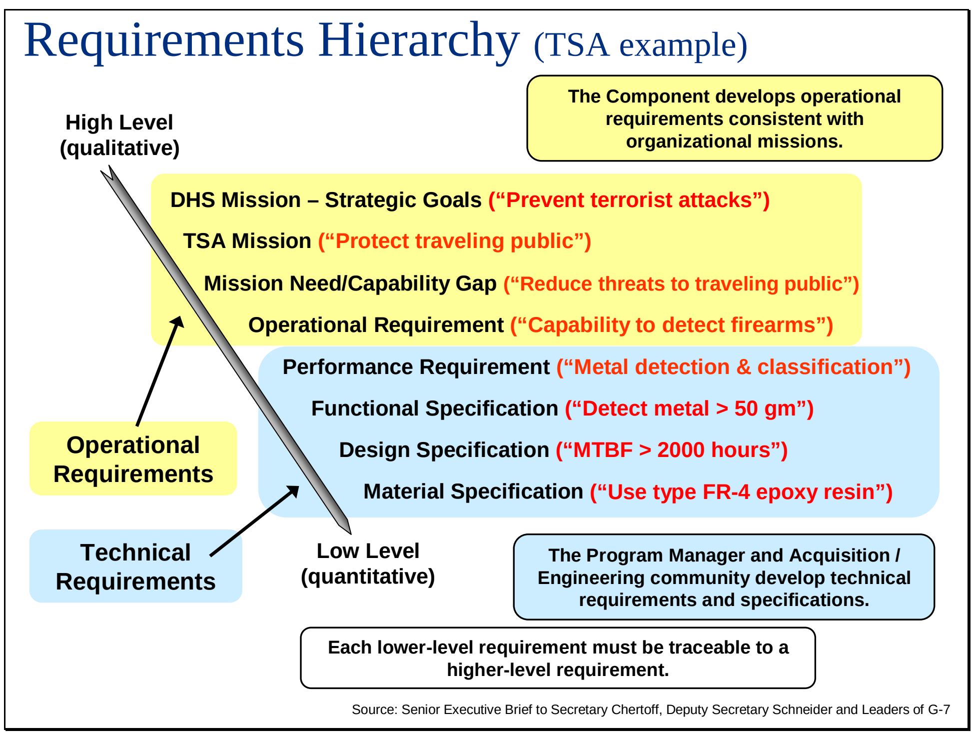
- Members:
  - S&T Program Manager(s)
  - Operating Component's Program Manager(s)
  - End-User(s)
  - Supplier/Provider
- Meet at Least Monthly
- Report to Capstone IPT Quarterly



Slide 17



Slide 18



Slide 19

ORD: Operational Requirements Document

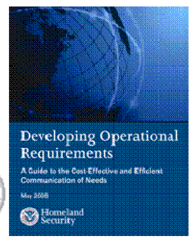
What: ORDs provide a clear definition and articulation of a given problem.

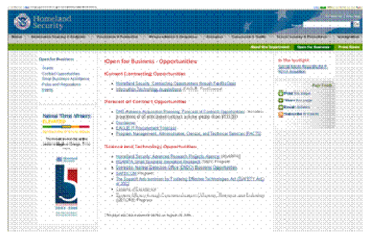
How: Training materials have been developed to assist drafting an ORD.

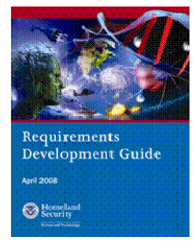
- *Developing Operational Requirements,* 194pp. Available online: http://www.dhs.gov/xlibrary/assets/Developing_Operational_Requirements_Guides.pdf

When: For Use in Acquisition, Procurement, Commercialization and Outreach Programs –Any situation that dictates detailed requirements (e.g. RFQ, BAA, RFP, RFI, etc.)

Why: It's cost-effective and efficient for both DHS and all of its stakeholders.

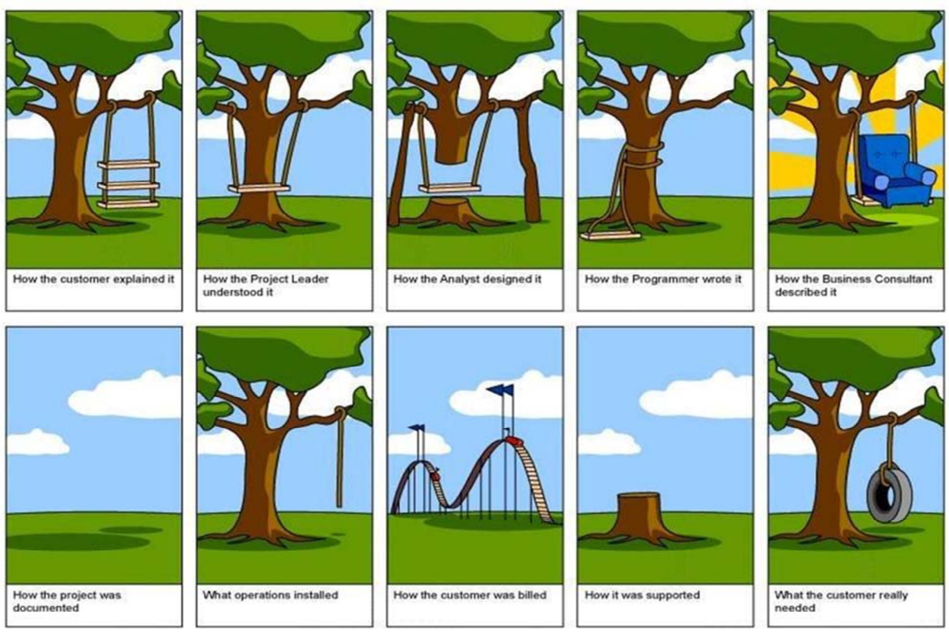






Slide 20

Does this look familiar?!



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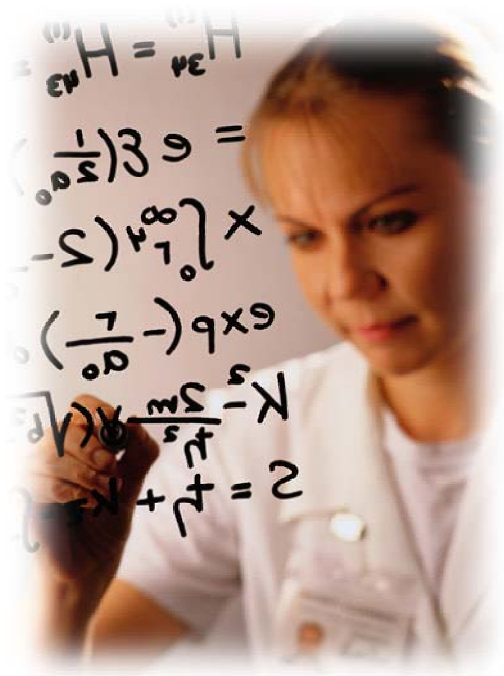
Slide 21

Getting on the "Same Page"

- Historical Perspective
- Language is Key
- Communication is Paramount

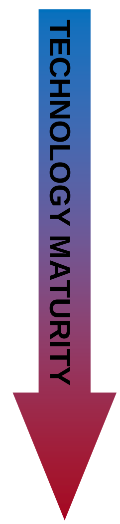


Slide 22

Technology Readiness Levels (TRLs): Overview

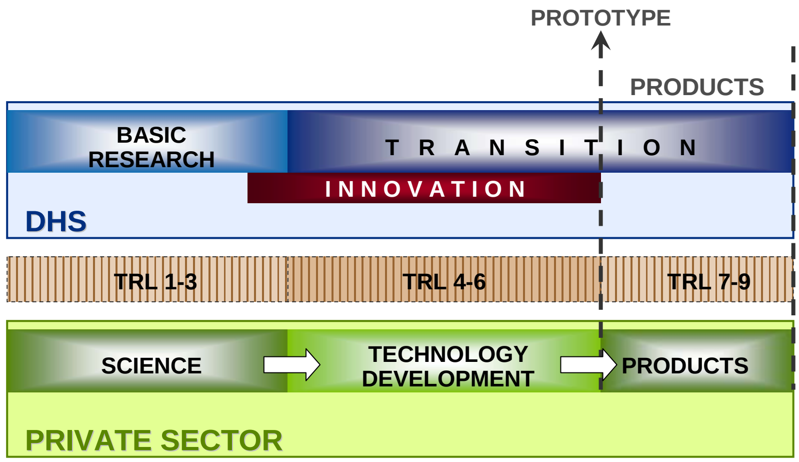
TRLs are NASA-generated and Used Extensively by DoD

Basic principles observed and reported	1	Basic
Technology concept and/or application formulated	2	
Analytical and experimental critical function and/or characteristic	3	
Component and/or breadboard validation in laboratory environment	4	Applied
Component and/or breadboard validation in relevant environment	5	
System/subsystem model or prototype demonstration in a relevant environment	6	Advanced
System prototype demonstration in a operational environment	7	
Actual system completed and 'flight qualified' through test and demonstration	8	
Actual system 'flight proven' through successful mission operations	9	



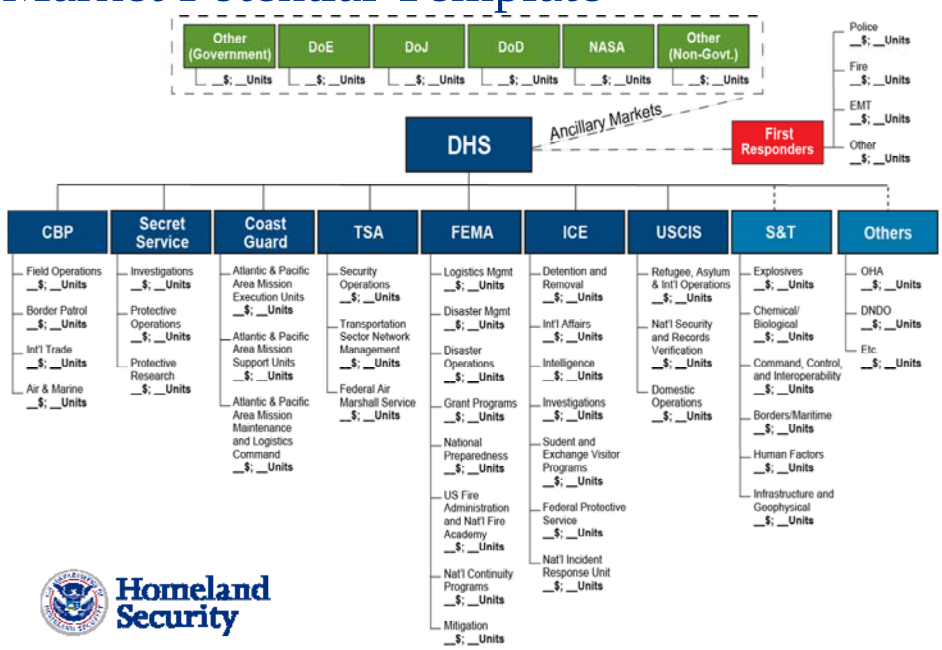
Slide 23

TRL Correlation: DHS and Private Sector



Slide 24

Market Potential Template

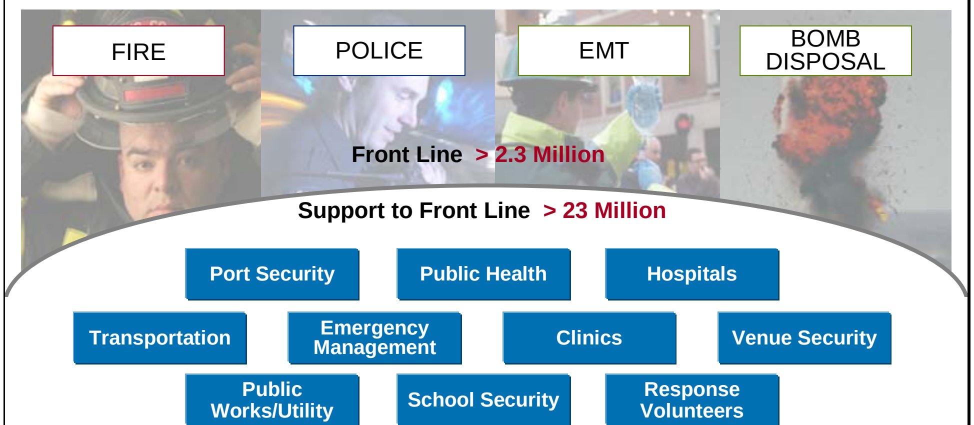


Slide 25

Conservative Estimate: Number of First Responders in the US

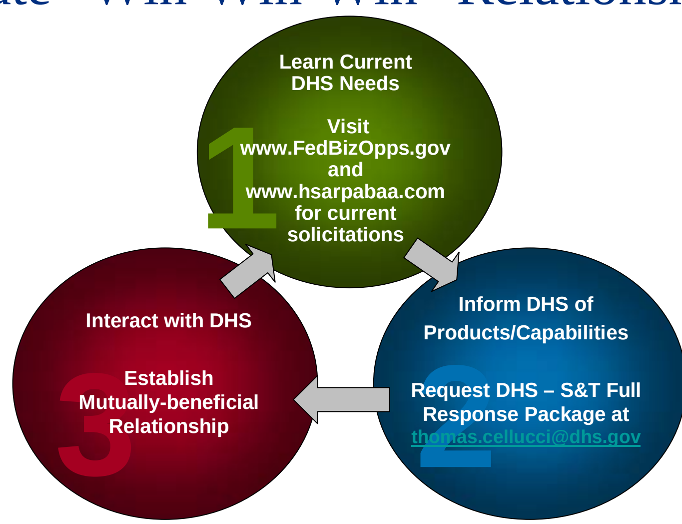
- Homeland Security Presidential Directive 8
- Steve Golubic (FEMA)

Total: > 25.3 Million Individuals



Slide 26

Call to Action: Mutual Benefits Create "Win-Win-Win" Relationships



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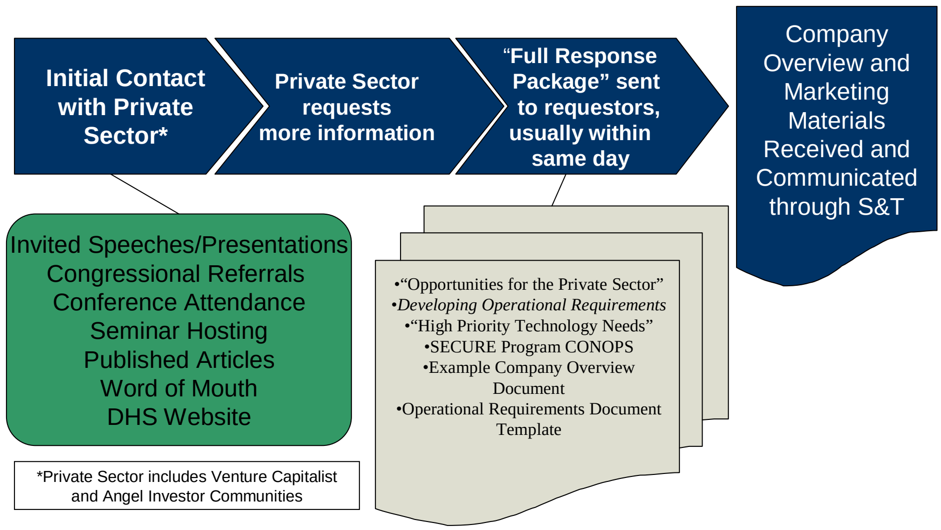
Contact with the Private Sector



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SECURE Program
Concept of Operations

Application → **Selection** → **Agreement** → **Publication of Results**

•Application – Seeking products/technologies aligned with posted DHS requirements

•Selection – Products/Technologies TRL-5 or above, scored on internal DHS metrics

•Agreement – One-page CRADA-like document. Outlines milestones and exit criteria

•Publication of Results – Independent Third-Party T&E conducted on TRL-9 product/service. Results verified by DHS, posted on DHS web-portal

Benefits:
•Successful products/technologies share in the imprimatur of DHS
•DHS Operating Components and First Responders make informed decisions on products/technologies aligned to their stated requirements
•DHS spends less on acquisition programs → Taxpayers win.

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SECURE Program
Benefit Analysis "Win-Win-Win"

Taxpayers	Private Sector	Public Sector
1. Citizens are better protected by DHS personnel using mission critical products	1.Save significant time and money on market and business development activities	1. Improved understanding and communication of needs
2. Tax savings realized through Private Sector investment in DHS	2. Firms can genuinely contribute to the security of the Nation	2. Cost-effective and rapid product development process saves resources
3. Positive economic growth for American economy	3. Successful products share in the "imprimatur of DHS"; providing assurance that products really work	3. Monies can be allocated to perform greater number of essential tasks
4. Possible product "spin-offs" can aid other commercial markets	4. Significant business opportunities with sizeable DHS and DHS ancillary markets	4. End users receive products aligned to specific needs
5. Customers ultimately benefit from COTS produced within the Free Market System – more cost effective and efficient product development	5. Commercialization opportunities for small, medium and large business	5. End users can make informed purchasing decisions with tight budgets

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Federal Business Opportunities

Sites where the Office of Procurement Operations (OPO) posts opportunities for prospective suppliers to offer solutions to DHS – S&T's needs:

- www.FedBizOpps.gov
- www.HSARPAbaa.com
- www.SBIR.dhs.gov
- www.Grants.gov

take advantage of...

- **Vendor Notification Service:** Sign up to receive procurement announcements and solicitations/BAA amendment releases, and general procurement announcements. http://www.fedbizopps.gov
- **S&T's HSARPA website:** Register to join the HSARPA mailing list to receive various meeting and solicitation announcements. Link to Representative High Priority Technology Areas, where DHS areas of interest can be found. http://www.hsarpabaa.com
- **Truly Innovative and Unique Solution**: Refer to Part 15.6 of the Federal Acquisition Regulation (FAR) which provides specific criteria that must be met before a unsolicited proposal can be submitted to Kathy Ferrell. http://www.acquisition.gov/far/current/html/Subpart%2015_6.html

Contact Information:
Kathy Ferrell
Department of Homeland Security
Office of the Chief Procurement Officer
245 Murray Dr., Bldg. 410
Washington, DC 20528
unsolicited.proposal@dhs.gov
202-447-5576

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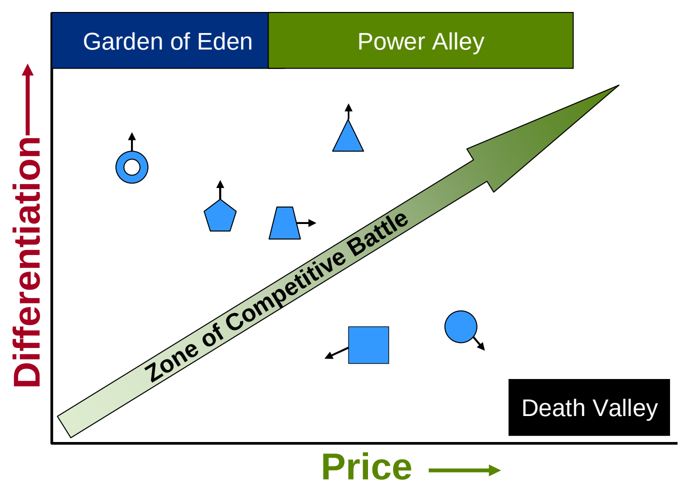
Show Us the Difference…

Hall's Competitive Model



As a function of:
- Market
- Application
- Technology

Differentiation = (A+B)C/(D+E)

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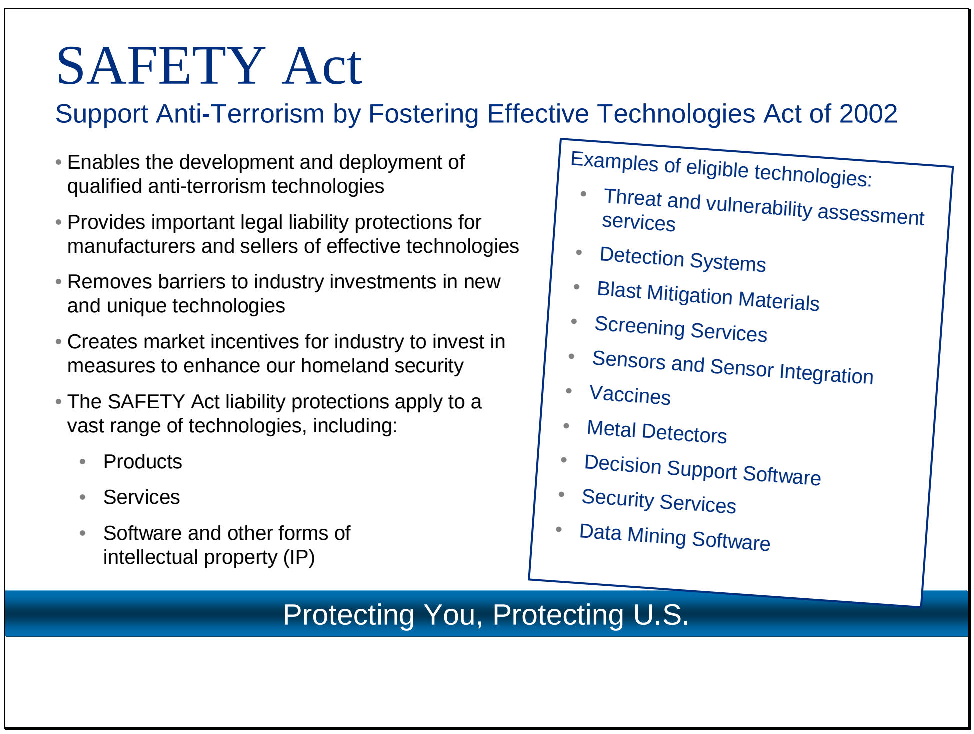

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Criteria as stated in the SAFETY Act

- Is it an Anti-Terrorism Technology?
- Is it effective and available?
- Does it possess large potential third party liability risk exposure?
- Does Seller need SAFETY Act?
- Does it perform as intended?
- Does it conform to Seller's specifications?
- Is it safe for use as intended?

Addition SAFETY Act information…
Online: www.safetyact.gov Email: helpdesk@safetyact.gov
Toll-Free: 1-866-788-9318

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Award Criteria

	Developmental Testing and Evaluation (DT&E)	Designation	Certification
Effectiveness Evaluation Conclusion	Needs more proof, has potential	Demonstrated effectiveness, i.e. Developmental testing (with confidence of repeatability)	Consistently proven effectiveness, i.e. operational performance (with high confidence of enduring effectiveness)
Protection	Liability cap • only for identified test event(s) and for limited duration (=3yrs)	Liability cap • for any and all deployments in 5-8 year term	Government Contractor Defense (GCD) • for any and all deployments in 5-8 years term
Examples	• EDS not yet TSL Certified • Novel incident pattern matching service	• Radiological detector with laboratory success Opt-out screeners, only similar projects completed	• EDS TSL Certified • Well-documented infrastructure protection service with history of excellent performance and meeting DoE standards

EDS=Explosive Detection System TSL=Transportation Security Laboratory (TSA)

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Tech Clearinghouse Mission

To rapidly disseminate technical information concerning existing and desired products and services to/between Federal, State, Local, and Tribal Government and the Private Sector in order to encourage technological innovation and facilitate the mission of the Department of Homeland Security.

- Establishes Central Federal Technology Clearinghouse
- Issues Announcements for Innovative Solutions
- Establishes S&T Technical Assessment Team
- Provides guidance for the evaluation, purchase, and implementation of homeland security enhancing technologies
- Provides users with information to develop or deploy technologies that would enhance homeland security
- Enables technology transfer

Improved Knowledge Sound Acquisition Decisions

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TechSolutions

The mission of TechSolutions is to rapidly address technology gaps identified by Federal, State, Local, and Tribal first responders

- Field prototypical solutions in 12 months
- Cost should be commensurate with proposal but less than $1M per project
- Solution should meet 80% of identified requirements
- Provide a mechanism for Emergency Responders to relay their capability gaps
  - Capability gaps are gathered using a web site (www.dhs.gov/techsolutions)
- Gaps are addressed using existing technology, spiral development, and rapid prototyping
- Emergency Responders partner with DHS from start to finish

Rapid Technology Development

Target: Solutions Fielded within 1 year, at <$1M

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TechSolutions Investments

Seatbelt Safety for Emergency Vehicles

Next Generation Breathing Apparatus

Fire Ground Compass

Under Consideration

Vehicle Mounted Chem/Bio Sensor Detection

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Getting Involved: S&T Contacts

Division	Email
Jim Tuttle	S&T-Explosives@dhs.gov
Beth George	S&T-ChemBio@dhs.gov
David Boyd	S&T-C2I@dhs.gov
Anh Duong	S&T-BordersMaritime@dhs.gov
Sharla Rausch	S&T-HumanFactors@dhs.gov
Chris Doyle	S&T-InfrastructureGeophysical@dhs.gov
Rich Kikla	S&T-Transition@dhs.gov
Starnes Walker	S&T-Research@dhs.gov
Roger McGinnis	S&T-Innovation@dhs.gov

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Summary

Detailed Requirements
Sizeable Market Potential
Delivered Products – PERIOD!

How Can You Afford NOT to Partner with DHS S&T?

Questions/Comments:
Thomas A. Cellucci, Ph.D., MBA
thomas.cellucci@dhs.gov

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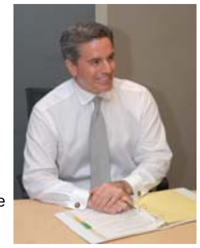
U.S. Department of Homeland Security: Science and Technology Directorate's Chief Commercialization Officer



Thomas A. Cellucci, PhD, MBA was recently appointed Chief Commercialization Officer for the Department of Homeland Security's Science and Technology (S&T) Directorate . The Chief Commercialization Officer (CCO) is responsible for initiatives that identify, evaluate and commercialize technology for the specific goal of rapidly developing and deploying products and services that meet the specific operational requirements of the Department of Homeland Security's Operating Components and its end users. The CCO also develops and drives the implementation of DHS-S&T's outreach with the private sector to establish and foster mutually-beneficial working relationships to facilitate cost-effective and efficient product/service development efforts.

Cellucci is an accomplished serial entrepreneur, seasoned senior executive and Board member possessing extensive corporate and VC experience across a number of worldwide industries. Profitably growing high technology firms at the start-up, mid-range and large corporate level has been his trademark. In 1999, he founded a highly successful management consulting firm--Cellucci Associates, Inc. -- that raises capital and provides strategic business services to top-tier global high technology firms. He serves on both public and private Boards and has authored or co-authored over 120 articles on Nanotechnology, Laser physics, Photonics, Environmental disturbance control, MEMS test and measurement, Mistake-proofing enterprise software, and Sales & Marketing. He has also held the rank of Lecturer or Professor at institutions like Princeton University, University of Pennsylvania and Camden Community College. Cellucci also co-authored ANSI Standard Z136.5 "The Safe Use of Lasers in Educational Institutions".

As a result of his consistent achievement in the commercialization of emerging technologies, Cellucci has received numerous awards and citations from industry, government and business.
Cellucci earned a PhD in Physical Chemistry from the University of Pennsylvania, an MBA from Rutgers University and a BS in Chemistry from Fordham University. He has also attended and lectured at executive programs at the Harvard Business School, MIT Sloan School, Kellogg School and others. Dr. Cellucci is regarded as an authority in rapid time-to-market new product development and is a frequent public speaker.

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Homeland Security

Appendix F: SECURE Program Concept of Operations

The following pages include the overview and Concept of Operations for the SECURE (System Efficacy through Commercialization, Utilization, Relevance and Evaluation) Program.

SECURE Program: Concept of Operations

Thomas A. Cellucci, Ph.D., MBA

Chief Commercialization Officer

Department of Homeland Security

Science and Technology Directorate

Email: Thomas.Cellucci@dhs.gov

Homeland Security

SECURE Program: System Efficacy through Commercialization, Utilization, Relevance and Evaluation

Scope:

We have developed a comprehensive program to enable DHS-S&T to efficiently and cost-effectively leverage the resources, skills, experience and productivity of the Private Sector to develop technologies and products in alignment with specific requirements obtained from DHS Components, the First Responder Community and other End-Users involved in Homeland Security applications.

Overall Process:

Below is a graphical representation of the overall outreach process we have implemented to stimulate and engage the Private Sector to use its resources to rapidly develop technology, products and services that can yield significant benefits for DHS-S&T with a speed-of-execution not typically observed in the Public Sector.

PHASES	Requirements Development	Market Assessment & Strategy	Open Competition	Product Development	Product Release, Marketing and/or Deployment
ACTIVITIES	• Prioritized capability gaps from Capstone IPTs • Identification of representatives of customer/ end users • Operational and technical requirements • Validation of price points • Technology Commercializ-ation Agreement (TCA) between DHS S&T and its DHS customer • Project plan	• Market survey • Technology scan • Communications plan and implementation (public relations and marketing communications) • Technology Commercialization Plan (TCP) • Test and Evaluation Master Plan (TEMP) • Standards assessment and/or development by S&T • Grant program development by DHS customer	• SECURE Program • CRADAs • BAAs • RFPs • RFQs • RFIs • MoUs / MoAs • Technology transfer licenses • OTAs/Agree-ments	• New Product Development (NPD) process implemented by private sector partner(s) • Project reviews • Test and Evaluation	• Transition to manufacture • QC/QA • Deployment (to Federal users) or Marketing (to independent users) • Measure product effectiveness

Legend: Black text = Typical Government activities
Blue text = Typical Private-Sector activities

Outreach to the Private Sector

Program Process:

In order to provide DHS Operating Components, the First Responder Community and other End-Users with products that meet their specific requirements, DHS-S&T will provide a vehicle by which Private Sector entities can offer products and/or conduct product development geared specifically toward meeting those needs. Private Sector entities currently possessing a technology/product/system rated at a Technology Readiness Level TRL-5 (i.e. applied or advanced R&D) or above that potentially closes a defined DHS capability gap by addressing detailed operational requirements supplied by DHS-S&T will have the opportunity to continue development of their technology/product/system to TRL-9 (i.e. fully field deployable product) at the expense of the Private Sector entity with the assurance that DHS-S&T will verify their independent third-party test(s) of a given technology/product/system.

Only when TRL-9 is achieved, will Private Sector entities be assured that their testing and evaluation (T&E) of the fully deployable technology/product/system (performed by an independent third-party) is verified by a DHS-S&T assessment of a given third party, independent T&E. DHS-S&T will publish its assessment on the DHS' public website as validation of the success (or failure) to meet the Private Sector entity's own established specifications. This approach enables DHS-S&T to review several highly developed technologies/products/systems in an open and fair manner while successful Private Sector entities will share in the imprimatur of DHS-S&T. DHS Operating Components, the First Responder Community and other End-Users are enabled to make informed purchasing decisions for necessary technologies/products/systems to enhance their capabilities through meeting their detailed requirements. In addition, these solutions are excellent candidates for liability protection under the provisions of the DHS SAFETY Act.

Application:

In the spirit of open and free competition, and in order to capitalize on the free-market system, DHS-S&T intends to publish this program and all ancillary requirements documents/information on the DHS-S&T website. These materials will be accessible by all businesses. Given this information, Private Sector entities may file an application to develop or enhance their technology/product/system in cooperation with DHS-S&T that will improve upon currently fielded DHS technologies. We envision a simple application for this program that can be completed via the internet. The contents of the application will include basic, non-proprietary business information, contact information, alignment to widely available DHS-S&T capability gaps and ancillary requirements documents we choose to offer such as ORDs (Operational Requirement Documents), etc.

Selection:

In order to be fully considered by DHS-S&T for cooperative development:

The company entity must demonstrate they possess technology at TRL-5 (i.e. applied or advanced R&D) or above and possess the resources to invest in the commercialization of its technology to TRL-9 (i.e. fully field deployable product)

The company entity must propose a technology/product development effort that has clear and substantial alignment with published DHS-S&T capability gaps and other announced requirements

A DHS selection committee will be established to review applications and monitor the mutually-agreed-upon roles and responsibilities of the partnership.

The selection committee will consider these and other DHS proprietary metrics for selection consideration.

Agreement:

The Private Sector entity and DHS-S&T will execute a simple, straightforward and binding agreement whereby the Private Sector entity details milestones with dates and agrees to bear full and total financial responsibility to develop its technology/product/system to a TRL-9 state (if not already at that level). DHS-S&T will publish on the DHS-S&T website the factual findings of such assessment. DHS-S&T has the right to cancel an agreement if the Private Sector entity does not fulfill/achieve any of its milestones by the mutually-agreed-upon dates.

Publication of Results:

It is apparent that the Private Sector highly values DHS-S&T's potential assessment of a given product's independent third-party test and evaluation. DHS-S&T will openly publish these T&E results on the DHS public web portal for review by the DHS Operating Components, First Responder communities and other end users.

SECURE Program: System Efficacy through Commercialization, Utilization, Relevance and Evaluation

Appendix G: DHS Management Directive 1400

The following pages include the Investment Review Process – DHS Management Directive 1400. *Note, at the time of publication DHS Management Directive 1400.1, which will update MD 1400, is in its final review stages.

Department of Homeland Security
Management Directive System
MD Number: 1400

INVESTMENT REVIEW PROCESS

1. Purpose

To establish an Investment Review Process (IRP) that will:

A. Integrate capital planning and investment control (CPIC), budgeting, acquisition, and management of investments (both Information Technology (IT) and non-IT) to ensure scarce public resources are wisely invested and the requirements of the authorities listed below are achieved.

B. Ensure that spending on investments directly supports and furthers DHS's mission and provides optimal benefits and capabilities to stakeholders and customers.

C. Identify poorly performing investments that are behind schedule, over budget, or lacking in capability so corrective actions can be taken.

D. Identify duplicative efforts for consolidation and mission alignment when it makes good sense or when economies of scale can be achieved.

E. Improve investment management in support of the President's Management Agenda (PMA).

2. Scope

This Management Directive (MD) applies to all Departmental offices, directorates, agencies, and sub-elements within DHS (hereafter referred to as Organizational Elements), unless specifically exempted by statutory authority. Additionally, this MD applies to the acquisition of all capital assets, including services. Joint agency initiatives will follow the IRP of the designated lead agency (or managing partner).

3. Authorities

A. Office of Management and Budget (OMB) Circular A-11, Preparing, Submitting and Executing the Budget, June 2002.

B. Public Law 107-296, the Homeland Security Act of 2002.

C. Clinger-Cohen Act

D. OMB Circular A-130, Management of Federal Information Resources, Nov 2001.

E. OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, Jan 2002.

4. Definitions

For detailed definitions and applicable terms, reference Enclosure (1).

5. Policy and Procedures

The management of Departmental investments is a key strategic function of DHS. Proper management also warrants a structured program management program, a systematic process for review and approval, visibility, and accountability to senior management.

There are two distinct objectives of the IRP: 1) acquisition oversight of new investments throughout their life cycle, and 2) portfolio management to achieve budget goals and objectives. The guiding principles for this process provided in Enclosure (2) should be used to further these objectives.

DHS investments are categorized in four levels based on defined criteria. These levels determine the documentation required for review as well as the approval levels. Threshold criteria will be reevaluated 6 months after the directive is issued and annually thereafter.

Threshold	Review/ Approval	Document Required	Criteria[1]	Additional IT Criteria[1]
Level 1	Investment Review Board (IRB) / Deputy Secretary	Exhibit 300	• Contract cost exceeds $50M • Importance to DHS strategic and performance plans • High development, operating, or maintenance cost • High risk • High return • Significance in resource administration	• Life-cycle cost exceeds $200M
Level 2	Management Review Council (MRC) / Directorate Head or Under Secretary	Non-IT: Exhibit 300 Light IT: Exhibit 300	• Contract cost $5M - $50M • Impacts more than one DHS component • Significant program or policy implication • High executive visibility	• Life-cycle cost $20M - $200M • Financial system with operation cost exceeding $500K • Was major in FY04 budget submission • Meets following criteria: E-Gov related, FEA, DHS EA, Strategic Data/Information sharing, DHS utility services and infrastructure, new technology initiatives, and sensitive initiatives (for definitions see Enclosure (1))
Level 3 (IT Only)	Enterprise Architecture Board (EAB) / CIO	Exhibit 300 Light		• Annual costs $1M - $5M annually • Life-cycle costs $5M - $20M • Falls in one of the E-Gov transformation focus areas (e.g. financial management, data and statistics, human resources, monetary benefits, criminal investigations, public health monitoring, etc.)

Level 4	Directorates or Organizational Elements	IT: Exhibit 53 Information	• Total acquisition cost less than $5M	• Does not meet Level 3 criteria • IT service contract • Total acquisition costs between $100,000 and $5M, and involves modifications / revisions to the existing IT infrastructure or security, with no new technology involved
• General Notes: Level 1, 2, and 3 IT investments require review by the DHS CIO and the EAB. Exhibit 300 Light is a DHS designation, not an official OMB Exhibit. • Note 1: Threshold levels are determined based on one or more of listed criteria.				

For Level 1 programs the Deputy Secretary is the acquisition executive who has final decision authority at a program's Key Decision Point (KDP). For Level 2 programs and below, the Under Secretary for the program's sponsoring directorate, the Commandant of the Coast Guard, or the Director of the Secret Service is the acquisition executive and decision authority. The Under Secretary for Management supports the acquisition executives by conducting formal, comprehensive investment reviews of acquisition programs through various boards and councils established by this directive.

6. Roles and Responsibilities

A. ***Investment Review Board (IRB)***.

The IRB is the executive review board that provides acquisition oversight of DHS Level 1 investments and conducts portfolio management. As the chair of the IRB, the Deputy Secretary is the Department's senior acquisition executive. The structure of the board follows:

Chair: Deputy Secretary
Vice Chair: Under Secretary of Management
Membership: Under Secretary, Border and Transportation Security
Under Secretary, Emergency Preparedness and Response
Under Secretary, Science and Technology
Under Secretary, Information Analysis and Infrastructure Protection
Deputy Chief of Staff for Policy
Chief Information Officer (CIO)
Chief Financial Officer (CFO)
Chief Procurement Officer (CPO)
Privacy Officer
General Counsel

The IRB is the forum that provides senior management the proper visibility, oversight, and accountability for Level 1 investments. The primary function of the IRB is to review Level 1 investments for formal entry into the annual budget process and at Key Decision Points (KDP). The IRB conducts systematic reviews of investment preparations and approves key decisions. It also serves as a forum for discussing investment issues and resolving problems requiring senior management attention.

B. ***Management Review Council (MRC)***.

The MRC is the review authority for DHS Level 2 investments and supports portfolio management. The structure of the council follows:

Membership: CIO
CFO
CPO

The MRC reviews Level 2 investments for formal entry into the annual budget process using Enclosure (3), Exhibit 300 Light (non-IT). Note that for acquisitions already in progress, reviews shall occur prior to award. A one-page request for MRC review shall be submitted in these instances (see Enclosure (4) for sample). If after the MRC meets, no issues are noted within the seven-day period, activities may presume the authority to proceed with the acquisition or award as planned. If issues are identified as a result of this review, appropriate coordination and resolution will take place with the Under Secretary, the Commandant of the Coast Guard, or the Director of the Secret Service, or designee, responsible for the acquisition. The Deputy Secretary will decide any issue that cannot be resolved. For additional guidance on IT only investments, reference the IT Investment Review provided in Enclosure (5).

C. ***Joint Requirements Council (JRC)***.

The JRC is a senior requirements review board that conducts program reviews to oversee the requirements generation process, validate mission needs statement, review cross-functional needs and requirements, and make programmatic recommendations to the IRB on proposed new programs. Note that the Enterprise Architecture Board ***(EAB) will provide this function for IT requirements***. The structure of the council follows:

Members: Chief Operating Officers (COO) of Directorates/Organizational Elements
Executive Secretary – Director, Program Analysis and Evaluation (PA&E)

Note: COO representation may not be delegated. Examples of COO include the Chief of Staff of the Coast Guard, Deputy Commissioner for Customs and Border Patrol, and Deputy Administrator, Transportation Security Agency.

The JRC reviews Level 1 investments annually and prior to KDPs and Level 2 investments at the time of submission to validate mission needs and review proposed programs for cross-functional applications, and/or to determine if existing capabilities can meet the need. The JRC makes a recommendation to the IRB or MRC as appropriate for each program.

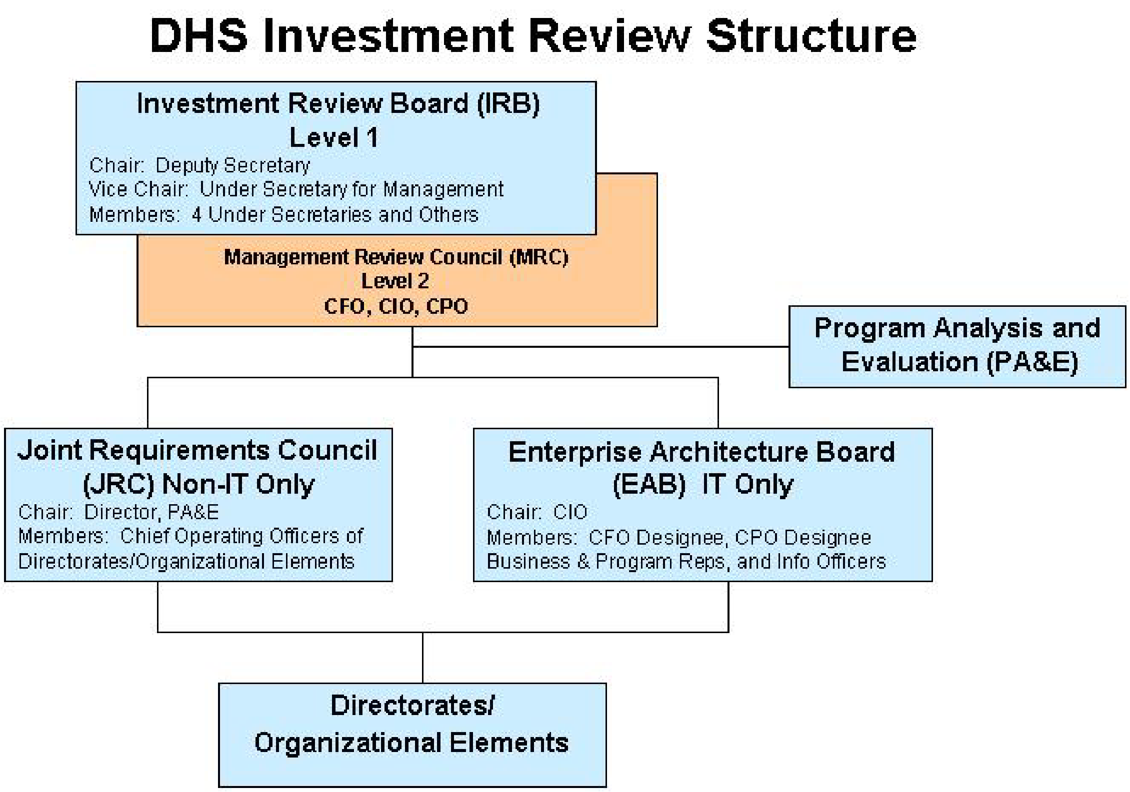
D. ***Enterprise Architecture Board (EAB)***.

The EAB reviews and approves Level 3 IT investments. The EAB also reviews and makes recommendations to the IRB and the MRC regarding Level 1 and Level 2 IT investments. On an annual and ongoing basis, the EAB approves business cases; participates in strategic planning and develops IT strategic guidance; and establishes standing and ad hoc committees as deemed appropriate. The structure of the board follows:

Chair:	CIO
Members:	CFO Designee
	CPO Designee
	Business Unit and Program Representatives
	Information Officers, Directorates/Organizational Elements

E. ***Director, Program Analysis and Evaluation (PA&E)***.

The Director, PA&E will develop a recommended prioritized list of investments based on portfolio management criteria and scoring criteria similar to the example found in Enclosure (6). Decision support information will be provided to the IRB on Level 1 investments and to the MRC on Level 2 investments.



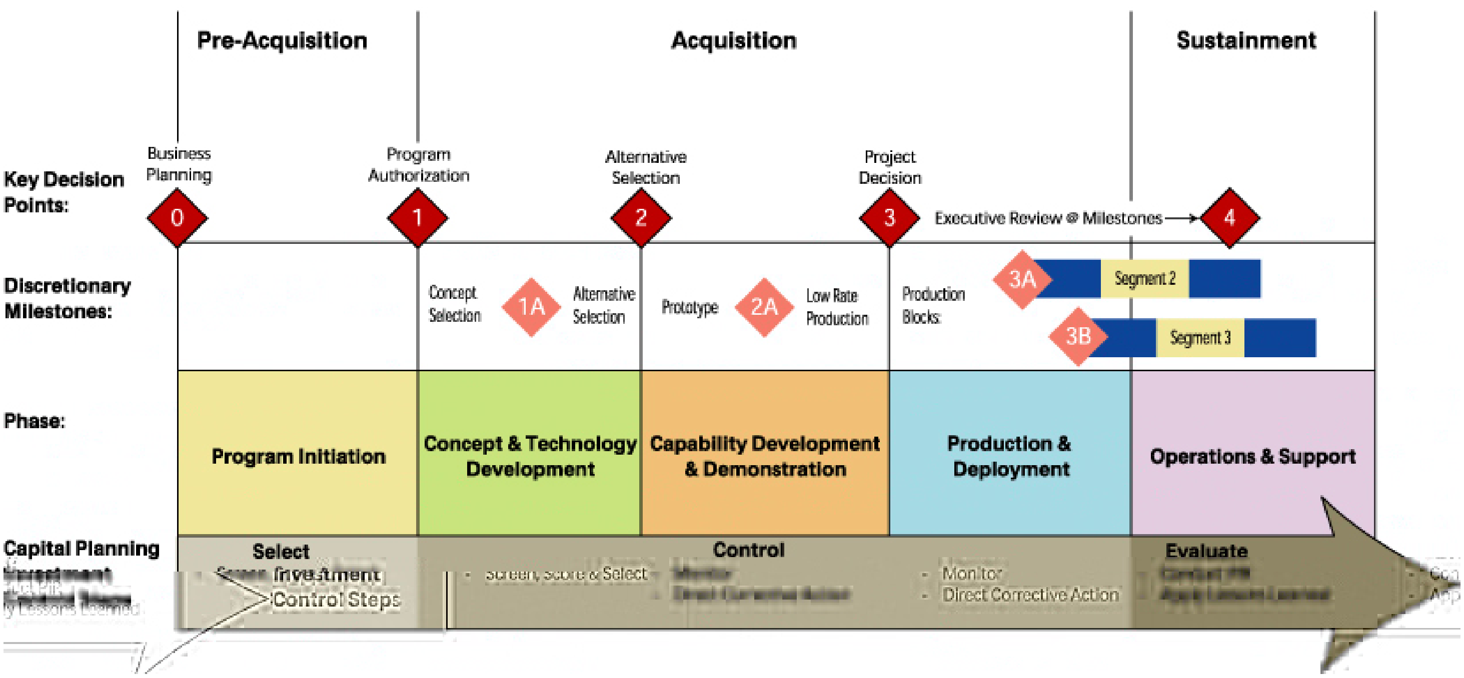
F. ***Acquisition Phases***.

Major investment programs are treated in a systematic manner progressing from pre-acquisition to sustainment. The acquisition process is categorized into the following phases: 1) Program Initiation, 2) Concept and Technology Development, 3) Capability Development and Demonstration, 4) Production and Deployment, and 5) Operations and Support.

Complex developmental investments require a highly disciplined structure and rigorous acquisition process while less complex investments (e.g., off-the-shelf procurements or service contracts) warrant combining phases and less complex risk management.

After validation by the JRC/EAB, the IRB reviews Level 1 investments at KDPs, which follow each acquisition phase, and are tailored to properly manage the inherent risk of a specific investment. At each KDP review, the program must: (1) review and update, as needed, documents prepared during the previous acquisition phases, (2) demonstrate achievement of activities appropriate to that phase, and (3) satisfy exit criteria approved by the IRB for that phase. IRB approval is mandatory at KDPs for programs to proceed to the next acquisition phase. ***Exit Criteria are program specific accomplishments or performance parameters that must be satisfactorily demonstrated before a program can transition to the next acquisition phase, phase segment, or production block***. It should be noted that discretionary KDPs might be required at critical milestones within an acquisition phase when top management decision-making is deemed necessary.

PROGRAM INVESTMENT REVIEW PROCESS



Program Initiation Phase. Programs are responsible for conducting ongoing operational analysis. A capability gap is determined when current or future program/mission requirements exceed existing capability. Program requirements are developed to define the new capability required to satisfy a mission. The key to obtaining resources to proceed is to develop an effective Exhibit 300 Business Case that justifies the need and value of the new investment.

In preparation for KDP1 the Program Manager is responsible for preparing: (1) a Mission Need Statement, (2) the Exhibit 300 Business Case, and (3) proposed Exit Criteria for the Concept & Technology Development Phase. The Program Manager will submit an initial Exhibit 300 Business Case containing or based on items identified above. This information and associated presentations are used to screen, score, and select initiatives.

With approval at KDP1, the initiative is: (1) designated as a Level 1 acquisition, (2) directed to charter a major acquisition Integrated Product Team (IPT), (3) authorized to commence the Concept & Technology Development Phase, and (4) entered into the budget process. Typically the initiative will enter the Fiscal Year (FY)+2 budget to provide staff and funding to proceed.

Concept and Technology Development Phase (CTD). The CTD Phase focuses on setting operational requirements and exploring alternative solutions for meeting mission needs. Typically, competitive, parallel short-term concept studies by the Government and/or industry will be conducted during this phase. The objective of CTD is to define and evaluate the feasibility of alternatives and to provide a basis for assessing the relative merits (e.g., advantages and disadvantages, degree of risk, life cycle cost, cost-benefit, etc.) of alternatives. Alternative solutions are solicited from across industry to achieve the optimal solution, with emphasis placed on innovation and competition. Promising alternative solutions are defined in terms of cost, schedule, and performance objectives; identification of interoperability, supportability, and infrastructure requirements; opportunities for tradeoffs; an overall acquisition strategy; and a test and evaluation strategy (including Development Test and Evaluation (DT&E), and Operational Test and Evaluation (OT&E)).

In preparation for KDP 2 the Program Manager will review and update documents prepared during the previous phase and develop: (1) a Program Plan, (2) a Risk Management Plan, (3) an Acquisition Plan, (4) Operational Requirements, (5) an Alternatives Analysis, including identification of life cycle costs, (6) an Acquisition Program Baseline, and (7) proposed Exit Criteria for the Capability Development and Demonstration Phase. The Program Manager will submit an updated Exhibit 300 containing or based on items identified above. This information and associated presentations are used to monitor initiatives, direct corrective actions, and determine when the investment is ready to proceed to the next phase.

In some cases, a discretionary KDP (KDP 1A) may be required prior to KDP 2. This would typically occur for developmental programs with a range of conceptual solutions. The KDP 1A decision results in the selection of a concept. The format would be similar to KDP 2 less proposed Exit Criteria.

With approval at KDP 2, a preferred acquisition alternative is selected, funds are identified for this phase, and the investment is authorized to commence the Capability Development and Demonstration Phase.

Capability Development and Demonstration Phase (CDD). The CDD Phase is focused on demonstrating feasibility of the preferred alternative and refining the solution prior to a full production commitment. CDD phase activities include developing the first article for the completion of DT&E. OT&E is conducted on production representative units to confirm that the item meets mission needs and operational requirements. Any Low Rate Initial Production (LRIP) units required for OT&E are fabricated during this phase.

In preparation for KDP 3 the Program Manager will review and update documents prepared during previous phases and develop: (1) proposed Exit Criteria for the Production and Deployment Phase. The Program Manager will submit an updated Exhibit 300. This information and associated presentations are used to monitor initiatives, direct corrective actions, and determine when the investment is ready to proceed to the next phase.

A discretionary KDP (KDP 2A) may be required prior to KDP 3. This would typically occur for a LRIP decision for developmental or high integration programs, after Developmental Testing.

With approval at KDP 3, the investment is authorized to commence the Production and Deployment Phase and the future years program plan must be fully funded.

Production and Deployment Phase (P&D). The P&D Phase activities produce systems and equipment for deployment into operational use. The objective of the P&D Phase is to achieve the full operational capability that satisfies the mission need. Asset(s) are produced and deployed in lots or blocks, each of which is a programmatically and economically useful segment. The necessary logistics systems are in place to support the end-items. Each operating unit is readied for unrestricted operations and deployment.

In some cases, a discretionary KDP (KDP 3A) may be required for follow-on block production authorization to implement useful segments.

Operation and Support Phase. The Operation and Support Phase activities include using the asset to perform required missions. Post Implementation Reviews (PIRs) are conducted to assure the asset(s) are meeting performance and cost goals. The operating program continues operational analysis to measure asset performance against department goals.

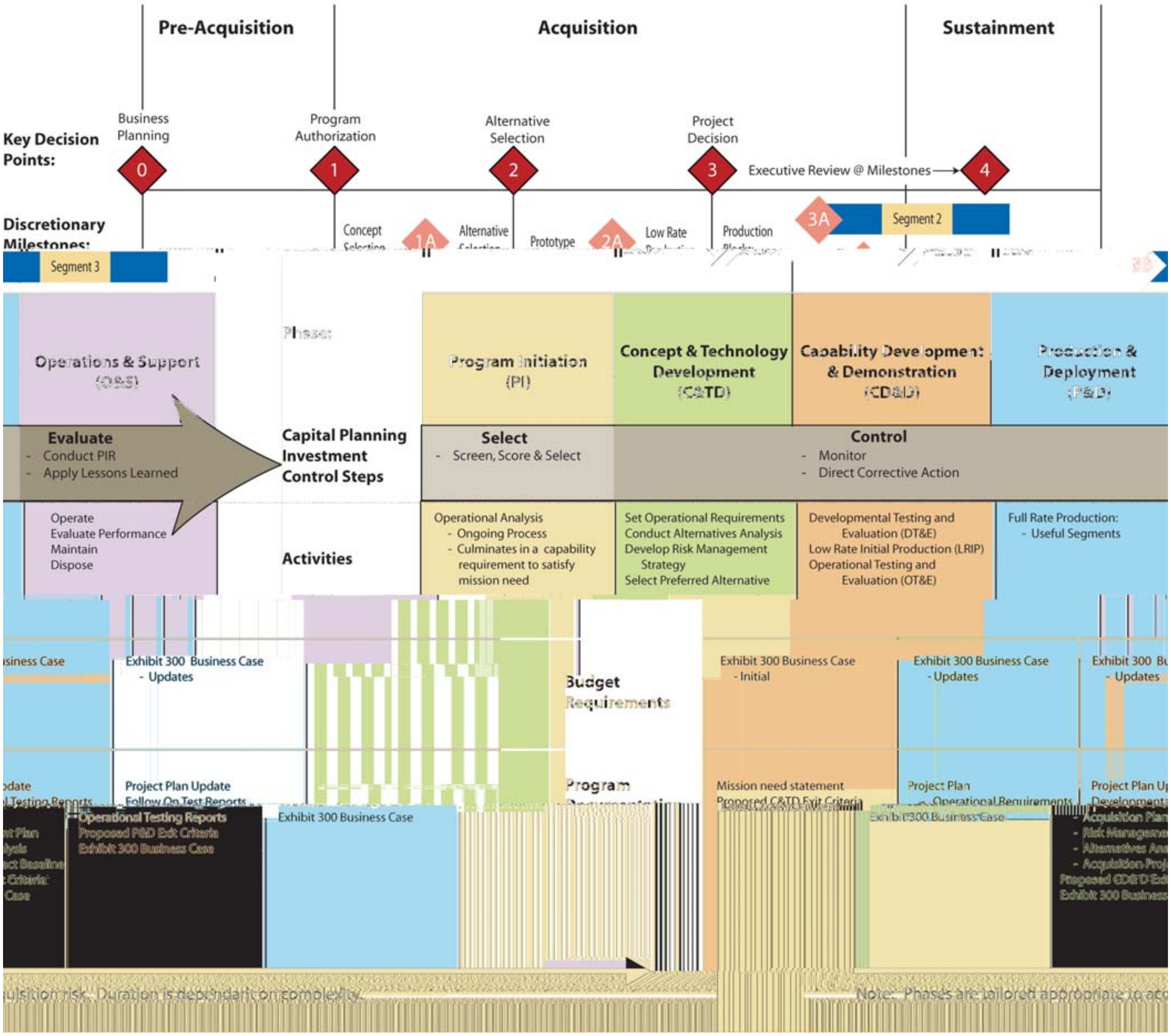
In some cases, KDP 4 is scheduled to conduct a Post Implementation Review (PIR). PIRs may be required annually to monitor effectiveness and continued value of an investment.

Exit Criteria

As described in the example, the Exit Criteria must be directly related to and supplement the objectives, required accomplishments and documents to be produced for the phase, phase segment or useful segment.

Sample Exit Criteria	
Discretionary KDPs	**Required KDPs**
Discretionary KDP 1A for entry into the Alternative Refinement Phase Segment	KDP 2 for entry into the Development and Prototyping Phase Segment/CDD Phase
• Establish IPT • Establish preliminary operational requirements • Completion of alternative analysis • Determine acquisition strategy	• Finalize operational requirements • Demonstrate program affordability • Establish program baseline • Document feasibility and tradeoff analyses (if applicable)
Discretionary KDP 2A for entry into the LRIP Phase Segment	KDP 3 for entry into the Production and Deployment Phase and 1st useful segment or production block (if applicable)
• Completion of Critical Design • Review	• Successful completion of OT&E • Validate production quantity
Discretionary KDP(s) 3A, B, etc. to authorize production of the next useful segment or production block	
• Revalidate operational effectiveness and suitability • Revalidate production quantity • Demonstrate affordability of next production block	

The IRP with associated activities, budget requirements, and required documentation is summarized in the table below.



Program Managers must understand the link between acquisition phase activities and the Exhibit 300 Business Case Evaluation Criteria/Elements. The figures in Enclosure (7) depict the acquisition phase activities that correspond to the evaluation criteria and Exhibit 300 elements.

G. ***Portfolio Management***,

The Department must annually ‘make the business case’ for all Level 1 and 2 investments (IT and non-IT) through budget exhibits to OMB. Exhibits prepared for inclusion in the President’s annual budget will go through a rigorous management process. This process begins with Program Managers submitting budget requests based on the Department’s annual budget process.

PA&E will adjust and publish programming and planning guidance based on executive level direction, legislation, and triggering events. In turn, the programming and planning guidance will influence annual procedural guidance for submission of the Exhibit 300 Capital Asset Plan and Business Case. The Exhibit 300 will be used for all Level 1 IT and non-IT programs, and for all Level 2 IT programs. I-TIPS will be use to record information for new non-IT investments and all IT investments (see Enclosure (6)).

PA&E will review all submitted Exhibit 300’s for structural integrity and compliance, and will distill cross-DHS issues for coordination and prioritization. PA&E will develop the overall DHS investment portfolio, monitoring and tracking the impacts that investment decisions have on individual programs and cross-DHS program capability interdependencies.

The IRB approves Level 1 investments (resolving associated cross-department issues), and approves and submits the DHS investment portfolio with required Exhibit 300 Business Cases to OMB. The MRC approves Level 2 investments and provides investment information to PA&E. Submission of the portfolio and accompanying exhibits are generally due to OMB in the early-September timeframe.

Appendix H: Uncovering Requirements

The following pages include slides on how to start the requirements gathering discussion. It includes useful questions that you may want to consider.

Slide 1

Uncovering Requirements

How to start the conversation…

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Slide 2

Discussion Guide

- Requirements versus Specifications
- An Example
- Methods for Uncovering Requirements
- Requirements Development
- Available Resources/Background Materials
- Open Discussion

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Slide 3

Requirements versus Specifications

- **<u>Requirements</u>** describe an environment—the way it should be—after a product, system or service is integrated (describes the problem)

- **<u>Specifications</u>** are descriptions that are sufficient for building a product or system or providing service (describes the solution)

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Slide 4

An Example (M. Jackson)

- **GOAL: Construction of a *system* with specified characteristics**
  - *<u>Example</u>*: An elevator should enable persons in a building to get from one floor to another

  - Components of the system:
    - ***Environment***: Part of "real world" relevant for the problem
      - *<u>Example</u>*: Floors, persons, etc.
    - ***Machine***: Controlling software and hardware

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Slide 5

An Example (continued)

- Properties of the environment are fixed. We have to build the machine so that it realizes the desired properties of the system
- Machine can interact with the environment by:
  - Observing certain phenomena (***input***)
  - Causing certain phenomena (***output***)
- Known:
  - 1. Fixed characteristics of the environment (***domain knowledge***)
  - 2. Desired characteristics of the system (***requirements***)
- Clear: Machine must close the "gap" between 1 and 2
- Searched: ***Specifications*** for the machine

"How should the machine act so that the system fulfills the requirements?"

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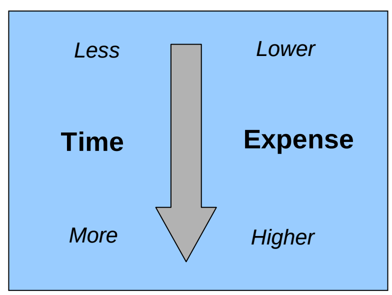
Slide 6

Methods for Uncovering Requirements

1. One-on-one interviews
2. Group discussions
3. Delphi focus groups
4. Observation



Note: Common Misconceptions:

- The customer is always right
- The potential customer knows what he/she needs/wants
- All customers are equal

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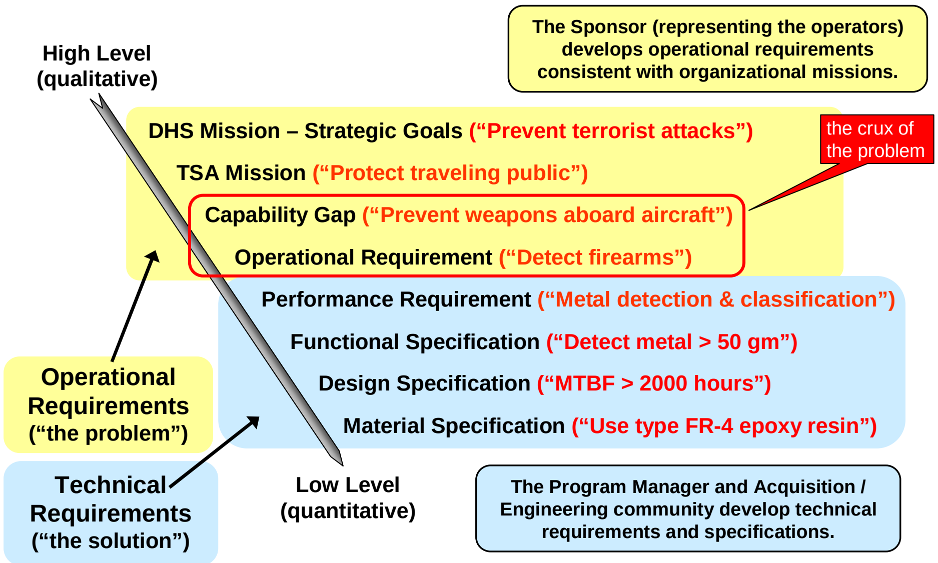
Slide 7

Requirements Hierarchy (TSA example)



Each lower-level requirement must be traceable to a higher-level requirement.

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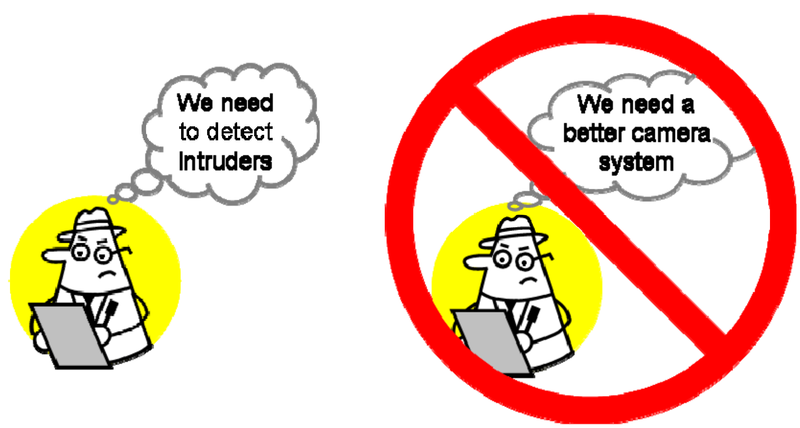
Slide 8

Remember to define the problem (not the solution)

- Must be expressed as a needed capability, not a needed product or system
- Usually expressed in broad operational terms



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Slide 9

How to start …

- Capability gaps are derived from analysis of threats, vulnerabilities, and consequences
- Operational requirements are derived from talking to operators
  - Include functional requirements ("what the product must do") as well as operational concepts ("how the product will be used")

Make sure you're talking with someone who has the authority and knowledge to represent both the end users and those who make buying decisions.

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Slide 10

Questions to ask a customer (1 of 3)

- **Users**
  - Who are the end users? And who are the "end customers" (those who make buying decisions), who may be neither the end users nor a DHS Agency.
- **Capability Gap**
  - What new capability do the end users need? Do they recognize the need? Can they articulate it? And what new capability do the "end customers" think the end users need?
- **Market Survey**
  - Does the new capability really require a new product or system? What's the existing COTS product which comes closest to meeting the need, and who produces it? And if no product exists, why not? (There may be a good reason why it doesn't exist, and that reason may be a good reason why DHS should not develop it.)
- **Logistics Requirements**
  - How will the product to be developed ultimately find its way to the field and have an impact on operations? Can it be deployed to captive users (e.g., Federal employees) or must it be adopted by independent users (e.g., first responders or shipping companies)? Who will develop the end product (prime contractor, private sector, S&T)? Who will manufacture it? Who will distribute it? How will the end users be trained, and by whom? In short, who will do the logistics planning and support?

This last cluster of questions is grouped because, taken together, these questions address one of the most critical questions that DHS must answer: *"What's the channel to the end users?"* If there's no feasible channel, then why develop the product?

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Slide 11

Questions to ask a customer (2 of 3)

- **Functional Requirements**
  - What is the product or system supposed to do? How well does it have to do it? (e.g., for detection systems, what detection probabilities are required, and what false-alarm rates are tolerable?)
- **Operational Concept**
  - What are the most typical use scenarios? What are standard operating procedures? Where will the product or system be used and under what conditions (dirty? cold? hot?). How often? How long?
- **Affordability**
  - How cheap does the product have to be to be affordable? Who will be paying the bill? What's their willingness to pay? How do we know?

The last topic is critical, particularly for the private sector where price (not performance) is king. If the product will be unaffordable, there's no sense in developing it, whatever its capabilities. (And remember that the "end customer," for whom it must be affordable, may be neither the end user nor a DHS component.)

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Slide 12

Questions to ask a customer (3 of 3)

- **Other Considerations**
  - Under what conditions will the products be shipped? Stored?
  - Any constraints on product size and weight? Any objectives for these parameters? Does the product have to be portable?
  - How rugged and reliable does the product have to be to be useful?
  - What other products or systems does the product have to interface with, be compatible with, or interoperate with?
  - Are there safety issues? Privacy issues?
- **User Contact**
  - How can we talk to and observe the intended end users in their operational environment?

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Slide 13

Selected Questions (continued)

- What are the most typical use scenarios? What are standard operating procedures?
- Where will the products of the system be used?
- Under what conditions will the products be used? (Dirty? Cold? Hot?)
- How often? How long?
- Under what conditions will the products be shipped? Stored?
- How cheap does the product have to be to be affordable? Who will be paying the bill? What's their willingness to pay?
- Any constraints on product size and weight? Any objectives for these parameters? Does the product have to be portable?
- How rugged and reliable does the product have to be to be useful?
- What other products or systems does the product have to interface with, be compatible with, or interoperate with?
- How will the product be maintained in the field? By whom? How will the maintainers get spare parts? What support equipment is required? Do the maintainers need maintenance training? Are any new facilities required?
- Are there safety issues? Privacy issues?
- How can we talk to and observe the intended end users in their operational environment?

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