Developing Operational Requirements

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

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Homeland Security

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Preface

This guide was developed specifically for the Operating Components within the Department of Homeland Security. It is an aid to the development of operational requirements that are critical in the efficient and effective communication of our needs to both internal and external recipients. To put it simply, operational requirements are a key element in cost-effective and efficient design, development and deployment of either one-off custom or widely distributed products and services used within and outside the Department.

The purpose of this comprehensive, yet simple-to-use guide is to provide the reader with the fundamentals of requirements development in order to enable one to articulate requirements effectively to other areas within DHS or to external audiences such as the Private Sector, other Federal agencies or First Responder communities. For those that are interested in a more in-depth treatment of requirements development, we have included detailed information used in DHS-S&T where requirements development is of utmost importance to the development of advanced technologies and products.

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May 2008

Acknowledgement
Many individuals contributed to the development of this resource. Their creativity, passion and dedication to this endeavor were gratifying to witness. Of special note is the contribution of two people who have worked tirelessly to not only develop these materials, but also enthusiastically coach and train others in its implementation. Both Sam Francis and Mark Protacio are thanked for their substantial contributions to this worthy effort. Please note that credit for the value this guide brings belongs to all those who have helped develop this guide, while I accept responsibility for any errors or omissions.

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Introduction

The purpose of this guide is simple and straightforward: to enable the reader to articulate 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). Just think about the number of times 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 we really don't have a clear picture of their problems, needs or requirements.' We can remedy this situation by implementing some fundamental best practices in a disciplined manner.

A well written ORD can be a truly effective vehicle to relay a given component/group/agency's needs in a clearly understood format to sedulously avoid the countless hours of time and other resources wasted to try "to interpret" what a particular organization needs. Research conclusively shows that the major reason for unsuccessful programs or projects is the lack of detailed requirements at the onset of a program. The effort we invest up front in developing solid requirements will pay dividends in the outcome of our programs not to mention the savings in both money and time in corrective actions taken to get a program "back on track" – if it is even possible in many instances.

We intend to make writing an ORD simple and easy. To that end, we'll provide an easy to read ORD template, along with a real world example. For those readers interested in learning how ORDs can enable win-win innovative partnerships between the public sector and the private sector, see Appendix A. Imagine how useful an ORD will be in the Capstone IPT process be referring to the article in Appendix B. Finally, for those interested in the details of systems engineering, please refer to Appendix C, which is the Requirements Development Guide now used by Program and Transition Managers at DHS-S&T.

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

Why Requirements?

A *requirement* is an attribute of a product or system necessary to satisfy the needs of a person, group or organization. Requirements therefore define "the problem." In contrast, "the solution" is defined by technical *specifications*.

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!

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.

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 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 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 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.

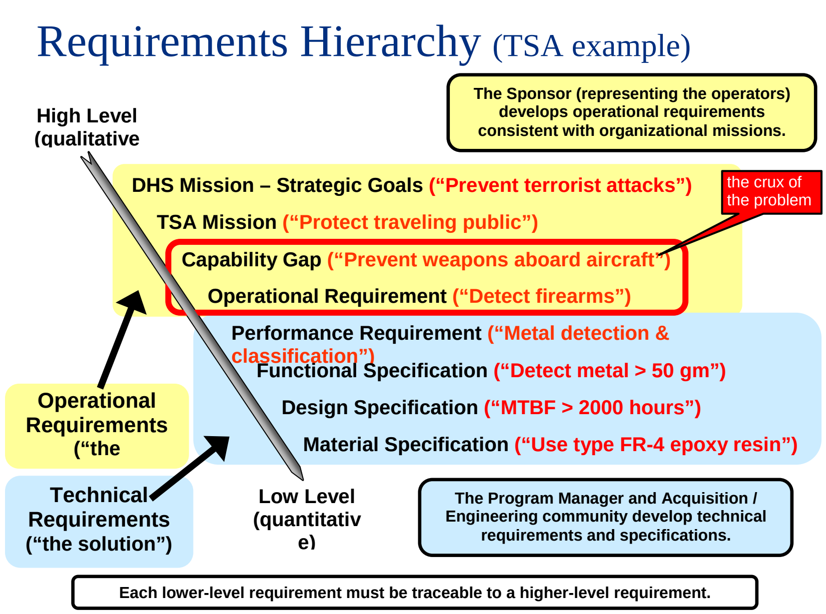

Figure 1. The requirements hierarchy

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.

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: 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 2.

OPERATIONAL REQUIREMENTS DOCUMENT

1.0 General Description of Operational Capability
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- 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
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5.0 System Support
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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
   - 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.

[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.

- 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 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 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 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, 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 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.

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'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

Operational Requirements Document Example:

Department of Homeland Security
Science and Technology Directorate
Washington, DC

April 7, 2008

Blast Resistant Autonomous Video Equipment (BRAVE) Operational Requirement Document

By

First Responder Technologies Program
Department of Homeland Security, Science and Technology Directorate
Washington, DC

And

U.S. Army Natick Soldier Research Development & Engineering Center – National Protection Center
Natick, MA

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Operational Requirements Document (ORD) for the Blast Resistant Autonomous Video Equipment (BRAVE)

Contents

1. General Description of Operational Capability

Mass transit vehicles and networks represent a potentially attractive target to terrorists and a unique challenge for law enforcement and transit personnel, due to their relative openness and large user base. Recent attacks in London, Madrid, and elsewhere around the world have demonstrated the devastating impacts of attacks carried out on mass transit vehicles. The investigation of the July 2005 attacks in London also demonstrated the forensic power of employing video surveillance data to successfully identify the terrorists directly and indirectly involved in such an attack.

While many communities and transit agencies in the United States have implemented the use of video surveillance systems within their transit infrastructure, uniformity of coverage is lacking. Financial, technical, and policy challenges continue to limit the implemented coverage. As a result, the requirement exists to enhance the capability to obtain, store and protect video surveillance information gathered from mass transit systems for forensic purposes.

The operational capability described herein, will provide the user community with a self-contained low-cost video surveillance option that can be implemented as an adjunct to an existing system or as a primary source for forensic video surveillance information. The system will support greater surveillance implementation and meet a range of surveillance requirements for operators in applications where infrastructure intensive approaches are impractical.

1.1. Capability Gap

A gap currently exists in the coverage of the majority of major mass transit systems to reliably collect, store and protect video surveillance of potential future terrorist attacks throughout their transit networks. While specific technical capabilities exist, coverage is limited in many localities due to high costs and infrastructure requirements of existing systems. Except in select localities (e.g. Chicago), most cities have video surveillance capabilities in as little as 10-50% of mass transit buses and often less in rail applications. This coverage gap directly limits the ability to investigate, pursue, and prosecute terrorists following a potential terrorist act involving non-covered conveyances.

The gap in coverage is most pressing on mobile platforms (i.e. buses and trains) and remote locations where infrastructure requirements of current technological approaches present the largest barriers to implementation. Existing surveillance approaches typically require an extensive wired (or wireless) network to support high bandwidth transmission of data to centralized processing and storage facilities. Centralized networked systems also incur intensive manpower requirements for installation, monitoring, and maintenance. Infrastructure intensive technical approaches present a capability gap for mobile platforms (e.g. buses and trains) where sufficient transmission bandwidth may not be available, is cost prohibitive, and may raise security concerns.

Pursuit of the system described herein will facilitate the closing of the coverage gap in video surveillance coverage by providing a low cost capability to supplement existing capabilities and coverage or a stand-alone system in the case where no legacy capability exists. The intended end users of the system are the impacted local transit authorities (represented within DHS by Transportation Security Administration – Rail and Surface Transportation), transit and local law enforcement officers, and the federal agencies involved in the forensic investigation of a terrorist attack.

1.2. Overall Mission Area Description

Video surveillance systems are currently used by mass transit operators and associated law enforcement departments in a range of missions. Mission applications include support of transit operations, criminal investigation, litigation support, enforcement of passenger regulations, training, and improved safety of passengers and employees due to a deterrent effect.

The system identified herein will have the additional capability to protect recorded video surveillance data, without external infrastructure, in the event of a terrorist attack, and to support forensic investigation of the same. The system is expected to provide coverage of areas not currently reached by video surveillance and in some cases to provide supplementary blast resistant video coverage in areas currently service by other systems. In addition to post terrorist attack forensics, the system is expected to extend coverage of other mission applications including criminal investigation and litigation support to newly covered areas. Due to its decentralized approach, however, the system will not directly support mission applications requiring real time monitoring of data (e.g. support to transit operations).

1.3. Description of the Proposed System

The proposed system will be a stand-alone fixed video surveillance unit that will produce and maintain a continuous video recording of a designated transit vehicle, infrastructure component, access control point, or other location of interest within its designated field of view. It is expected that multiple such units will be necessary to provide full coverage of individual transit vehicles and other areas of interest. Each unit will record continuously and store data for a specified period of time, after which data will automatically be overwritten as necessary. Following installation, the system will not require user intervention to maintain continued operation.

In the event of a terrorist attack or catastrophic event, the unit will protect the recorded data from damage or tampering until retrieval by authorities. Only survival of the video data sufficient for retrieval and playback of the collected video surveillance is expected. The system will also allow for data retrieval by authorized individuals as required for other mission applications.

Each BRAVE unit will be a self contained device that includes a camera, removable data storage, and protective hardening for the data storage. System power may be provided by the installed platform (e.g. bus) or by an included power source. In the case of an external power option, a transformer, as necessary, will be included within the system housing.

1.4. Supporting Analysis

This ORD is supported by “Application of Video Surveillance Technology in Public Transit Systems” submitted to DHS S&T through the U.S. Army Natick Soldier Research Development and Engineering Center (NSRDEC) and prepared by the Center for Technology Commercialization. The analysis is further supported by visits to transit authorities in Seattle, WA; Washington, DC; New York, NY; and Chicago, IL conducted by NSRDEC and DHS S&T representatives in February 2008.

1.5. Mission the Proposed System Will Accomplish

The proposed system will provide a low-cost option for provision of a blast-resistant video surveillance capability to mass transit platforms without such a capability. Once installed, BRAVE will support investigation of terrorist and criminal activities conducted within the visual coverage of the deployed system.

The system will serve primarily to visually record all activity within its field of view for a designated period of time. Video data will be recorded continuously during designated operational periods. Video data stored beyond the designated storage duration will be overwritten as necessary to provide storage for more recent video data. In the event of an explosion caused by a terrorist attack, the system will protect the data from blast and other damage and allow recovery of the video data for purposes of forensic investigation and/or prosecution.

1.6. Operational and Support Concept.

1.6.1. Concept of Operations

BRAVE will be used by local transit authorities and law enforcement officials to supplement video surveillance coverage in areas and vehicles not currently covered by legacy systems. Localities making use of the system will identify areas requiring coverage based upon their local procedures, including identification of specific installation locations.

Transit maintenance or contracted personnel will install units in identified locations including connection to locally available power source as applicable. Upon installation, each unit will provide continuous video recording whenever powered. User support and maintenance will be minimal.

Retrieval of data will use commercially standard interfaces (e.g. Secure Digital card, or USB connection) to retrieve data. Video will similarly be stored in a commercially standard, non-proprietary format to facilitate easy review of data in a range of commercially available software applications.

1.6.2. Support Concept

The design will support easy installation by transit service maintenance or contracted personnel. No special skills except knowledge of the interfacing platform's power system will be required.

Maintenance requirements for the system will be minimal. Each unit will include basic self test mechanisms to indicate proper operation visually (e.g. through the use of LEDs). System design allow for easy replacement of defective unit by a new unit with no need for user level maintenance. Defective systems will be returned to the manufacturer for disposition.

No user installed spare parts are expected. Memory cards, if used to meet storage requirements, will be compatible with existing commercially available formats.

2. Threat

Public transportation systems continue to be potentially vulnerable targets of terrorist attacks. Recent attacks including London (2005), Madrid (2004), and elsewhere around the world demonstrate a general persistent terrorist threat to mass transit systems. In particular, transit systems provide a potentially attractive target to terrorists by virtue of their access to large populations with currently less restrictive access controls than airline and other transportation methods.

3. Existing System Shortfalls

Existing video surveillance systems provide a variety of technical capabilities including systems that meet or exceed specific technical capabilities required herein. However, system and supporting infrastructure costs and maintenance requirements for these systems are often high enough that implementation and system coverage has been limited, thereby reducing the system-wide surveillance capability.

Existing fixed systems include those placed in stations, in tunnels, on bridges, and at access control points. These systems typically rely on a hardwired infrastructure to transmit data away from the point of interest for storage, processing, and commonly viewing. Onsite backup storage is optional but is not often employed. In cases where onsite backup is employed currently, the level of protection in the event of a terrorist attack is largely unknown.

4. Capabilities Required

4.1. Operational Performance Parameters (T: Threshold / O: Objective)

4.1.1. Form Factor

Each BRAVE unit will occupy a volume of less than 3” by 3” by 2” (T) 2” x 2” x 1.5” (O).

4.1.2. Resolution

The system will record and store color video data at a resolution of at least 1CIF (T) / 4 CIF (O).

4.1.3. Frame Rate

Video data recorded and stored by BRAVE will have a frame rate of at least 7.5 FPS (T) / 30 FPS (O). The frame rate will be adjustable at time of installation (O).

4.1.4. Field of View/Focal Length:

The system will be capable of recording video at focal lengths ranging from 3 to 50 ft. Focal length will be set at installation (T) / adjust automatically (O).

4.1.5. Data Format

Video data will be stored in a MPEG2, MPEG4 or H264 format in a manner suitable to meet evidentiary requirements (T/O). Recorded data will include a calibrated time stamp that can be used during data retrieval and review (T/O). The system will produce a message digest or “digital fingerprint” of recorded data using cryptographic hash function MD5 or SHA-1 (T/O) to assist in preserving the evidentiary status of the recorded data. Stored videos shall be accessible with standard commercial and open source video playback software (O).

4.1.6. Tamper Resistance

BRAVE units will be constructed to prevent unauthorized access to stored data, device power, and device activation mechanism (T/O).

4.1.7. Power Source

BRAVE units will be compatible with 48V DC, 120 AC, and 12V DC power sources and include any necessary transformer with the system (T) Device will provide self-contained power capability (e.g. solar cells) (O)

4.1.8. Environmental

BRAVE will demonstrate capability to perform within the full range of environmental conditions without degraded performance. System will meet all environmental requirements specified in IEEE 1478 Standard for Environmental Conditions for Transit Rail Car Electronic Equipment for the E3 (Vehicle Exterior, Body Mounted) and E4 (Vehicle Interior, Non-Conditioned) environments.

- Temperature: In addition to the requirements of IEEE 1478, the system will experience no degraded performance due to rapid changes in temperature of 20°C
- Dust: Blowing sand and dust testing will include testing with steel sand and dust particulates
- EMI/EMC: System performance will not be degraded due to electromagnetic interference from external devices

4.2. Key Performance Parameters (KPPs)

4.2.1. Price

Individual unit price will not exceed $200 (T) / $100 (O) based on production quantities of 100,000 or more. Price of support equipment and software to operate and access data on individual surveillance units will not exceed $1,000 (T) / $0 (O) per 100 units in use.

4.2.2. Storage Capacity

Data storage will be sufficient for data storage of continuous video recording for a period of 7 days (T) / 14 days (O).

4.2.3. Blast Survivability

Parameters to be provided via separate correspondence.

4.3 System Performance.

4.3.1 Mission Scenarios

BRAVE units will be located on mass transit vehicles or infrastructure (e.g. tunnels and bridges). Units will be installed to continuously monitor a designated area with minimal human intervention required until data retrieval or unit replacement is required. BRAVE will operate in a range of environmental conditions including large temperature swings, humidity, rainfall, vibration/shock, dust, and EMI/EMC considerations. Units will also be capable of recording in low light conditions.

In the event of a terrorist attack, when catastrophic data retrieval is required, video storage will be recovered and transferred from the potentially damaged housing of the units of interest. Recorded video data will be reviewed and analyzed as part of the forensic investigation as appropriate.

In non-catastrophic data retrieval scenarios, such as data use in a criminal investigation or forensic investigation from a unit not damaged by the attack; the unit housing and electronics will be reused. In these cases, the operator will remove the current memory card, taking care to document the proper chain of evidence, and replace it with a new unused memory card.

Periodic visual checks of the system's self diagnostic indicator will be conducted by operators or maintenance personnel. Minimal training of personnel is required to ensure proper understanding of system self diagnostic indicators.

4.3.2 Interoperability

Recorded data will be compatible with existing commercial and open source file formats including MPEG2, MPEG4 or H264 (T/O). Stored videos shall be accessible with standard commercial and open source video playback software (O)

4.3.3 Human Interface Requirements

Once installed, direct human interface with the system will not be required except for data retrieval. Installation will require basic mechanical skills to attach and position the unit. Knowledge of the interfacing power system will also be required. Data access and retrieval will require basic to intermediate computer skills and familiarity with using memory cards or USB storage mediums (dependant of final design).

Human interface is also required to periodically check maintenance self check indicators. If needed, unit replacement will require similar skills to installation.

4.3.4 Logistics and Readiness

The system is required to be operational for long periods of continuous operation without interruption. No user level maintenance or spare part replacement is required. Replacement units and memory cards should be available in case replacement is required.

Mean Time Between Failure (MTBF): 40,000 hours (T) 80,000 hours (O)

5. System Support

5.1 Maintenance

Each BRAVE unit will have the capability to visually indicate to a minimally trained individual that it is no longer functioning and needs repairs or replacement. User level maintenance shall be limited to monitoring of self diagnostic indicator and installation, removal and replacement of the system. All other maintenance will be vendor provided as necessary.

5.2 Supply

No special tools or support equipment are required for installation or replacement. Manuals will be provided to the operator by the vendor and will include installation procedures, information on diagnostic indicators of unit self test, and replacement procedures. Manual will also provide information on routine and catastrophic (i.e. after a terrorist attack) data retrieval.

5.3 Support Equipment

All self test diagnostic tests will be contained within the unit. No external support equipment will be required to maintain and operate the unit. Suitable computer equipment will be required to review data retrieved from the system. Specific hardware and software requirements will depend on the level of analysis to be conducted and the quantity of video data to be analyzed.

5.4 Training

Users will be instructed on the installation and replacement of units; interpretation of self test diagnostic indicators; and data retrieval procedures by manuals and written procedures supplied by the unit manufacturer.

5.5 Transportation and Facilities

Once installed, individual units will remain in place until removed or replaced. Transportation of individual units for installation or replacement is expected to be well within individual carriage limitations and will be dependant on the local installation point.

Transportation of retrieved digital media will require no special technical capability but should be conducted consistent with applicable procedures to preserve chain of custody when data retrieval is conducted for use in legal proceedings (e.g. criminal prosecution or civil litigation).

Facilities and suitably computer equipment will be required to review data retrieved from the system. Facility sophistication and size will depend on the level of analysis to be conducted and the quantity of video data to be analyzed.

6. Force Structure

Video surveillance cameras are typically positioned on vehicles to cover each entrance and the length of the vehicle in each direction. Cameras can also be positioned to show vehicle exteriors. Each standard bus is expected to make use a minimum of 4 units. Longer articulated buses will use 7 or more units, while Train cars can make use of 6 or more units. Based on current public transportation fleet size and current video surveillance usage rates, approximately 200,000 – 300,000 units would be required to provide the discussed video surveillance capability to mass transit vehicles without a current video surveillance capability.

Additional systems will be required within each locality based upon the demonstrated reliability rate to ensure that replacement systems are on hand for quick replacement of faulty units. An additional quantity of the appropriate removable memory cards will be necessary as well, to ensure availability of replacement cards when data is removed for forensic and other purposes.

Additional systems may be required for in station, infrastructure, and other surveillance purposes.

7. Schedule

Demonstration of an initial operational capability is required within 4 (T) / 3 (O) months. For the purpose of this effort, initial operational capability is defined as installation and field demonstration of 100 fully operational units will include in an identified major city transit system.

8. System Affordability

Individual unit price will not exceed $200 (T) / $100 (O) based on production quantities of 100,000 or more. Prices of support equipment and software to operate and access data on individual surveillance units will not exceed $1,000 (T) / $0 (O) per 100 units in use.

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 illustrated how an Operational Requirements Document (ORD) is generated using an ORD template. We also provided real-world examples.

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Appendix A: SECURE Program Article

Commercialization: It's not business as usual at DHS

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 general, 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.

We are currently piloting such a program under the name of the **SECURE** (**S**ystem **E**fficacy achieved through **C**ommercialization, **U**tilization, **R**elevance, and **E**valuation) Program. ***If you are interested in being considered as a participant in this pilot program, please contact Dr. Cellucci at Thomas.Cellucci@dhs.gov.***

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.

Acknowledgement:
The author would like to express his sincere appreciation for all of the valuable assistance provided by Mr. Mark P. Protacio in the preparation of the materials used in this paper.

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

FIGURES

Fig. 1: Capstone IPT Process

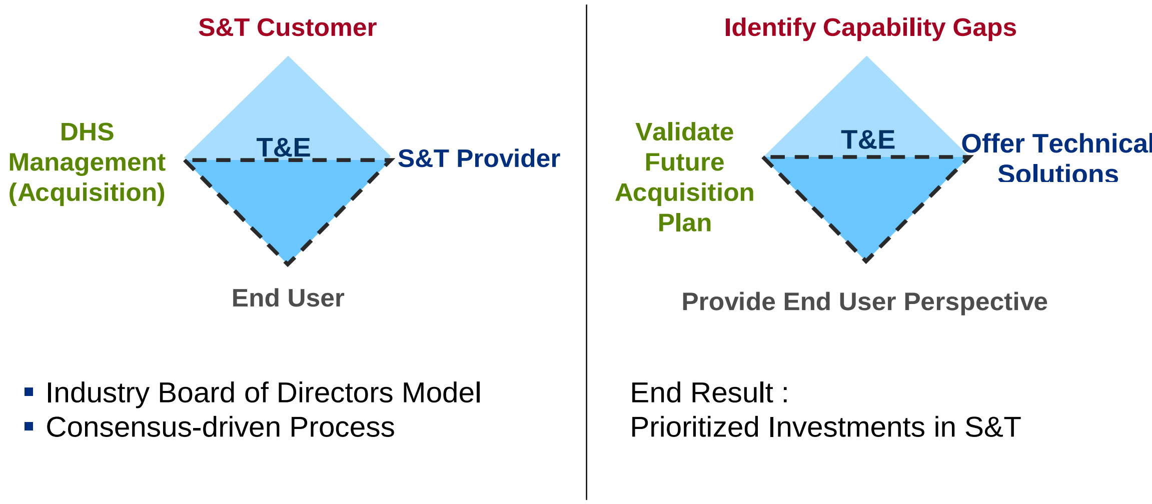

Fig.1 – This graphical representation shows the Capstone IPT (Integrated Product Team) process implemented at S&T that enables all stakeholders to participate actively in identifying and discussing the *Capability Gaps* germane to a specific functional area, such as people screening. S&T works with its 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

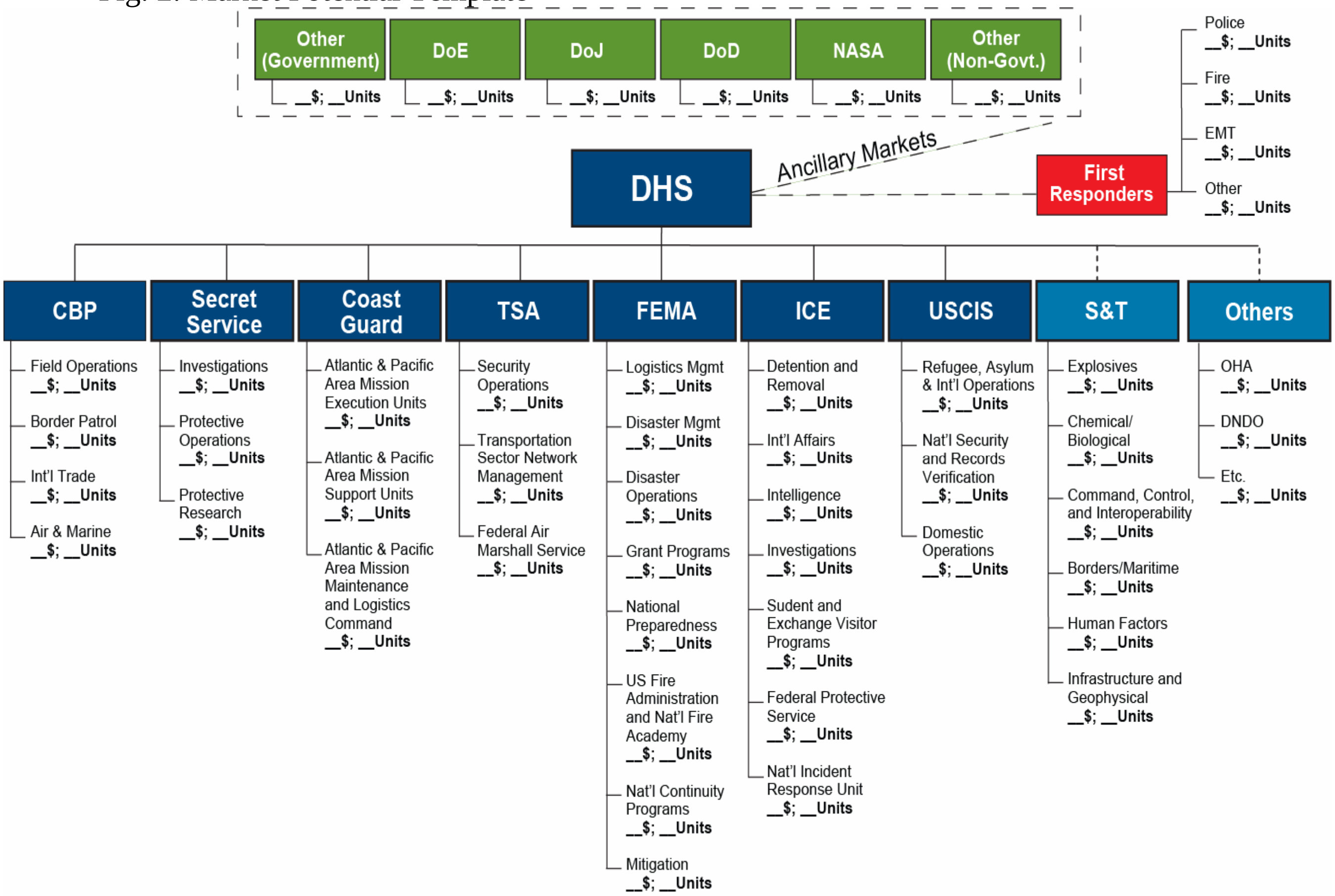

Fig. 2 – This graphic shows a market potential template used to conservatively estimate the DHS market segment by operating components, as well as demonstrate how DHS is a conduit to other large ancillary markets.

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

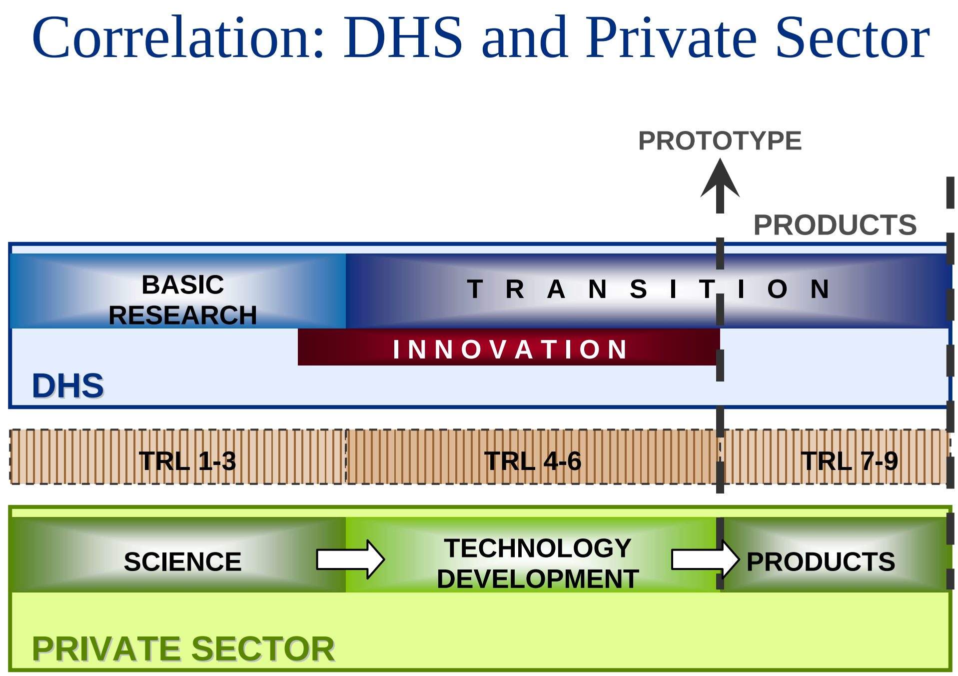

Fig. 4: This chart shows the correlation between the various nomenclatures to delineate differing levels of product development. The Technology Readiness Levels (TRL) serves as a standardized lexicon for enhanced communications.

Fig. 5: Technology Readiness Levels

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	

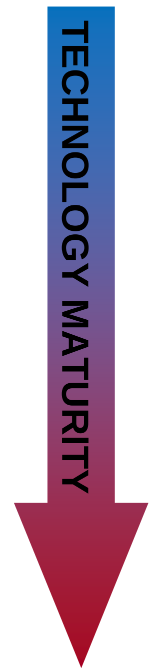

Fig. 5 – TRLs are used to assign a numerical value to a corresponding stage in a technology's development and maturity. This system of standardization is useful to communicate effectively between entities that may have used varying technology-maturity lexicons.

Appendix B: Capstone IPT Article

CAPSTONE Integrated Product Teams:

Even in Government -- the Customer Comes First!

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In today's dynamic homeland security environment, delivering customer-driven products and technologies is a primary objective for the U.S. Department of Homeland Security (DHS). 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). The 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 manages this diverse group of Operating Components and supporting elements whose missions address a wide variety of terrorist and natural threats to our homeland. 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), led by Under Secretary Jay M. Cohen, 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.). DHS-S&T, through the Capstone Integrated Product Team (IPT) process, ensures that quality, efficacious products are developed in close alignment with detailed customer needs. The Capstone IPT process represents the requirements-driven, output-oriented portion of DHS' technology development investments in the Transition portfolio. The Office of Transition delivers products to our customers and our customers' customers.

The Capstone Integrated Product Teams (IPTs) are chartered to ensure that technologies and products are engineered and integrated into systems scheduled for delivery or made available to DHS customers. Consistent with the Homeland Security act of 2002, Capstone IPTs establish a lean and agile world-class S&T management team that delivers the technological advantage necessary to ensure DHS agency mission success. 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 customer-led forum through which the identification of functional capability gaps and the prioritization of these gaps 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.

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), 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.

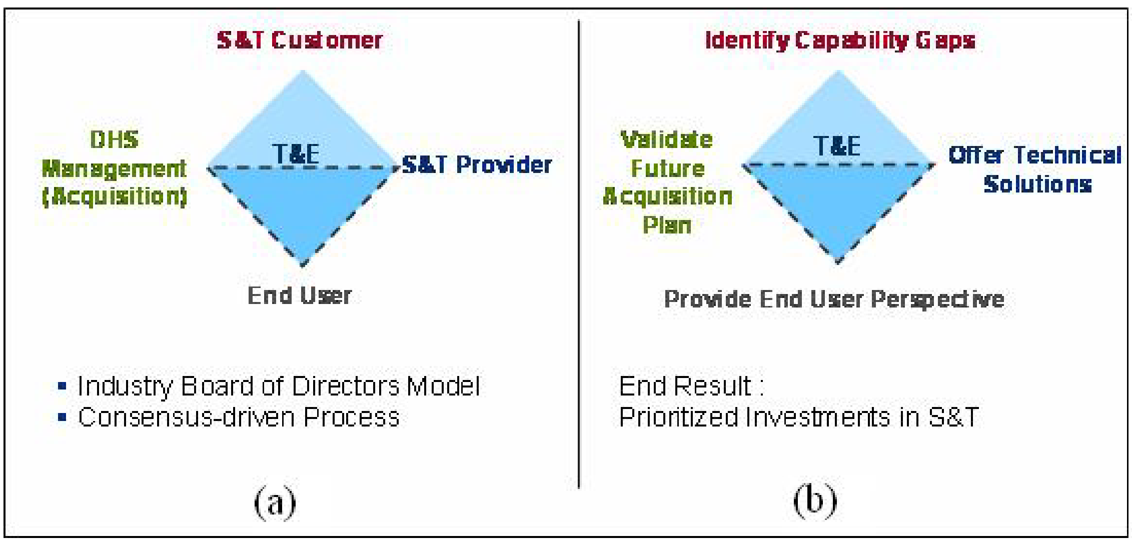

Fig. 1 (a) This diagram shows the structure of the Capstone IPT model with (b) the models' output functions carried out by each IPT member.

The Capstone IPTs are structured to focus on functional, department level requirements 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 corresponding needs within that specific functional area. Technology development is functionally aligned to allow technologies to be used in support of multiple Operating Components within DHS. 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 for the captive members for each IPT.

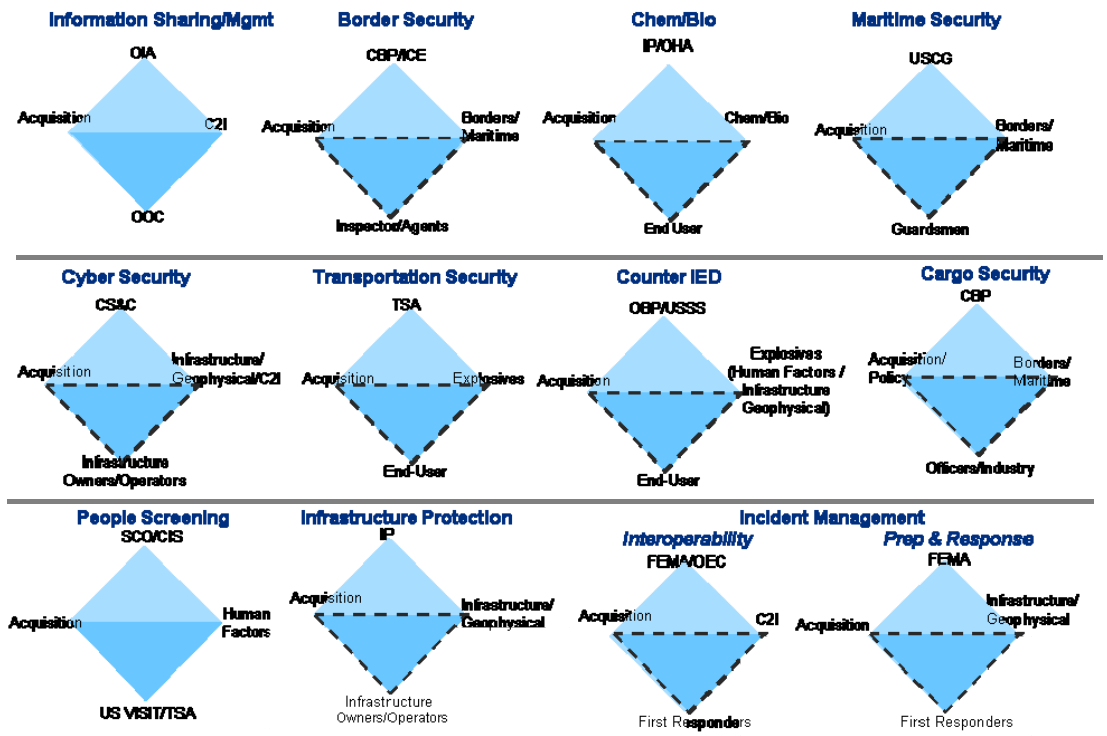

Fig. 2. This diagram shows the twelve Capstone IPTs, the DHS Operating Component, DHS end-user(s), the S&T Division technical provider, and, when applicable, the Acquisition conducted by DHS management.

Capstone IPTs purposefully cover very broad core functional areas. 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, 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.

Capability Gaps and Enabling Homeland Capabilities (EHCs)

Capstone IPTs generate several outputs that guide the development and fielding of technologies 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 respective 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. Capability gaps often start with "We need to be able to do…" statements that identify mission needs rather than suggested solutions. See Figure 3 for the requirements hierarchy diagram. Led by their IPT Chairs/Co-chairs, Capstone IPTs are responsible for the analysis, identification, and prioritization of their capability gaps. Capability gaps can come in several forms. Some gaps may appear in the form of personnel numbers, training, standards, plans/protocols/procedures, resources, technology, systems, etc.

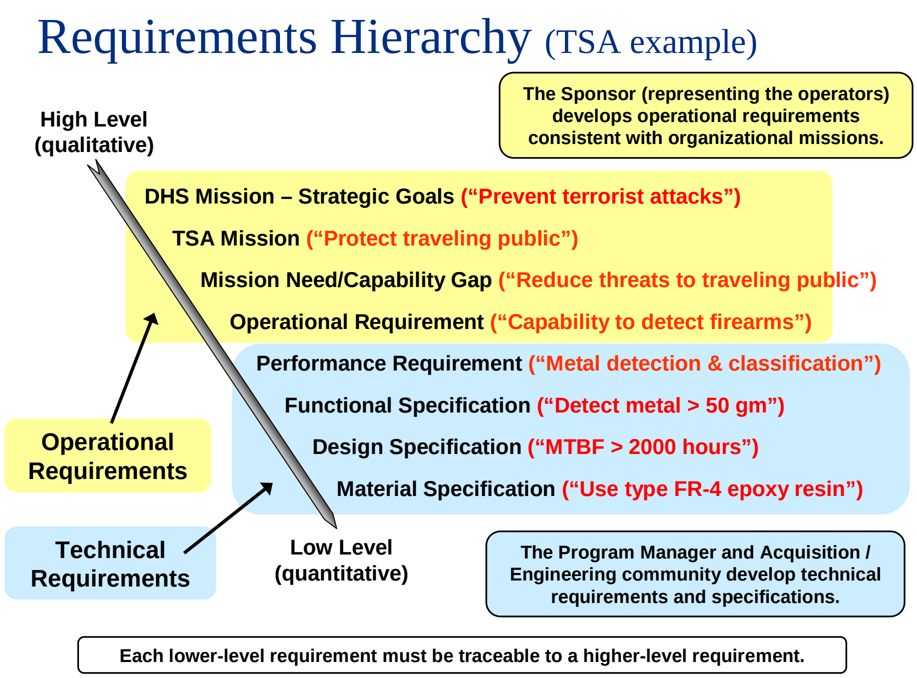

Figure 3. This requirements hierarchy shows the evolution of requirements from a high-level macro set of operational requirements to a low-level micro set of technical requirements. Note that each lower level requirement stems directly from its higher requirement so that all requirements are traceable to the overall DHS Mission.

For those capability gaps requiring technology-based solutions, a grouping of technology solutions is identified by DHS-S&T to address the various needs delineated in the capability gaps. These grouped technology solutions, or EHCs, collectively deliver new gap closing capabilities to the customers. EHCs focus on technologies that develop, mature and deliver to DHS acquisition programs, are commercialized or are validated as a standard within a three-year period or less. DHS-S&T develops EHCs that contain quantifiable metrics that allow for effective management of development progress. These metrics define how the EHC will address/close the related capability gap the cost and schedule over the life of the EHC, identify the specific S&T efforts addressing the EHC and endorsements and recommendation of proposed EHCs and corresponding deliverables by the relevant Capstone IPT.

Management – DHS Leadership and DHS-S&T

The Capstone IPTs prioritize EHC proposals that respond to customer capability requirements. DHS leadership has a critical role in determining Capstone IPT funding levels and investments once prioritized EHCs are identified. Once approved, budgets are submitted, solicitations may be issued, pre-award technical reviews are conducted, and commercialization efforts are considered. DHS leadership conducts reviews of current EHCs every six months to ensure that EHCs meet cost objectives and technical development is progressing along previously agreed-upon milestones. DHS leadership also reviews new EHCs and continually reviews on-going EHCs in order to make informed decisions regarding continued funding of programs.

The Transition Office manages the process to develop and deliver required technologies/products as defined in the EHCs. Working with its customer requirements, DHS-S&T proposes the technology-based solutions approved EHCs. By understanding the needs and requirements of its customers, DHS-S&T identify the programs that are ineffective/insufficient in meeting the EHC expectations and offer technical solutions to address the stated requirements. DHS-S&T works to conduct market and technology scans to find technology-based solutions that can be developed matured and delivered to DHS acquisition programs, commercialized or validated as a standard within a three-year period. There are several ways products can transition into fully developed, widely distributed products. Figure 4 identifies transition paths. DHS-S&T may recommend available commercial-of-the-shelf (COTS) products or other non-S&T alternatives in lieu of developing an S&T solution. DHS-S&T also reviews responses to solicitations for capabilities that cannot be readily addressed with COTS products. Once development plans are approved, DHS-S&T engages and involves the customer via technology demonstrations and experimentation to ensure adequate customer feedback throughout the development life cycle. DHS-S&T manages costs, schedules and technical performance of programs under the oversight of the Capstone IPT. The Director of Transition chairs monthly status meetings that allow technology execution problems to be discussed and resolved in a timely and efficient manner.

Transition Approaches

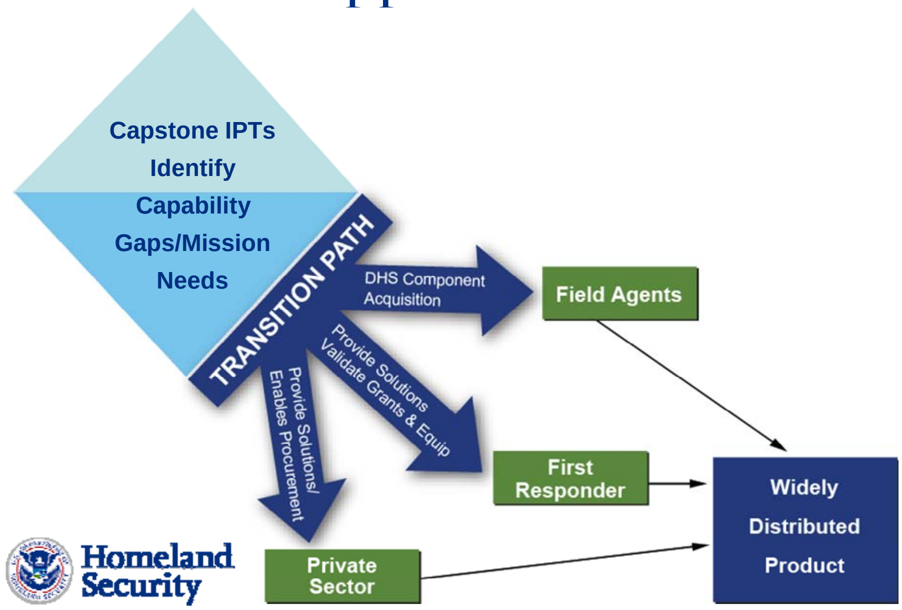

Figure 4: DHS has three major methods to transition products to end-users. DHS field agents are captive end-users of the Capstone IPT process; while the First Responder community is typically able to select its own solutions, all newly proposed DHS programs must now identify technologies/products already in development in the private sector that are aligned with end-user requirements for DHS field agents and/or to enable First Responders to make informed purchasing decisions.

Technology Transition Agreements (TTAs)

Technology Transition Agreements (TTAs) represents a good-faith contract between the S&T developer and the DHS customer. The TTA is negotiated and signed at the product level by those communities responsible for a delivering or advocating a specific product or technology. As a consensus agreement, the TTA is signed by all of the stakeholders responsible for the technology/product in order for continued funding. This good faith agreement determines the specific exit criteria that must be demonstrated in order for the "hand off" of the technology/product to the customer. The TTA specifically states the deliverable promised by the DHS-S&T program managers. The customer program manager certifies that the need for the product or technology is consistent with the needs/requirements as defined by their Operating Component, and the requirements or acquisition agents state their commitment to integrate the successfully demonstrated technology/product or into an identified and funded acquisition program. The TTA ensures that all parties explicitly understand the deliverable is aligned to customer needs and that a funding source is available and aligned with the customer. If any problems are identified by DHS-S&T, customer agency or acquisition offices informed decisions are made regarding continued funding. Once the TTA has been signed the next step is to move forward with product development and eventual product deployment to the customers.

Next steps

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 shown in Figure 3. 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 their respective customers to produce an Operational Requirements Document (ORD) in order to relay effective requirements to the Private Sector.

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 partnerships are beneficial to taxpayers and expedite the development of products and services to protect the nation. Recently announced commercialization initiatives (like our recently introduced SECURE 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. These efforts are a natural extension of the Capstone IPT process.

The future of these initiatives looks bright; we have already experienced an overwhelmingly positive response to the initial Private Sector outreach initiative. DHS-S&T stands at the forefront of innovative thinking within the Public Sector and we will continue to monitor and measure the benefits this program will provide. Please contact Thomas A. Cellucci, Ph.D., MBA at Thomas.Cellucci@dhs.gov if you would like more information about our innovative commercialization efforts.

Summary

The Capstone IPT process is a process that requires the participation and input from several DHS constituents. This collaborative effort centers on the principle that the customer is "the focus" of this process. The product and technology outputs of the Capstone IPT process are customer-requirements-driven from start to finish. The customer is involved throughout the process to ensure that they receive products and technologies specifically aligned to their detailed operating requirements. Ultimately, our customers receive quality products that effectively deliver the necessary, mission-critical capabilities to secure our nation.

Acknowledgment

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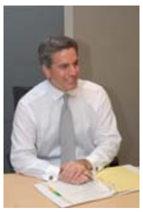

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