Intelligent Transportation Systems
U.S. Department of Transportation

Next Generation 9-1-1 (NG9-1-1) System Initiative

Final Analysis of Cost, Value, and Risk

Washington, DC

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The US Department of Transportation (USDOT) has taken a leadership position in assessing Next Generation 9-1-1 (NG9-1-1) technologies and developing a framework for national deployment

- USDOT understands that access to emergency services provided by 9-1-1 in today's world of evolving technology will ultimately occur within a broader array of interconnected networks comprehensively supporting emergency services—from public access to those services, to the facilitation of the services, to the delivery of emergency information to dispatchers and first responders
- USDOT's intent is to—
  - Promote the vision for the Next Generation 9-1-1 (NG9-1-1) system
  - Provide leadership, guidance, and resources to work with public and private 9-1-1 stakeholders
  - Develop a path forward with the goal of migrating to a nationally interoperable† emergency services network using a phased approach
- *"The objective of the NG9-1-1 Initiative, as a USDOT-sponsored research and development project, is to define the system architecture; develop a transition plan that considers responsibilities, costs, schedule, and benefits for deploying IP-based emergency services across the Nation; and implement a working proof-of-concept demonstration system"**
- USDOT views the NG9-1-1 system as an evolutionary transition to enable the general public to make a 9-1-1 "call" from any wired, wireless, or Internet Protocol (IP)-based device, and allow the emergency services community to take advantage of enhanced 9-1-1 (E9-1-1) call delivery and other functions through new internetworking† technologies based on open standards

†*The emergency services internetwork will be "interoperable" in that the networks and systems that comprise the NG9-1-1 architecture system of systems will have the ability to work together using standard formats and protocols.*

**As defined in the NG9-1-1 Concept of Operations, April 2007, available at http://www.its.dot.gov/ng911/pdf/ConOps.pdf (last accessed March 4, 2009).*

A case for change can be made for a next generation upgrade to the Nation's 9-1-1 system

- USDOT and the 9-1-1 community believe that a technological and operational transition to NG9-1-1 is essential for the Nation's public safety emergency service networks to adapt to the general public's increasing use of wireless communications and digital and IP-based devices with the ability to transmit text, images, and video

- Among the clear needs addressed* by a transition to NG9-1-1 are—
  - Quicker receipt of more robust information as the result of making a 9-1-1 call
  - Better and more useful forms of information (text, images, and video) from any networked communications device, which will allow better provision of services to the hearing and auditory-impaired communities
  - Transfer of 9-1-1 calls between geographically dispersed public service answering points (PSAP) (and from PSAP to remote public safety dispatchers), if necessary
  - Increased aggregation and sharing of data, resources, procedures, and standards to improve emergency response
  - Effective use of available public capital and operating costs for emergency communications services
  - Promotion of increased coordination and partnerships within the emergency response community

** Source: Next Generation 9-1-1 (NG9-1-1) System Initiative: Preliminary Transition Plan, available at: http://www.its.dot.gov/ng911/pdf/ng911_preliminary_transition.pdf (last accessed March 4, 2009). A final version of this document will be available at: http://www.its.dot.gov/ng911/ng911_pubs.htm*

This analysis aims to provide insights on migrating to an NG9-1-1 national framework based on an assessment of value, cost, and risk factors

- This analysis aims to—
  - Help support a common vision and approach for NG9-1-1
  - Help assess the current 9-1-1 operating environment
  - Reflect NG9-1-1 deployment scenarios
  - Help analyze and compare the current 9-1-1 environment with NG9-1-1
  - Provide a summary of value, costs, and risks across the current and NG9-1-1 scenarios
- This analysis does not consider* —
  - Detailed Design. This analysis is not based on NG9-1-1 detailed design requirements and technical specifications nor the requisite planning and development details
  - Governance Model. This analysis does not consider an overall governance model
  - Funding Alternatives and Issues. A key assumption inherent in the national deployment model is that funding is readily available pursuant to the notional rollout schedule (However, this analysis does recognize that funding may be a challenge, as reflected in the Risk Analysis section)
  - Government Regulations and Mandates. It is assumed that requisite regulations and legislation will be created to support a uniform approach to NG9-1-1
  - Local Jurisdiction Organization/PSAP Structure. The optimization of PSAP arrangements and other operations support entities is not a key component of this analysis

** While these items are no less important, they are not included within the scope of this analysis. It is recognized that 9-1-1 Authorities across the nation are in process or need to address these issues in short order.*

A local or state authority may refer to this report in evaluating migration to NG9-1-1 in terms of cost, value, and risks

- The information in the report may be used to help educate policy and decision makers at county, regional, and state levels about the value and risks of moving to an NG9-1-1 system
- This study employed a rigorous scientific approach to the analysis, reducing the need for a state, region, or county to incur the time, expense, and effort to conduct a similar study of its own, solely for the sake of validating migration to NG9-1-1*
- General conclusions that could be applied as presented in this report are—
  - The current system needs to be upgraded to satisfy unmet current and identified future needs
  - The best value approach is a uniform, coordinated NG9-1-1 system implementation
  - The cost of this approach is within the range of the estimated cost to purchase equipment to support an obsolete system
  - The overall benefits to end users, PSAP personnel, and first responders are measurable and significant

** The reader should recognize that this study is high level and is not intended to take the place of a state conducting its own, state-specific cost/benefit analysis*

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The approach for this preliminary analysis is based on the Value Measuring Methodology (VMM)

- The objective of VMM is to try to capture the full range of cost and value provided by a particular alternative while considering project risks that might decrease value or increase cost
- VMM provides a scalable and flexible approach for estimating and analyzing cost, value, and risk and evaluating the relationships among them
- VMM allows the calculation of non-financial value that might not be accounted for in traditional financial metric calculations, which permits a more rigorous comparison of alternative scenarios
- VMM has been cited as a best practice by the CIO Council and is available at—

http://www.cio.gov/documents/ValueMeasuring_Methodology_HowToGuide_Oct_2002.pdf, (last accessed March 4, 2009)

Benefits of the Methodology

- Qualitatively and quantitatively measures direct and indirect benefits and subjective variables
- Provides an approach to conduct risk assessments and reasonably predict outcomes
- Focuses on being certain that the answer lies within a range of values, rather than specifying a single answer of indeterminate probability; provides a range of outcomes and probability of occurrence for each
- Considers multiple perspectives and measures in quantifiable and comparable terms

VMM was developed in response to the changing definition of value brought on by the advent of the Internet and advanced software technology. This methodology incorporates aspects of numerous traditional business analysis theories and methodologies, as well as newer hybrid approaches

The key to VMM is to clearly define a decision methodology to ensure a consistent evaluation of value, risk, and cost

Decision Framework Components

Value Structure

Facilitates development and prioritization of a detailed quantitative benefits (performance measurement) analysis

Cost Element Structure

Allows for a high-level view and Rough Order of Magnitude (ROM) estimate of the lifecycle costs to develop and deploy NG9-1-1

Risk Structure

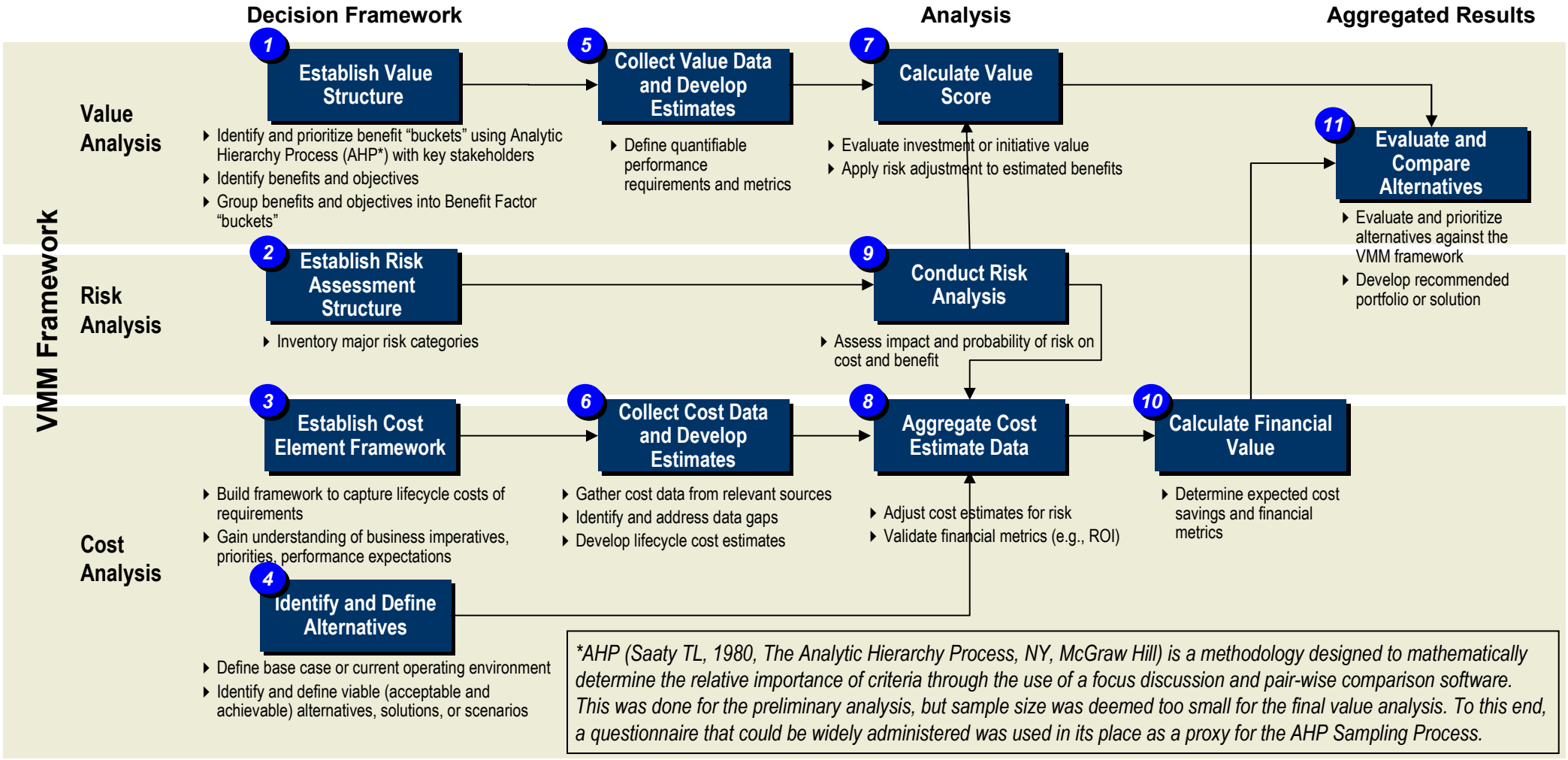
Identifies known factors that may impede the ability of an initiative to achieve its goals, degrading projected levels of performance and escalating estimated cost

Analysis Outputs

- Clearly communicates intended benefits of the chosen management approach for specific stakeholders
- Identifies the relevant needs and priorities of stakeholders and users
- Provides transparency regarding the executive-level management decision making process
- Establishes an understanding of USDOT's key success factors that will require management attention
- Comprehensively identifies risks to help develop appropriate mitigation strategies early in the development process

The VMM offers a holistic and structured approach for evaluating cost, value, and risk

VMM Framework Approach (analysis steps in sequence by number)



**AHP (Saaty TL, 1980, The Analytic Hierarchy Process, NY, McGraw Hill) is a methodology designed to mathematically determine the relative importance of criteria through the use of a focus discussion and pair-wise comparison software. This was done for the preliminary analysis, but sample size was deemed too small for the final value analysis. To this end, a questionnaire that could be widely administered was used in its place as a proxy for the AHP Sampling Process.*

VMM's Value Structure takes into account stakeholder perspectives through weights assigned to each Value Factor

Illustrative Value Structure

Value Factor	Definitions and Examples	Weights
Direct User	▸ Benefits to the customers/users ▸ *Example: Commute Time Reliability*	
Operational	▸ Level of efficiency and ease of management ▸ *Example: Emergency Management Response Time*	
Strategic/Political	▸ Contributions towards achieving strategic goals, priorities, and mandate compliance ▸ *Example: Supports DOT's mission in improving highway safety*	
Public	▸ Benefits to society and key stakeholders ▸ *Example: Reduced Fuel Emissions*	
	Total	***100%***

Benefit Measures are also weighted within each value factor

These weights formulate a basis for comparison of value between the base case and the alternatives

For this analysis, a questionnaire completed by a range of stakeholders and subject matter experts (SMEs) provided inputs to the structure. This was done to ensure that a representative sample of 9-1-1 stakeholders was reached for their opinions on value weighting. A full overview of the questionnaire can be found in Appendix A, slides 91 and 92. The Analytical Hierarchy Process (AHP) was used in the Preliminary Analysis of Cost, Value and Risk, published in February, 2008 (available at: http://www.its.dot.gov/ng911/pdf/NG911_FINAL_PreliminaryCostValueRiskAnalysis_v2.0_021208.pdf, last accessed March 4, 2009). To ensure that the Final Analysis of Cost, Value and Risk maintained continuity with this prior analysis, the general process framework was kept, despite the necessary modifications made to expand the sampling process

The risk structure provides the foundation to predict possible outcomes and impact on cost and benefits

- **Purpose:** Developing the risk structure provides a starting point for identifying risk factors that may jeopardize the program's success and ensures that plans for mitigating their impact are developed and incorporated into the alternative solutions. The risk structure also serves to identify the program's level of risk tolerance in terms of cost and value
- **Approach:** Risks are identified and documented through working sessions with key stakeholder representation
- **Outcome:** Provides a detailed risk inventory from which to assess the impact on cost (increase) or a decrease in value over the lifecycle under consideration

Risk Analysis Objectives

- Identify and inventory potential risk factors to ensure that risk mitigation plans are comprehensively populated
- Quantify the potential program impacts from risk through probability of occurrence and effect on costs
- Explicitly account for risk so that programs will have sufficient funding to cover foreseen but inherently risky programs

A hierarchical cost element structure captures all costs to generate a lifecycle cost for each scenario

- **Purpose:** A Cost Element Structure (CES) is a hierarchy of cost elements and assumptions for use in estimating the costs of deploying and operating the scenarios. A CES will be constructed and consistently applied to each scenario
- **Approach:**
  - First, cost categories are defined that fully capture expected costs associated with the stages of the investment and operations over its lifecycle
  - Second, a detailed basis of estimate is initiated that:
    1. Captures global assumptions (i.e., economic factors such as the discount and inflation rates)
    2. Captures program-specific drivers and assumptions (i.e., assumptions about the development and deployment of each alternative)
  - Third, a cost profile is compiled for each scenario based projected estimates of costs
- **Outcome:** The proper use of a detailed CES ensures completeness in terms of capturing all expected costs and consistency in estimating across scenarios

Cost Analysis Objectives

- Identify all cost categories leveraging the systems requirements and architecture analyses of the scenarios
- Tailor the CES to end state requirements
- Document all assumptions to be used for estimating the costs of deploying and operating the program
- Model uncertainty where appropriate
- Consistently approach the lifecycle cost development of each scenario

Published studies and working sessions with subject matter experts are leveraged to gather and populate the CES, resulting in lifecycle cost estimates for the base case and alternative scenarios

- Data collection templates serve as a tool in gathering data from relevant sources
  - ROM estimates are developed based on secondary research, available studies, and sampled populations for primary cost data
  - Data gaps are identified and assumptions are developed concerning gaps that may remain
- Lifecycle estimates are derived for the status quo and each scenario, with a comprehensive basis of estimate detailing global and alternative specific assumptions

Cost Element Structure Template

ILLUSTRATIVE

Scenario 1 Lifecycle Cost Estimate				
Cost Element	**Base Year**	**…**	**Year n**	**Total Lifecycle Costs**
1.0 Planning and Deployment				
2.0 Acquisition and Implementation				
3.0 Maintenance and Operations				

Oracle's Crystal Ball was used to run a Monte Carlo simulation on the costs identified for each scenario

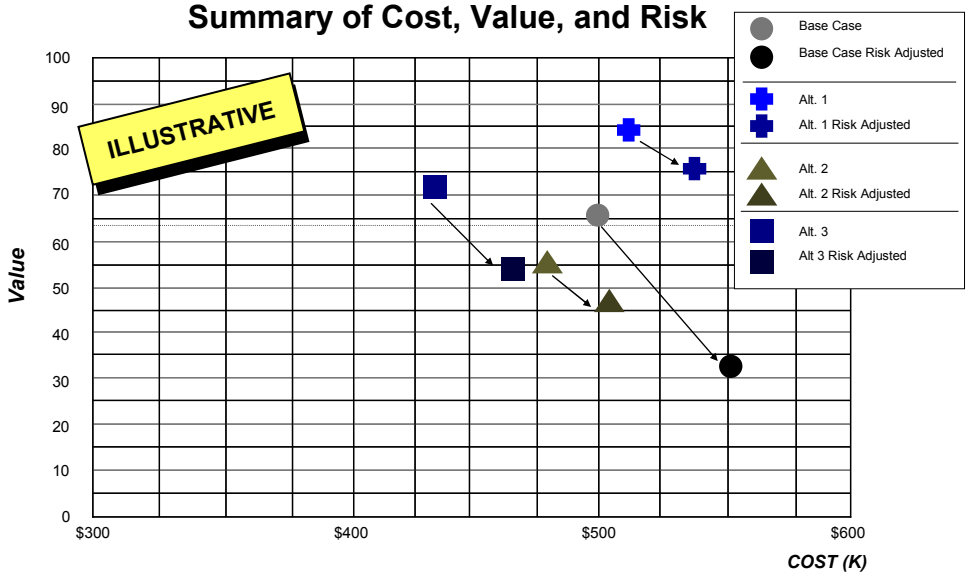
- Crystal Ball is a leading spreadsheet-based software suite for predictive modeling, forecasting, Monte Carlo simulation, and optimization. With more than 4,000 customers worldwide, including 85 percent of the Fortune 500, Crystal Ball is used by customers from a broad range of industries, such as aerospace, financial services, manufacturing, oil and gas, pharmaceuticals, and utilities. Crystal Ball is also used at more than 800 universities and schools worldwide for teaching risk analysis concepts*
- Through the use of Crystal Ball, a range of possible costs based on a likely distribution can be applied to simulate uncertainty surrounding individual costs over time
  - By running multiple trials with a random number generator, which selects a cost value within the designated range for each cost type selected, a viable range of costs (low, most likely, and high) can be generated
  - This allows the user to fully determine the possible range of cost outcomes for a given scenario. The average of the total costs from each outcome simulated then becomes the most likely scenario given the actual range of uncertainty surrounding each cost data point

* http://www.oracle.com/crystalball/index.html *(last accessed March 4, 2009).*

Recommendations are then formulated based on the risk-adjusted lifecycle costs and value scores

- Metrics are developed for each alternative to provide a basis for evaluation. These include:
  - **Total Investment Cost**, which reflects the resources required to initially design, develop, and implement the alternative
  - **A Value Score**, which quantifies the full range of value that a particular alternative delivers across all five Value Perspectives
  - **Impact of Risk**, which takes into account potential cost increases and the potential for unrealized value associated with each alternative, to determine risk-adjusted figures for both cost and value

- The risk-adjusted value and cost are plotted, providing a basis for a decision that is inclusive of business user needs, risks, strategic alignment, and cost implications
- These metrics are designed to help provide insight into the interactions among cost, value, and risk within each alternative to create the basis for a more informed decision



This analysis uses the VMM framework to compare various NG9-1-1 scenarios against a scenario in which the current 9-1-1 environment is maintained in today's state

- The relative values of different 9-1-1 system scenarios were outlined, weighed, and quantified by the NG9-1-1 project team in conjunction with a full array of industry stakeholders
- The relative costs of each 9-1-1 system scenario were quantified through research, use of existing studies, and NG9-1-1 project team expertise
  - Costs were then allocated over a 20-year lifecycle to help fully factor in the impact of recurring and periodic costs on the overall investment scenario
- The risks inherent to the various 9-1-1 system scenarios were outlined, risk probabilities estimated, possible impacts weighed, and then those risks were tracked to the costs and values by the NG9-1-1 project team
- Risks were factored into cost and value in two ways:
  - Cost values were adjusted by using Monte Carlo simulation to provide a range of uncertainty for each (see next slide for details)
  - After this simulation was completed, both cost and value were adjusted further by determining the probability and impact magnitude of specific risks identified by the project team on each
- Finally, lifecycle costs are presented in both nominal and present value terms in order to account for the risk of inflation and to adjust for the time value of money, respectively (see Glossary of Terms for definitions)

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This analysis aims to compare the cost, value, and risk of the current environment with those of an NG9-1-1 environment

Environment	Description
9-1-1 Baseline (Current) Environment	Status quo of current PSAP and 9-1-1 Authority operations. Operations are based on varying levels of technology, from Remote Call Forwarding (RCF) to Wireless Phase II and some degree of voice over Internet Protocol (VoIP) solution*
Next Generation 9-1-1 (NG9-1-1) Environment	The NG9-1-1 system will enable the general public to make a 9-1-1 call† from any wired, wireless, or IP-based device, and allow the emergency services community to take advantage of enhanced call delivery and advanced functional and operational capabilities through new internetworking‡ technologies based on open standards§

** Recognizing that today's VoIP solutions are similar to Wireless Phase II and have limited financial impact on the PSAP community (as opposed to the VoIP provider community)*

† *The term "call" is used to indicate any real-time communications—voice, text, or video—between a person needing assistance and a PSAP call taker*

‡ *The term "internetwork" is used to mean going between one network and another; a large network made up of a number of smaller networks*

§ *Source: NG9-1-1 Final Architecture Analysis Report, November 2007, available at http://www.its.dot.gov/ng911/pdf/1.F2_FINAL_MED_ArchitectureAnalysis_v1.0.pdf (last accessed March 4, 2009).*

NG9-1-1 can be presented in more than one deployment configuration (scenario)

- In the USDOT *Preliminary Analysis of Value, Cost, and Risk*, February 2008, a basic assumption of the analysis was that the cost of upgrading the defined segments to NG9-1-1 was **uniform** across all segments.* Such uniformity would require some degree of national coordination and implementation for full deployment
- Regarding other deployment approaches, the USDOT *NG9-1-1 Transition Plan*†, suggests that NG9-1-1 deployment within the public sector is likely to stem from one of two general deployment environments that largely reflect existing institutional and service delivery arrangements around the country:
  - **Coordinated, Intergovernmental Implementation.** System services generally reflect planned and coordinated deployments of 9-1-1 capabilities, facilitated by statewide 9-1-1 authorities, regional authorities, or informal mechanisms that enable a cooperative environment
  - **Independent, Unilateral Implementation.** System services generally reflect decentralized deployments of 9-1-1 capabilities by local jurisdictions through an environment featuring piloting independent initiatives
- However, only a handful of states consistently represent one or the other of these deployment scenarios statewide
- Pragmatically, many, if not most, states exhibit a **hybrid** or combination of the two, with some degree of coordination and planning in some locations

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**Assumption validated based on subject matter expert input from project team partners, including the National Emergency Number Association and L.R. Kimball and Associates*

† Source: Next Generation 9-1-1 (NG9-1-1) System Initiative: Preliminary Transition Plan, available at: http://www.its.dot.gov/ng911/pdf/ng911_preliminary_transition.pdf (last accessed March 4, 2009). A final version of this document will be available at: http://www.its.dot.gov/ng911/ng911_pubs.htm

Two primary NG9-1-1 deployment scenarios were selected for analysis based on the issues raised in the NG9-1-1 Transition Plan

- Two potential NG9-1-1 deployment scenarios where selected for analysis:
  - **Uniform:** This scenario represents the Coordinated, Intergovernmental Implementation option laid out in the USDOT *Transition Plan.* Based on extensive stakeholder interviews conducted during the development of the USDOT Transition Plan (November, 2008), this scenario was considered the most conservative possible outcome of an NG9-1-1 Deployment, due to the difficulty of standardizing an IT solution nation-wide
  - **Hybrid:** This scenario stems from deployment in a hybrid environment, as described in the previous slide. Essentially, there is a coordinated deployment of nationwide NG9-1-1 based on issued national standards; however, some jurisdictions will remain independent. The "hybrid" nature of this alternative reflects a combination of:
    - Independent/unilateral deployment for 5 percent of the population
    - Uniform deployment serving approximately 60 percent of the population
    - Regional deployment in which three large regional networks service approximately 35 percent of the total population

    Based on the stakeholder interviews conducted during the USDOT Transition Plan process, this scenario was deemed the most likely outcome of an NG9-1-1 deployment, due to the fragmented nature of the current 9-1-1 environment
- This analysis considers the **Baseline** in conjunction with the two NG9-1-1 deployment scenarios described above

To ensure that the Baseline environment cost estimates were representative, a range was developed based on a detailed build of the current environment coupled with existing data sources

- From the preliminary research conducted by the project team, it became apparent that the annual cost of current 9-1-1 operations nationwide is currently under debate
- To avoid the risk inherent in calculating a single value that would be subject to estimation errors, the NG9-1-1 project team decided to calculate two separate scenarios for baseline costs:
  1. Conduct a detailed cost build leveraging existing data sources, project team subject matter expert (SME) input, and state 9-1-1 system administrator input
  2. Leverage documented “cost per call” estimates from existing studies to determine whether the cost build is reasonable, and to what extent a range (upper or lower) should be considered
- The purpose was to create a reasonable range within which it was likely that actual annual baseline costs would fall

In summary, three primary scenarios were chosen for analysis as likely options for the Nation's future 9-1-1 systems

Scenarios for Analysis

Scenario	Description
Baseline Low Cost (Current Environment)*	Current 9-1-1 operating environment, modeled to reflect the state of 9-1-1 as of the year 2008. Costs estimated by NG9-1-1 project team SMEs
Baseline High Cost (Current Environment)*	Current 9-1-1 operating environment, modeled to reflect the state of 9-1-1 as of the year 2008. This scenario reflects the high end of cost estimates from current studies
NG9-1-1 Uniform Deployment	NG9-1-1 with a standard deployment nationwide. PSAP sizes, network sizes, and data center sizes are all scaled identically, regardless of location. Full costs assumed attributable to the 9-1-1 Authority
NG9-1-1 Hybrid Deployment	NG9-1-1 with a varied deployment nationwide. PSAP sizes, network sizes, and data center sizes are all scaled differently for various segments of the population. Full costs assumed attributable to the 9-1-1 Authority

** For the baseline environment operations, the project team defined a range for 9-1-1 current annual costs because there continues to be much debate surrounding the actual costs of operating the nation's 9-1-1 system. The team developed a detailed cost build estimate and leveraged existing studies and benchmarks to arrive at a ROM range of costs for this analysis*

To begin the estimate for the Baseline scenario, key levels of technology across the Nation on a county basis were identified

- To provide an assessment of cost, value, and risk for the current and next generation environments on a national basis, the team defined segment profiles for counties based on the population served and current technologies employed. The five hierarchical levels of 9-1-1 technology are defined as—

Remote Call Forwarding	A permanent call forwarding feature that allows a call to one Directory Number to be automatically advanced to another Directory Number. In this context, it covers the forwarding of 9-1-1 calls to a location when no other 9-1-1 service exists
Basic	An emergency telephone system that automatically connects 9-1-1 callers to a designated answering point. Call routing is determined by an originating central office only. Basic 9-1-1 may or may not support Automatic Number Identification (ANI) and/or Automatic Location Identification (ALI)
E9-1-1	An emergency telephone system that includes network switching, database, and customer premises equipment (CPE) elements capable of providing Selective Routing, Selective Transfer, Fixed Transfer, and ALI
Wireless Phase I	Required by Federal Communications Commission (FCC) Report and Order 96-264 pursuant to Notice of Proposed Rulemaking (NPRM) 94-102. The delivery of a wireless 9-1-1 call's callback number and identification of the cell tower from which that call originated. Call routing is usually determined by cell-sector
Wireless Phase II	Required by FCC Report and Order 96-264 pursuant to NPRM 94-102. The delivery of a wireless 9-1-1 call with Phase I requirements plus location of the caller within 125 meters 67-percent of the time and Selective routing based on those coordinates. Subsequent FCC rulings have redefined the accuracy requirements

Source: http://www.nena.org/media/files/NENA00-001_V1020070605.pdf (last accessed March 4, 2009).

The environment for the 9-1-1 Baseline scenario was further defined by the population served on a county basis

- For purposes of this analysis, a logical segmentation of counties based on population served was developed. A population of 50,000 was chosen as a measure to differentiate rural from urban counties
  - **Nearly 70 percent of all counties in the United States have a population of 50,000 or fewer**
  - All of the counties with 9-1-1 calls routed those calls via remote call forwarding, and nearly all of the counties with Basic 9-1-1 level of service are characterized as rural in nature—that is, have population of 50,000 or fewer
- Other segmentations reflect various sizes of urbanized counties. The project team chose segments based on the following population size of counties—
  - **50,000–250,000 population** to represent urbanized areas of medium size
  - **250,000–1,000,000 population** to represent urbanized areas with large sized cities
  - **1,000,000 or more population** to represent large metropolitan areas
- As population size increases, the extent of E9-1-1 availability and availability of wireless Phase I and Phase II services also increases. This is to be expected, given the propensity of larger areas to have more well-developed 9-1-1 systems, as well as the ability to fund them through various funding alternatives

Applying these factors yielded eight primary county segments on which to base the environments for the Baseline and NG9-1-1 scenarios

- Segment profiles provide a basis for estimating the costs, value, and risk of moving to the defined alternatives
- The segmentation also considers the seven states that have statewide systems. These states (and corresponding counties within) are not included within the county segmentation presented below. Costs for these segments are calculated on an individual, state-by-state basis (see Appendix B, slides 104-124 for details). This segment represents a population bloc of approximately 15 million people
- **More than 80 percent of counties have some level of wireless 9-1-1 service, with 3 percent of counties served only by remote call forwarding**

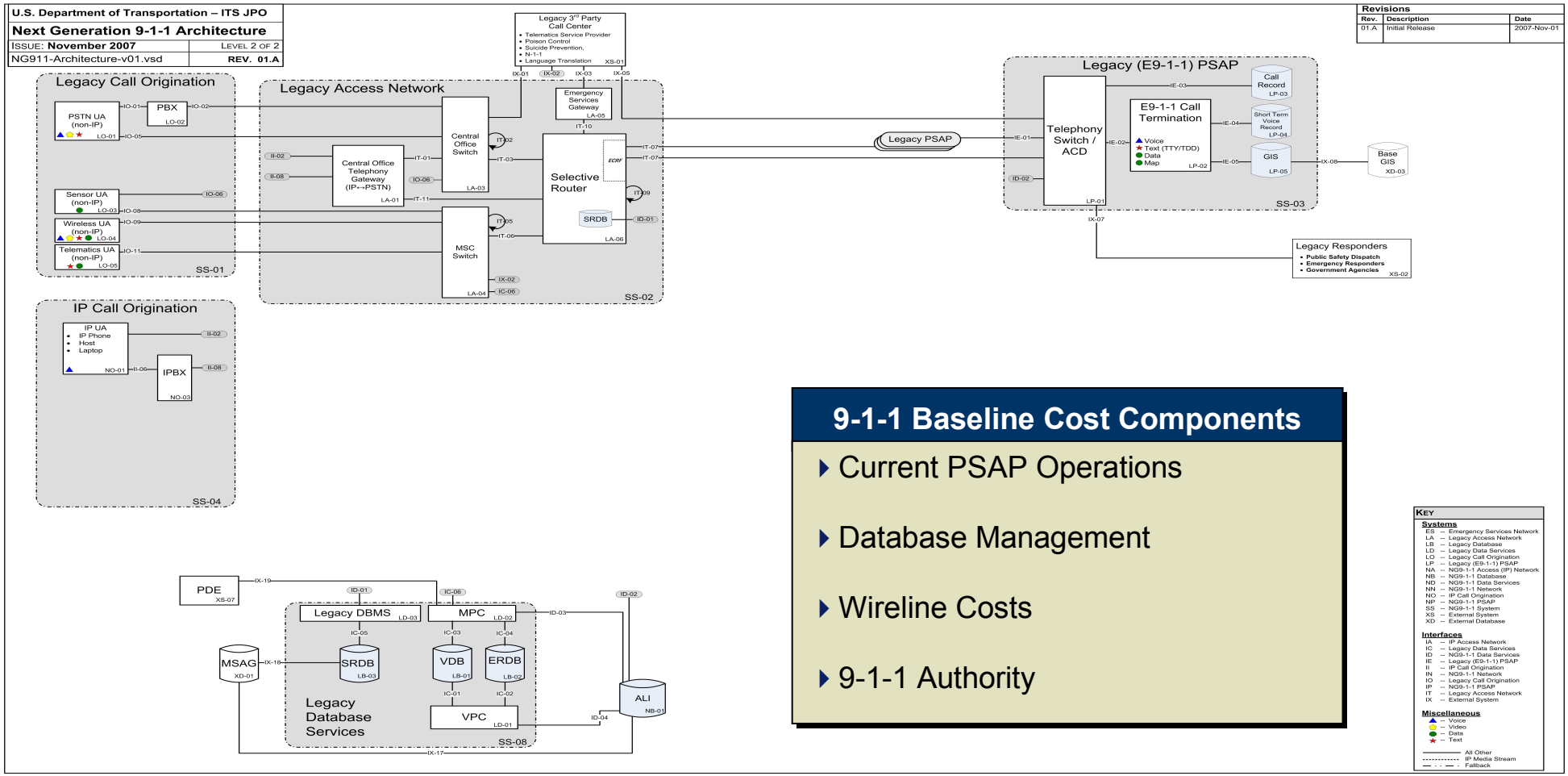
County Segmentation for Cost Profile Development*
(Seven state systems are not included in this table†)

	1 RCF	2 Basic	3 E9-1-1	5 Wireless‡	Total
Fewer than 50,000	**98**	**114**	**304**	**1,684**	***2,200***
50,001 to 250,000	0	2	4 **62**	6 **588**	***650***
250,001 to 1,000,000	0	0	4	7 **175**	***175***
More than 1,000,000	0	0	2	8 **25**	***25***
Total	**98**	**116**	**366**	**2,472**	**3,052**

Source: Wireless Deployment Profile maintained and updated by the Nation*al* Emergency Number Association (NENA). *Available on http://www.nena.org/pages/Contentlist.asp?CTID=6 (last accessed March 4, 2009)*
**For this analysis, it is assumed that a county is equivalent to a 9-1-1 Authority*
‡ *Includes Phase I and Phase II as well as counties that have started wireless deployments as of July 7, 2007*
NOTE: Outlying segments for all population sizes (see blue boxes in table) have been factored into the average population size of Segment 8 counties to ensure that the entire population of the United States is covered in this estimate

The architecture of 9-1-1 Baseline scenario's environment provides a high-level description of current operations and associated costs

9-1-1 Baseline (Current) Environment: Reference Architecture



9-1-1 Baseline Cost Components

- Current PSAP Operations
- Database Management
- Wireline Costs
- 9-1-1 Authority

Source: NG9-1-1 Final Architecture Analysis Report, November 2007, available at http://www.its.dot.gov/ng911/pdf/1.F2_FINAL_MED_ArchitectureAnalysis_v1.0.pdf (last accessed March 4, 2009).

The NG9-1-1 vision is to provide a foundation for public emergency services in an increasingly mobile and technologically diverse society

- The transformation and integration of IP technology with NG9-1-1 is a major change from traditional E9-1-1. The impetus for the use of IP is its widespread and increasing standardization as the communication protocol for wired and wireless networks

- The NG9-1-1 system must be able to interface with multiple systems and to transport traffic using a common protocol (IP) to achieve end-to-end interoperability

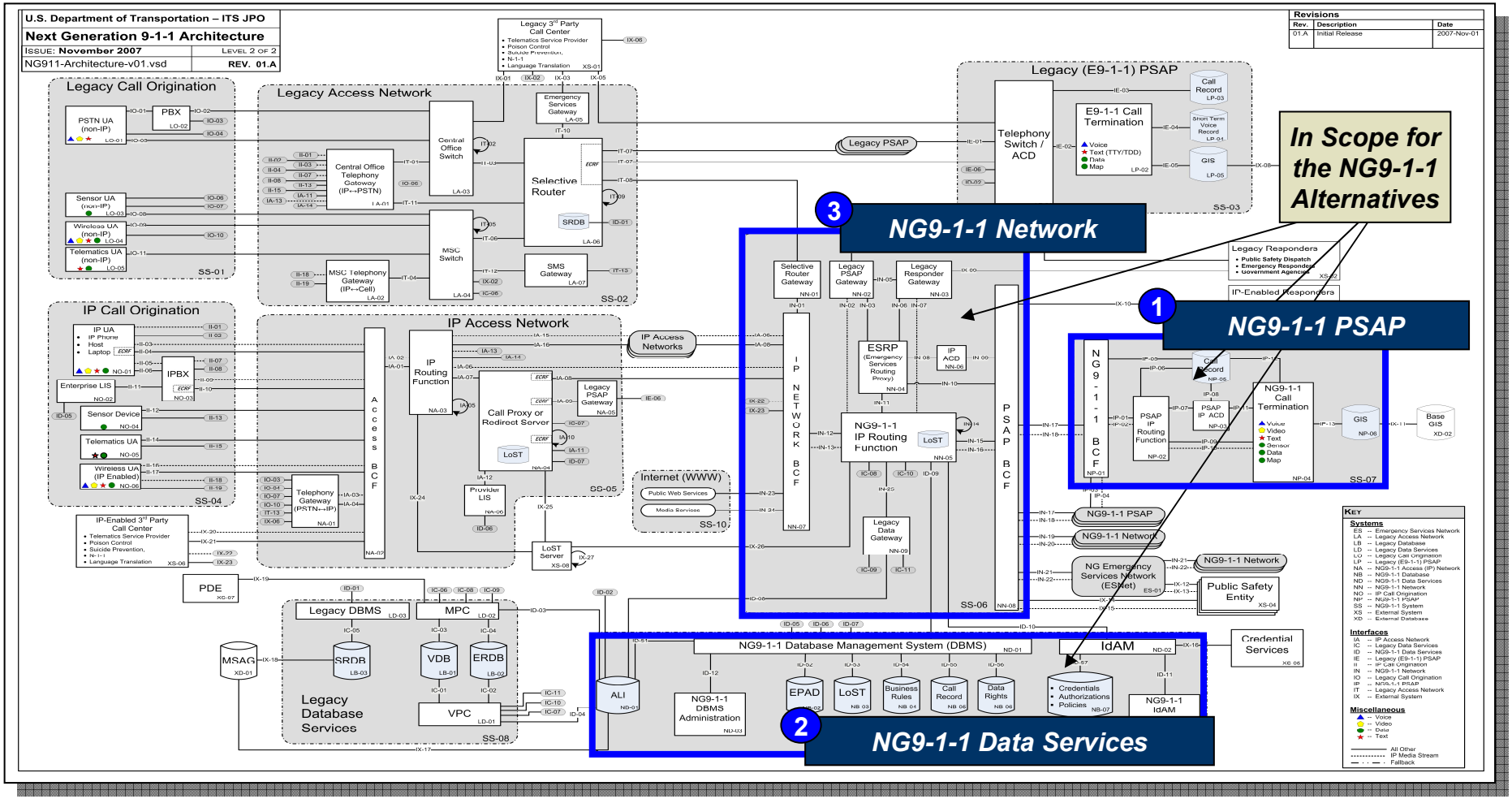
- As a next generation system, NG9-1-1 will use the IP and routing capabilities to transform and link existing public safety systems

- Three primary components combine to form the NG9-1-1 architecture and the basis for this analysis:
  - **PSAP.** First point of reception of a 9-1-1 call (recognizing that some calls are relayed through third-party service providers)
  - **NG9-1-1 Network.** Telecommunications system that will transmit 9-1-1 media from end users to call takers and from call takers to dispatchers (and databases)
  - **NG9-1-1 Data Services.** Data centers that will house servers that will store address, geographic information system (GIS), and other 9-1-1 relevant information

- It is also important to note that in this model, telecommunications service providers will continue to be responsible for providing access to emergency communications and delivering 9-1-1 calls to the appropriate Emergency Services network, as well as providing services and applications to help support NG9-1-1

The NG9-1-1 architecture for this analysis comprises three key areas: PSAPs, Network, and Data Services components

NG9-1-1 Reference Architecture



Source: NG9-1-1 Final Architecture Analysis Report, November 2007, available at http://www.its.dot.gov/ng911/pdf/1.F2_FINAL_MED_ArchitectureAnalysis_v1.0.pdf (last accessed March 4, 2009).

For the NG9-1-1 alternative scenarios, a *UNIT* approach was devised to provide a scalable, repeatable building block on which to base deployment scenarios

- ***Unit,*** in this context, reflects a population size that could be used as a building block for national deployment. This allows for the assessment of cost, value, and risk in a modular way, and scales the unit to fit a national framework that would coincide with the baseline segments
- In its 2006–2007 implementation of an IP-based 9-1-1 network, Vermont (population 623,908) determined that the maintenance of 32 call-taker positions was appropriate for a population of its size
  - Vermont's staffing requirements are based on an average traffic estimate of 1.47 erlangs (unit that measures total call traffic volume in 1 hour) per position*
- Based on the number of call-taker positions currently in operation in the United States, the average ratio of call-taker position per person under a non-IP based system is approximately 40 call-taker positions for a population of 625,000
  - National figures are based on an estimated average of 1.45 erlangs per position†
- Given the increased call handling and queuing efficiencies inherent in switching to an IP-based system, the lower value of 32 call-taker positions per 625,000 population was selected for the purposes of calculating alternative costs (recognizing that workload per call-taker position may change in an NG9-1-1 environment)
- In this analysis, call takers per population served is held constant between the **NG9-1-1 Uniform** and **Hybrid** scenarios; however, PSAP and Data/Network Units have been scaled in accordance with the requirements of the two scenario definitions involved

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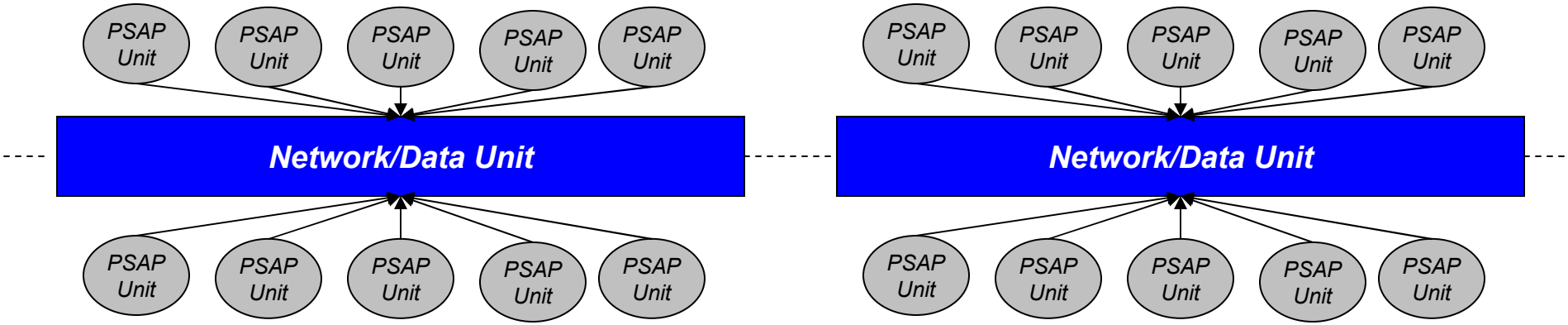
** Source: Vermont Department of Public Safety and Vermont Communications Study Group, Dispatch Services Executive Summary, September 2005*

† Source: L. Robert Kimball and Associates, PSAP Staffing Guidelines Report, as Commissioned by NENA SWAT Operations Team, 2003

The key driver for the NG9-1-1 Uniform deployment scenario is based on a PSAP Unit defined by 32 call-taker positions

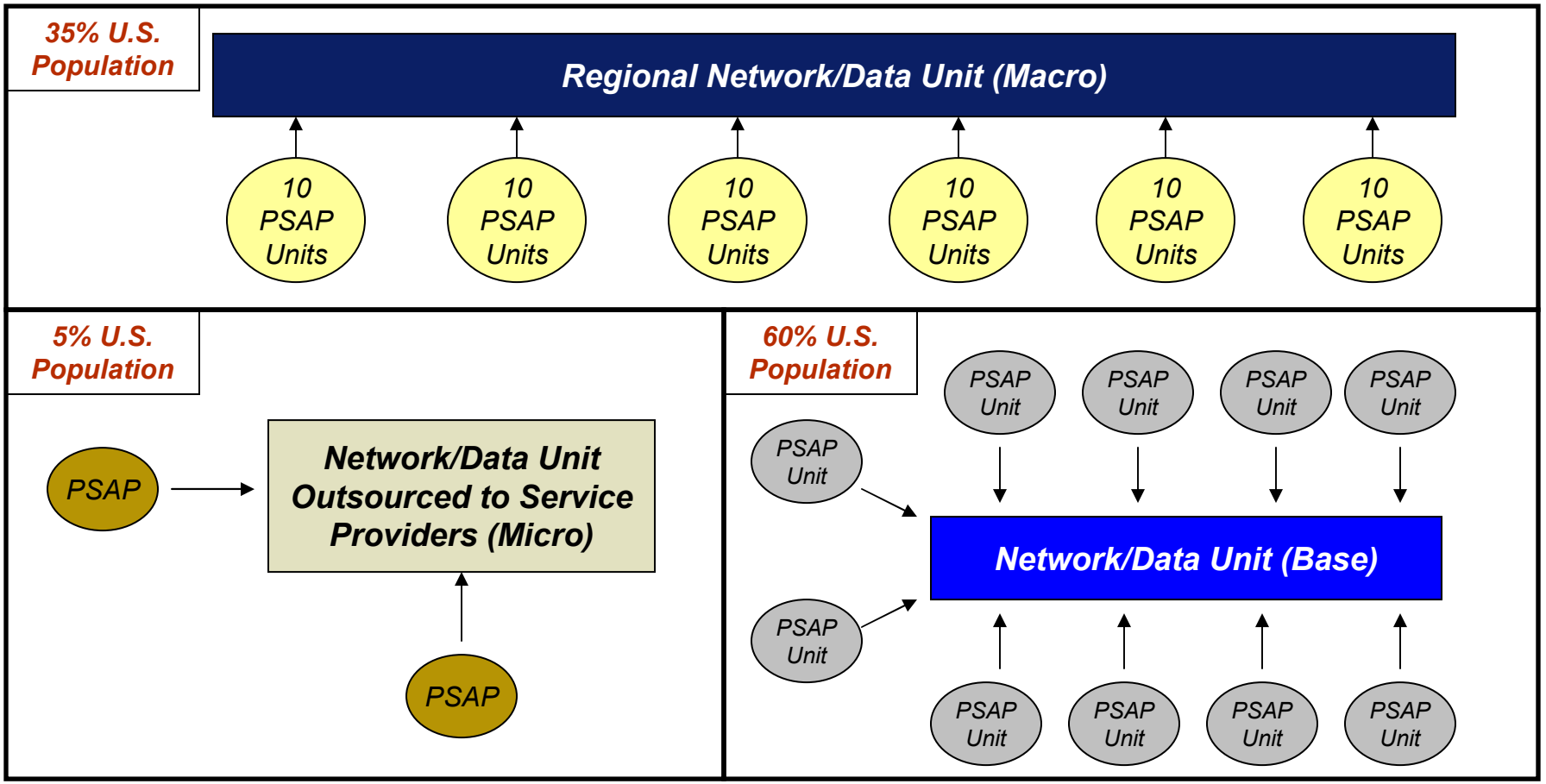
NG9-1-1 Uniform Alternative Deployment Assumptions



- The median population = 625,000 people (based on existing data) for each PSAP Unit
- **625,000 people = 32 call-taker positions** to serve them on average (based on existing data/national average of population/position). Thirty-two call-taker positions are assumed to cover between 10 and 12 physical PSAPs; however, this analysis is based on call-taker positions not physical PSAPs
- Redundant data centers (mirrored centers for the sake of backup) and the network will host, on average, 320 call-taker positions (10 PSAP units per Network/Data unit)
- In the Uniform deployment scenario, the United States contains approximately 508 populations of 625,000, meaning that each redundant data center and network would correspond to approximately 10 to 11 PSAP units. The analysis was scaled to represent a total of 508 PSAP Units and 50 Redundant Network/Data Units
- A key assumption for the base unit in the Uniform national deployment scenario is that each state would maintain jurisdiction of its own 9-1-1 system

The NG9-1-1 Hybrid scenario represents a range of deployment options as a measure to realize a full national rollout of NG9-1-1

NG9-1-1 Hybrid Alternative Deployment Assumptions



Note: Distribution of population across options was constructed based on project team experience with current NG9-1-1 adoption practices

For the NG9-1-1 Hybrid scenario, the Unit has been scaled to accommodate varying sizes of data centers and networks with the key driver being population served

Workload Assumptions for Scalable Units

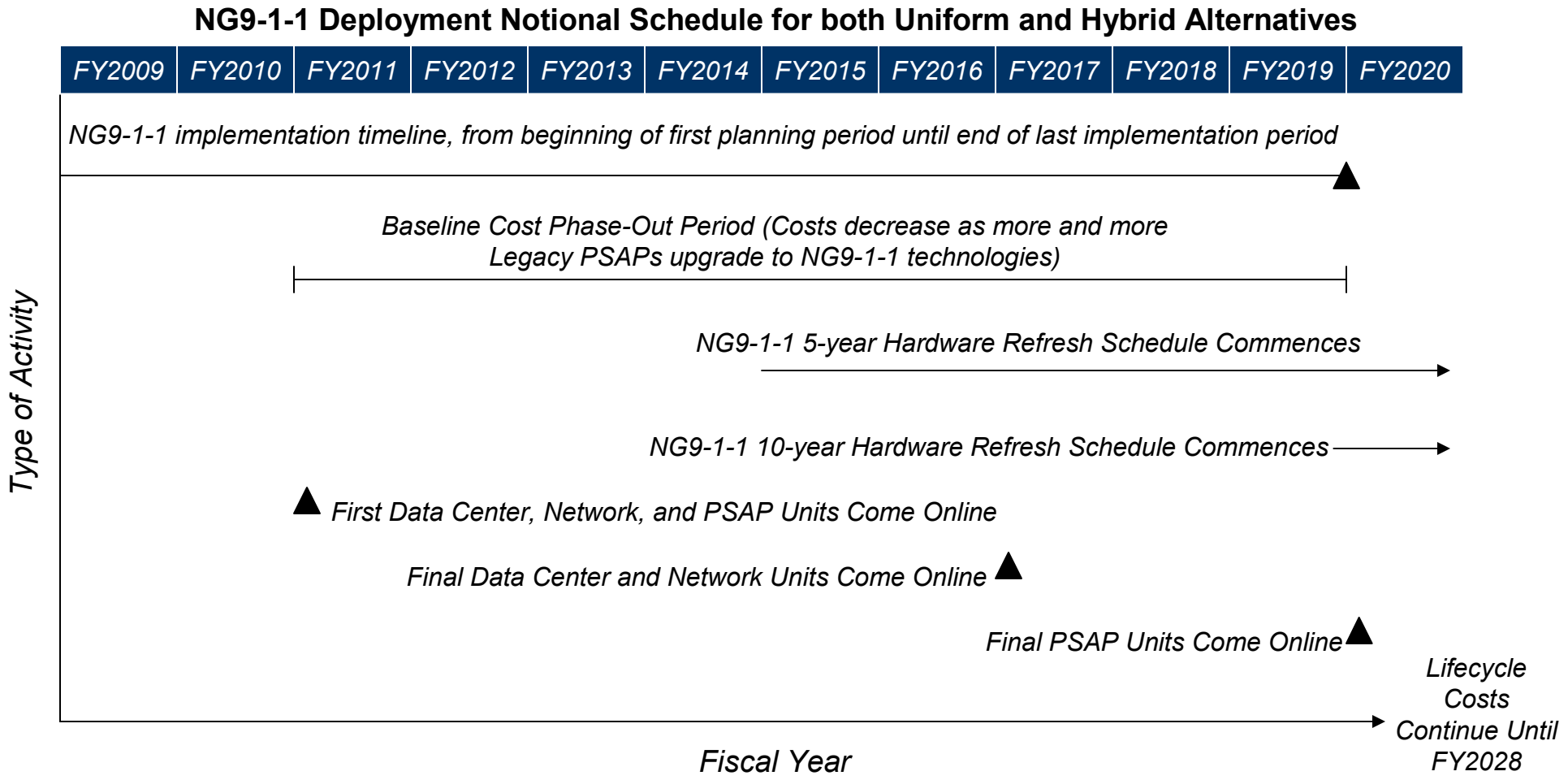
	Base Unit	Macro Unit	Micro Unit
Percentage of Population Served by This Segment	60%	35%	5%
Total Population Served by This Segment	180,600,000	105,350,000	15,050,000
Population Served Per Network	6,250,000	35,116,667	625,000
Number of Call Taker Positions Per PSAP Unit	320	1,798	32
Estimated Number of PSAPs	100–120	560–675	10–12
Total Calls Per Network*	3,840,000	21,575,680	384,000
Network Points of Presence (POP)†	5	10	N/A
Total Number of Networks	29	3	24

** Based on a projected call volume of 12,000 calls annually per call-taker position*

† Points of interconnection between networks, or access points

Note: The PSAP units are scaled at the same population levels as NG9-1-1 Uniform scenario, but the ratio of PSAP Units to Data/Network Units is different in this scenario

A notional rollout schedule for NG9-1-1 and concurrent phase-out of the baseline system spans a 10-year implementation period



Four deployment strategies are considered, each of which has advantages and disadvantages

NG9-1-1 Deployment Strategy Issues for Discussion

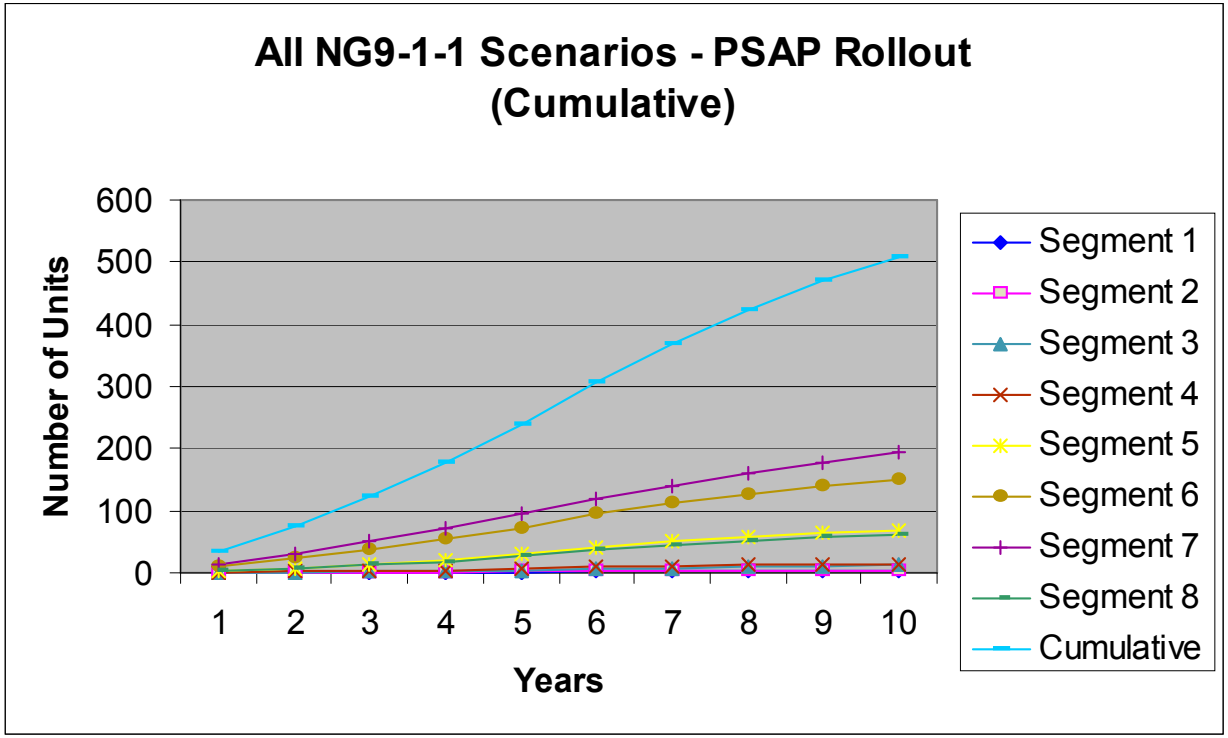
Deployment Strategy	Advantages	Disadvantages
Largest County Segments Adopt First	▸ May be better able to afford the up-front costs of NG9-1-1 system ▸ Would likely plan on being among the first adopters because of their heavier call volumes	▸ May be less complicated for pilot studies to take place in smaller cities, making them more likely to be early adopters ▸ May be politically inexpedient to allow an urban-rural divide right from the start
Smallest County Segments Adopt First	▸ Is politically expedient for more rural areas to be involved early ▸ Allows for the creation of rural-oriented pilot studies	▸ Will likely not be able to afford systems without significant help from the state, potentially causing short-term budgetary problems for adopting states
Middle County Segments Adopt First	▸ Matches pattern of feasibility studies currently underway ▸ Middle size cities could probably afford up-front costs	▸ Assumes that no large cities would implement until later because of the complexity ▸ Raises equity concerns similar to assuming largest segments would adopt first
Random Sequencing—Used for Both the Uniform and Hybrid NG9-1-1 Deployment Scenarios	▸ Allows for middle size cities being early adopters, while allowing possibility of largest segments following close behind, or as part of that effort ▸ Solves equity of implementation concerns	▸ Is unclear that this is the pattern that will track with actual implementation ▸ Is more difficult to fit in logistically ▸ Segment numbers may not fit with optimal implementation sequence

The Uniform NG9-1-1 deployment scenario is assumed over a 10-year period, with the majority of PSAP units deploying in years 5 and 6

- PSAP Units were deployed over the course of a 10-year span, with a few early and late adopters at the beginning and end, respectively, and the majority of units rolling out in the middle
- PSAP Units were composed of baseline population segments corresponding to a total population level of 625,000

Assumptions

- Total Number of Units Deployed: 508
- Each unit rollout was implemented over a 2-year time period
- O&M Costs commence in year 3

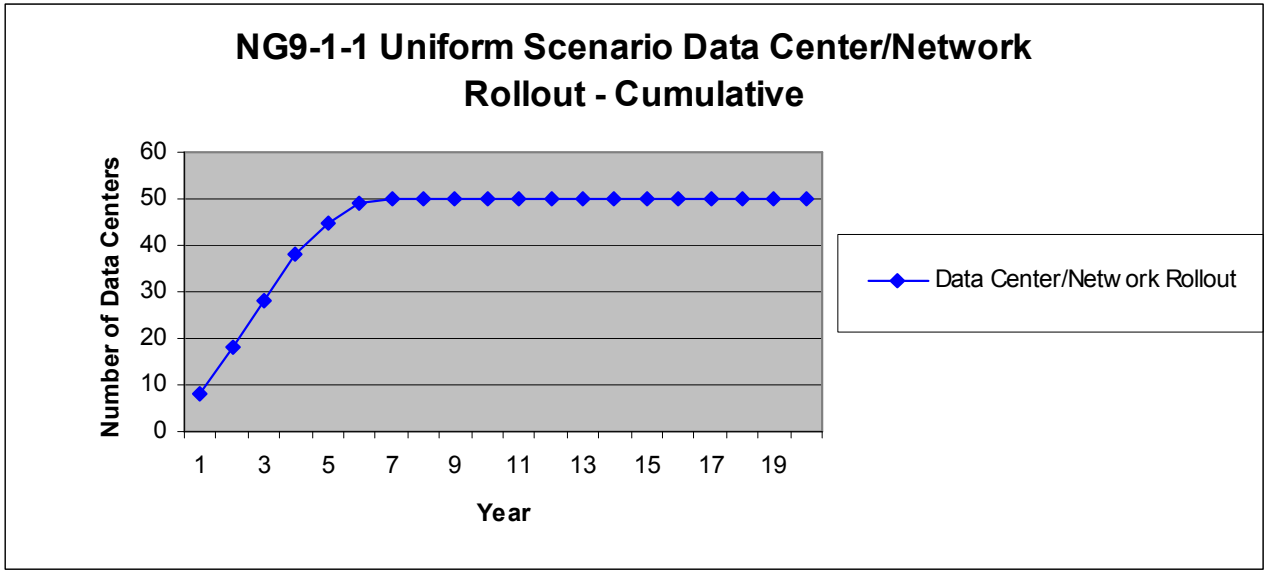


For the Uniform deployment scenario, data center and network unit implementation drive the deployment of PSAP units

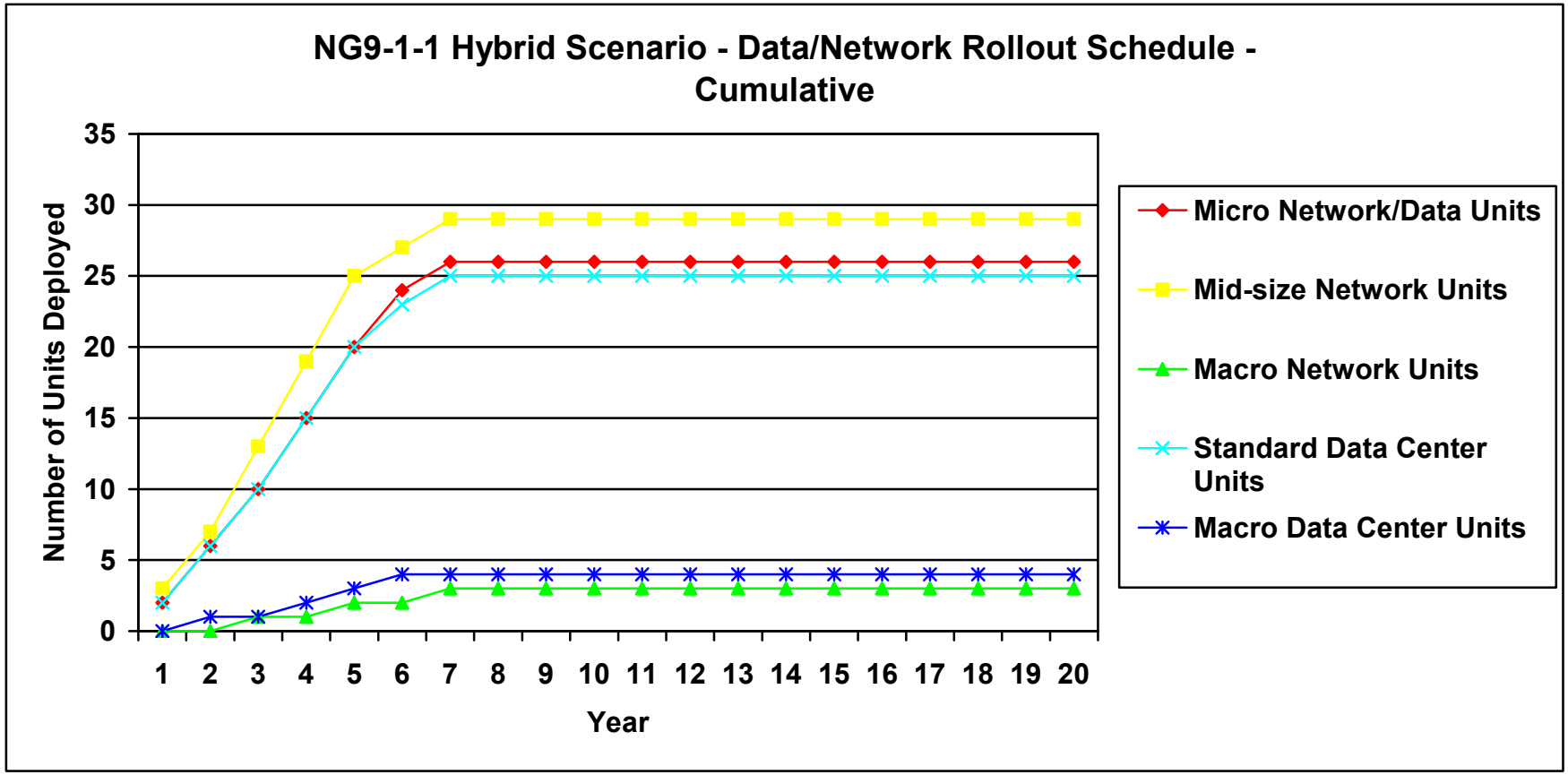
- Because each pairing of redundant data center and network (i.e., one data/network unit) will support 10 PSAP units, and PSAP units are assumed to deploy randomly, all data center/network units will roll out in the first few years to allow PSAPs to come online at will
- This is the equivalent of each state building a data/network unit and then letting counties upgrade their PSAPs at their own pace

Assumptions

- Total Number of Data Center/Networks Units Deployed: 50
- Equivalent to 1 Redundant Data Center/ Network per state
- Each Data Center/ Network supports a population of 6,250,000, or the equivalent of 10 PSAP units



In the NG9-1-1 Hybrid scenario, several different sizes of network and data center units are deployed nationwide, with each deploying independently from the others



Note: *PSAP Deployment Schedule remains unchanged from NG9-1-1 Uniform Deployment Scenario*

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The Value Structure facilitates development and prioritization of a detailed quantitative benefits analysis based on expected performance of the scenarios

- The Value Structure (composed of the four Value Factors—Direct User, Operational/Foundational, Strategic/Political, and Social) provided the framework by which to assess and compare the defined scenario alternatives
- Value measures and performance metrics were developed over the course of several working sessions with technical, functional, and business representation from the SMEs on the USDOT's project team
- A value questionnaire* was completed by 9-1-1 stakeholders across a range of sectors to evaluate the relative value provided by the Nation's 9-1-1 system
  - Questionnaires were completed a full range of stakeholders, including direct users of the system, state and local government agencies, industry associations, standards development organizations (SDO) and academia, and service providers
  - Facilitated working sessions allowed for the completion of questionnaires. For example, the National Emergency Number Association (NENA) queried member stakeholders during a working group session
- Respondents were asked to attribute a percentage of the overall value of 9-1-1 system to each of the value factors and measures

* See Appendix A, Value Details

In assessing the 9-1-1 environment, multiple stakeholder perspectives are incorporated into the value framework

9-1-1 Stakeholder Segmentation

Stakeholder Segment	Definition	Represented by	
Direct Users	Any and all organizations that improve the safety of the public by being able to exchange information in emergencies	▪ General public ▪ Special needs communities (e.g., hearing impaired) ▪ PSAP/9-1-1 Authority system management	▪ PSAP call takers ▪ Public safety dispatchers ▪ First responders ▪ Support responders
Government Agencies	Responsible for establishing policy, funding, and overseeing the operation of PSAPs and emergency response services	▪ Local, state, regional, and federal policy, regulatory, and funding agencies	▪ Local and state emergency communications agencies ▪ Local, state, regional, and federal emergency response agencies
Industry Associations and SDOs	Responsible for overseeing development of key ubiquitous components of the NG9-1-1 system and for representing the interests and needs of affected stakeholder communities in that development	▪ Professional and industry associations ▪ SDOs ▪ Research and academia	▪ Private emergency response and recovery organizations ▪ Citizen and special interest advocacy organizations
Service Providers	Responsible for functional services essential to the operation of next generation systems and the access to those systems by the public, emergency communications personnel, and responders Represent specific public communities or consumer groups responsible for providing access to emergency services and/or data	▪ “Traditional” telecommunications service providers ▪ “Public safety/emergency” service providers ▪ “Other” information technology (IT)/telecommunication application service providers (ASP) ▪ IP-network access infrastructure/ service providers	▪ Service and applications providers ▪ Third-party service providers ▪ Telematics ▪ Poison control ▪ Medical alert ▪ Central alarm monitoring ▪ Relay services ▪ N-1-1 services

The Value Structure is composed of four key value factors that represent viewpoints across key stakeholders

Value Factors Defined

Value Factor	Definitions
Direct User	Value to all direct users of the network, including all callers, the hearing and sight impaired, system operators, and organizations that use 9-1-1 systems and processes to exchange information in emergencies
Operational/ Foundational	Value associated with current federal, state, and local government 9-1-1 operations, the order of magnitude improvements realized in current 9-1-1 operations and processes, and in laying the groundwork for future initiatives
Strategic/ Political	Contributions to achieving both public (federal, state, and local governments) and private sector strategic goals and priorities
Social	Value related to non-direct users (i.e., those not immediately involved in specific 9-1-1 incidents), communities of stakeholders, the larger economy, and society as a whole

Value analysis findings indicate that the greatest value provided by the 9-1-1 system is to the Direct Users of the system

- Although each of the four factors represents important stakeholder value, delivering value in one factor may be more important than delivering value in another. In other words, the factors are not necessarily equal in importance and therefore should not carry equal "weight" in the decision-making process
- Within each value category are individual value measures. The relative importance of these value measures must be accounted for even though they may not be equivalent
- To better model the relative importance of the value factors and measures, each of the value factors and measures was assigned a weight or level of importance. The weighting was determined through the aggregation of stakeholder input (see Appendix A, slides 91-92 for more information)

Value Factor Resulting Prioritization

Value Factor	Weight
Direct User	34.4%
Operational/Foundational	28.9%
Strategic/Political	18.4%
Social	18.3%
TOTAL	100%

Within each value factor, the value measures were also prioritized

Value Measure Resulting Prioritization

Direct User	Weight
Overall Value Factor Weight	**34.4%**
Accessibility	28.5%
Reliability of Service	27.0%
Call-Taker Timeliness	24.7%
Ease of Use	19.8%
Total	**100.0%**

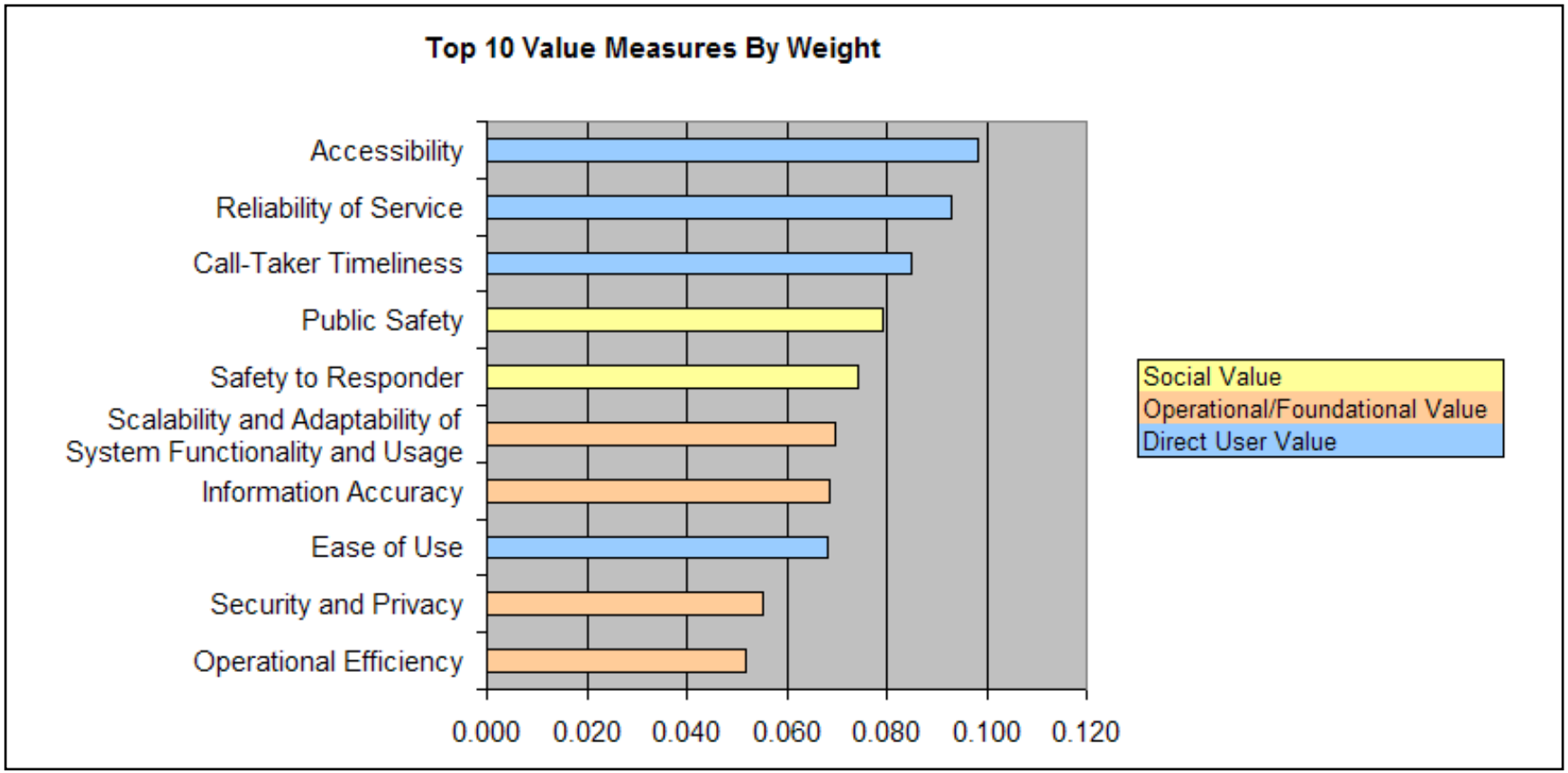
Operational/Foundational	Weight
Overall Value Factor Weight	**28.9%**
Scalability and Adaptability of System Functionality and Usage	24.1%
Information Accuracy	23.7%
Security and Privacy	19.1%
Operational Efficiency	17.9%
Data Management and Sharing	15.1%
Total	**100%**

Strategic/Political	Weight
Overall Value Factor Weight	**18.4%**
Coordination Between PSAPs at Local, State, and International Levels as Well as with Other Public Services	28.2%
Technology Standards, Laws, and Regulations	24.5%
Strategic Use of Resources and Data	19.1%
Alignment of Strategic Goals	15.8%
Value to Industry	12.4%
Total	**100%**

Social	Weight
Overall Value Factor Weight	**18.3%**
Public Safety	43.3%
Safety to Responder	40.6%
Energy and Environment	16.1%
Total	**100%**

*NOTE: For the complete Value Structure, measures and performance metric definitions, see Appendix A, slide **84.** For details on value calculations, see slide 101. Table totals may not reflect sum of numbers presented because of rounding*

The top 10 values resulting from the prioritization of value measures indicate a strong preference for "Direct User" Values*



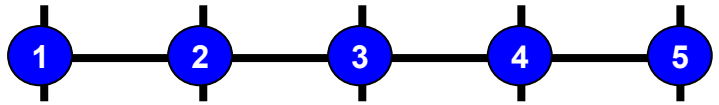
These results indicate that the value score for each scenario is most influenced by its perceived value to direct users of the system, followed by its value to the operational improvements provided by the system in question

To compare the expected value of the 9-1-1 Baseline with the NG9-1-1 alternative deployment scenarios, each scenario is evaluated using the defined value factors, measures, and metrics

- To arrive at a score for each value measure, the team evaluated whether NG9-1-1 (Uniform) and NG9-1-1 (Hybrid) scenario would be expected to provide more or less value than the Baseline

- Each measure was scored on a scale of 1 to 5
  - The Baseline was assumed to be at the midpoint of the scale (3)
  - Using a combination of 9-1-1 data and SME input for each measure, the team estimated whether each NG9-1-1 scenario would provide more, less, or consistent value compared with the current 9-1-1 environment

Value Analysis Metric Scale



Significantly Less Value	Same Value as the Baseline	Significantly More Value

Once relative weights were determined, each metric was assigned a score on a 1–5 scale across scenarios based on a combination of 9-1-1 data and SME input

Example

Direct User Value Measures Performance Estimating

Value Measure/Metric	Baseline (Current Environment)	NG9-1-1 Uniform	NG9-1-1 Hybrid
Accessibility			
Overall percentage of population with 9-1-1 service	3	5	4.5
Number of types of communications devices or services that enable the general public to make a 9-1-1 call (including event devices)	3	5	5
Number of PSAPs where call takers can transfer and receive 9-1-1 calls to or from beyond their local system to facilitate correct 9-1-1 call delivery and dispatch.	3	5	4.5
Call Taker Timeliness			
Call set-up times (from gateway to NG9-1-1 network to PSAP) for call delivery and associated data	3	5	5
Time to process data at PSAP (ACN, queuing)	3	5	5
Call-taker processing (receive, process, and release call to dispatch)	3	4	4.5

NOTE: All metrics are given equal weight within their measure categories for the purposes of this analysis. For full metric scoring details and calculations, please see Appendix A, slides 93-101

Each scenario is evaluated as defined in the value structure performance measures and metrics based on its expected performance

- Once each metric was rated on the scale from 1–5, it was then combined with the factor and measure weights to determine a value score for each measure
- The raw 1–5 scores are first normalized based on a scale of 1–100 to convert each metric score to a more nuanced and intuitive standard

Normalized Score Conversion Table				
1	2	3	4	5
0	**25**	**50**	**75**	**100**

- To generate the value score for a measure, the factor weights previously determined were multiplied by the measure weights, and the result then multiplied by the normalized score for each measure to identify its overall value (A detailed example calculation is given in Appendix A, slide 101)
- Finally, all the measure value scores were then summed to provide an overall value score for a given scenario

Both NG9-1-1 deployment scenarios are expected to deliver significantly more value than the current 9-1-1 environment

- The value analysis considered multiple stakeholder perspectives in an attempt to leverage expectations to identify the key performance indicators for 9-1-1 and the potential performance of an NG9-1-1 environment
- The overall value analysis results were—
  - **9-1-1 Baseline: 50.0**
  - **NG9-1-1 Uniform: 90.2**
  - **NG9-1-1 Hybrid: 86.6**
- Based on the value analysis, the NG9-1-1 Uniform deployment scenario is expected to deliver more than **80-percent** additional value over the current operating environment to the 9-1-1 community
- The Uniform scenario would deliver greater overall value because it assumes that all networks are based on the same standards, whereas the Hybrid scenario would result in 5 percent of the population adopting proprietary standards

Value Analysis Results: Point Estimate*

		9-1-1 Baseline*	NG9-1-1 Uniform*	NG9-1-1 Hybrid*
Value Factors and Measures	**Weight**	**Score**		
Direct User Value	**34%**	**17.2**	**33.7**	**32.1**
Accessibility	29%	4.9	9.8	9.0
Call Taker Timeliness	25%	4.2	7.8	8.1
Reliability of Service	27%	4.6	9.3	8.1
Ease of Use	20%	3.4	6.8	6.8
Foundational/Operational Value	**29%**	**14.5**	**21.5**	**20.6**
Scalability & Adaptability of System Functionality & Usage	24%	3.5	7.0	7.0
Information Accuracy	24%	3.4	4.3	4.3
Data Management & Sharing	15%	2.2	4.4	3.8
Operational Efficiency	18%	2.6	5.2	4.9
Security and Privacy	19%	2.8	0.7	0.7
Strategic / Political Value	**18%**	**9.2**	**17.6**	**16.6**
Alignment of Strategic Goals	16%	1.5	2.2	2.2
Technology Standards, Laws, & Regulations	25%	2.2	4.5	4.2
Coordination Between PSAPs at Local, State and International Levels as well as with Other Public Services	28%	2.6	5.2	4.8
Strategic Use of Resources and Data	19%	1.8	3.5	3.1
Value to Industry	12%	1.1	2.3	2.3
Social Value	**18%**	**9.2**	**17.3**	**17.3**
Public Safety	43%	4.0	6.9	6.9
Safety to Responder	41%	3.7	7.4	7.4
Energy & Environment	16%	1.5	2.9	2.9
Total	**100%**	**50.0**	**90.2**	**86.6**

Note: Table totals may not reflect sum of numbers presented because of rounding

**For the definition of "Point Estimate," see slide 75*

The greatest variations between the Baseline and NG9-1-1 scenario environments reflect greater value will be realized by NG9-1-1

- **Accessibility** (+4.9 value points, 100-percent increase over the current environment for the uniform deployment and +4.1 value points, 83-percent increase for the hybrid deployment): This major increase is expected because of the large number of IP-based devices that will be capable of using the system under NG9-1-1 that currently cannot under the present system

- **Reliability of Service** (+4.6 value points, 100-percent increase over the current environment for the uniform deployment and +3.5 value points, 75% increase for the hybrid deployment): This significant increase is expected because of the stronger linkages between PSAPs under an NG9-1-1 scenario that allow for complete redundancy in the event of natural disasters or individual PSAP failure

- **Public Safety** (+2.6 value points, 75-percent increase over the current environment, for both the uniform and hybrid deployments): This boost is expected because of the improved capacity that would allow the public safety system to more effectively reach the public in the case of large-scale incidents, e.g., using resources such as “reverse 9-1-1,” backup PSAPs, and call transfer between PSAPs, including across state lines

- **Security** (-2.1 value points, 75-percent decrease from the current environment for both the uniform and hybrid NG9-1-1 deployment): This decrease in value is due to the increased security requirements for the IP-based (next generation) systems. The current environment, which is mostly analog based, is not as vulnerable to high-level computer-based sabotage as an IP system, and data security process requirements are not as necessary as they would be in an next generation environment because of the limited amount of data being conveyed through the current system

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This analysis is intended to estimate a rough order of magnitude for a national deployment of NG9-1-1

- This analysis was conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool
- The cost data collected for this report were developed based on general population segments and may not be suitable for use in costing out individual county or state needs for NG9-1-1 investment purposes
- High-level assumptions regarding network and data center sizing are used in all NG9-1-1 scenarios and may not reflect individual needs
- This report does not make assumptions about funding availability or allocation of costs across entities, other than to note that this these issues may be a potential risk for all 9-1-1 deployment scenarios

Baseline segmentation is derived based on population served and the current operating environment at the county level

- Segments are created by grouping counties based on population and their current level of 9-1-1 service. These profiles provide a basis from which to estimate the costs, value, and risk of moving to the defined alternatives
- Segmentation also considers the seven states that have statewide systems and state administration components that are not included in the table below
  - State systems are assumed to be Wireless Phase I or II
- The population of the outlying segments in the blue cells below were accounted for in the cost build constructed for segment 8, "population more than 1,000,000". This was designed to limit the complexity of the builds needed, while still accounting for the full population of the U.S.

County Segmentation for Cost Profile Development*

	RCF	Basic	E-9-1-1	Wireless†	Total
Fewer than 50,000	98	114	304	1,684	*2,200*
50,001 to 250,000	0	2	62	588	*650*
250,001 to 1,000,000	0	0	4	175	*175*
More than 1,000,000	0	0	2	25	*25*
Total	**98**	**116**	**366**	**2,472**	**3,052‡**

**For this analysis, it is assumed that a county is equivalent to a 9-1-1 Authority*

†Includes Phase I and Phase II as well as counties that have started wireless deployments as of July 7, 2007

‡Does not include counties participating in statewide systems

Source: Wireless Deployment Profile maintained and updated by NENA. Additional information available on NENA's website at: http://www.nena.org/pages/Contentlist.asp?CTID=6 (last accessed March 4, 2009).

For each county and state segment, a profile is developed to define the current environment and operating costs

Baseline Segmentation Cost Profile Template*

Segment 1	System Costs	PSAP	Database (GIS)	Total
Hardv				
Softw				
O&M				
Netwo				
Secur				
Recur				
Facili				
Other				
Total				

Segment n	System Costs	PSAP	Database (GIS)	Total
Hardware				
Software				
O&M Personnel				
Network Operations				
Security				
Recurring Training				
Facilities				
Other Direct Costs				
Total Operating Costs				

Completed county segment and state profiles are included in Appendix B: Cost Analysis, slides 104-124

- **System Costs:** Voice/Data network, Selective Routing, ALI Database Equipment, ALI data links by PSAP, dynamic update downloads (by Mobile Positioning Center/VoIP Position Center [MPC/VPC] vendor and ALI server), central system database management system (DBMS), and security costs
- **PSAP Costs:** Hardware and Software used by the PSAP to receive and transfer incoming data. Includes CPE costs and interfaces but not public safety dispatch/responder systems or related expenses
- **Data Services (with GIS):** Data management equipment, local DBMS software, cost of GIS database, mapping system, base layer data, any provider costs for telephone number (TN) subscriber extraction records, security costs, and application software costs

Personnel:
In Scope: PSAP staff and management, System Administrators, System Operators, Data Base Administrator (DBA), 9-1-1 Authority
Out of Scope: Dispatchers/Responders

Baseline Low Scenario: The national 9-1-1 baseline is estimated to have an annual cost of $2.2 billion

9-1-1 Baseline Operating Environment Total Annual Cost Estimate
(Recurring + Capital Reinvestment Costs, $2007, Millions)

Segment/State	Individual Segment Cost (B/A)	Number of Segments (A)	Annual Recurring Costs (B)	Annual Capital Costs* (C)	Total Annual Cost (B + C)
1	$ 0.0	98	$ 0.2	$ 0.0	$ 0.2
2	$ 0.1	114	$ 16.4	$ 3.3	$ 19.7
3	$ 0.4	304	$ 107.0	$ 21.4	$ 128.4
4	$ 0.7	62	$ 42.4	$ 8.5	$ 50.9
5	$ 0.4	1684	$ 624.4	$ 124.9	$ 749.3
6	$ 0.7	588	$ 425.4	$ 85.1	$ 510.5
7	$ 1.7	175	$ 290.9	$ 58.2	$ 349.1
8	$ 4.4	25	$ 110.8	$ 22.2	$ 132.9
Sub Total	$ 8.4	3050	$ 1,617.4	$ 323.5	$ 1,940.9
State 1	$ 14.6	1	$ 14.6	$ 2.9	$ 17.6
State 2	$ 20.6	1	$ 20.6	$ 4.1	$ 24.7
State 3	$ 29.2	1	$ 29.2	$ 5.8	$ 35.1
State 4	$ 144.4	1	$ 144.4	$ 28.9	$ 173.3
State 5	$ 20.5	1	$ 20.5	$ 4.1	$ 24.6
State 6	$ 6.7	1	$ 6.7	$ 1.3	$ 8.1
State 7	$ 4.8	1	$ 4.8	$ 1.0	$ 5.7
State Program	$ 0.2	31	$ 6.2	$ 1.0	$ 7.2
				Grand Total:	$ 2,237.1

**Annual capital costs are estimated as a percentage of total annual costs in accordance with the cost build details presented in Appendix B, slides 104-124*
For the definition of nominal costs, see Appendix D: Glossary/Acronyms
Note: Capital Costs are calculated as an annual percentage of Recurring Costs because detailed capital good purchasing data are not available for all segments

Baseline Low and High Scenarios: The current 9-1-1 environment is estimated to cost between $11.18 and $15.86 per call

- Annual recurring costs were developed based on SME* input for each county and state profile and data queries
- Annualized capital costs were estimated by leveraging industry benchmarks and SME input
  - A benchmark of 20 percent of total cost was applied to estimate capital costs for each baseline segment†
- Approximately 200,000,000 calls are received by 9-1-1 PSAPs annually
  - Total annual operating costs of $2.2 billion yield an average cost per call of $11.18
  - Two (2004) industry studies estimated that the average cost per call is in the range of $15.86‡ to $36.85§ (values in 2007 dollars)
  - Leveraging the higher call center cost per call cited by industry experts as a conservative measure, a range is established to represent the current operating environment

9-1-1 Baseline Total Annual Costs (Recurring + Capital Reinvestment costs, $ Nominal)
Based on an estimated volume of 200 million annual calls

	Baseline Profile	Industry Estimates
Average Cost Per Call	**$11.18**	**$15.86**
Annual Estimate ($M)	**$2,237**	**$2,892**

** NENA, Kimball, and Booz Allen representatives*
† Source: Booz Allen Hamilton IC
‡ http://www.nena.org/media/File/NENASWATStaffingReport-5Jan04revpart3.pdf, (last accessed March 4, 2009) in 2004 dollars, inflated to 2007 dollars. Capital Costs are calculated as an annual percentage of Recurring Costs because detailed capital good purchasing data are not available for all segments. See Appendix B, slide 123 for details
§ National Benefit/Cost Analysis of Three Digit-Accessed Telephone Information and Referral Services, University of Texas, 2004, inflated to 2007 dollars

Baseline Low Scenario: The current 9-1-1 environment lifecycle costs are estimated at $55.7 billion in nominal dollar terms

9-1-1 Baseline, Low Cost Scenario, Point Estimate Costs ($ Million, Nominal)

Cost Elements	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014–2028*	Total
1.0 Program Planning and Research and Development	$-	$-	$-	$-	$-	$-	$-
2.0 Acquisition and Implementation	$373	$381	$390	$398	$407	$7,324	$9,273
3.0 Operations and Maintenance	$1,864	$1,907	$1,949	$1,993	$2,038	$36,648	$46,399
Total Lifecycle Cost (Nominal)	$2,237	$2,288	$2,339	$2,391	$2,445	$43,972	$55,672
Total Lifecycle Cost (Discounted)†	$2,237	$2,177	$2,117	$2,060	$2,004	$24,269	$34,863

**FY2014–2028 represents the sum of the 15-year period for presentation purposes*

† Base Year estimates are in 2007 Constant Dollars, Discount Rate: 5.10 percent, Inflation Rate: 2.24 percent (per Office of Management and Budget [OMB] Circular A-94, Appendix C)

Definition of Point Estimate Cost is given in slide 75

For definitions of Lifecycle, Nominal, and Discounted costs, please see Appendix D: Glossary/Acronyms.

For a complete breakdown of lifecycle costs, see Appendix B, slides 126-127

*Baseline High Scenario**: 9-1-1 lifecycle costs increase to $79 billion in nominal dollar terms

9-1-1 Baseline, High Cost Scenario, Point Estimate Costs ($ Million, Nominal)

Cost Elements	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014–2028†	Total
1.0 Program Planning and Research and Development	$-	$-	$-	$-	$-	$-	$-
2.0 Acquisition and Implementation	$529	$540	$553	$565	$578	$10,388	$13,152
3.0 Operations and Maintenance	$2,644	$2,704	$2,765	$2,827	$2,890	$51,983	$65,814
Total Lifecycle Cost (Nominal)	$3,173	$3,245	$3,318	$3,392	$3,468	$62,371	$78,966
Total Lifecycle Cost (Discounted)‡	$3,173	$3,087	$3,003	$2,922	$2,842	$34,423	$49,451

** The difference between "Baseline High" and "Baseline" Costs is outlined in slide 56. A premium based on the additional "per call" cost of the high-end estimate over that estimated in the "Baseline" scenario has been added to the costs of the "Baseline High" scenario*

† FY2014–2028 represents the sum of the 15-year period for presentation purposes

‡ Base Year estimates are in 2007 Constant Dollars, Discount Rate: 5.10 percent, Inflation Rate: 2.24 percent (per Office of Management and Budget [OMB] Circular A-94, Appendix C)

For definitions of Lifecycle, Nominal, and Discounted costs, please see Appendix D: Glossary/Acronyms.

Definition of Point Estimate Cost is given in slide 75

For a complete breakdown of lifecycle costs, see Appendix B, slides 128-129

Once the Baseline scenario costs were analyzed, costs for the two NG9-1-1 scenarios were developed*

- **NG9-1-1 Uniform and Hybrid Scenarios**
  - Assume deployment from a total cost basis for PSAP, Data Services, and Network implementation and operations costs
- In both NG9-1-1 scenarios, **PSAP labor and facilities costs** are held constant to the lower bound baseline. Labor costs alone represent approximately 70 percent of the baseline environment costs ($37 billion to $53 billion over the lifecycle). Facility costs make up $1.8 billion to $2.6 billion of the baseline environment costs
- **Additional assumptions for NG9-1-1 include—**
  - No data migration will occur from the legacy to the NG9-1-1 environment
  - Service providers will be responsible for the provision and maintenance of location information services
  - Call Recording and Automatic Call Distributor (ACD) functionality are assumed to be a network function for costing purposes in all cases except in the NG9-1-1 Hybrid scenario micro unit, where this function is assumed to be hosted at the PSAP level
  - All unit costs were sourced from either publicly available sources, such as GSA Advantage, or Booz Allen IC estimates

**The NG9-1-1 scenarios are fully defined in Slide 21*

For all NG9-1-1 scenarios, a consistent cost element structure provided the foundation for the development of lifecycle costs

High-Level Cost Element Structure

Cost Element	Specific Cost Type
1.0 Program Planning and Research and Development (R&D)	1.1 Program Planning and Personnel
	1.2 R&D
	1.3 R&D Network Operations
	1.4 Travel and Other Direct Costs
2.0 Acquisition and Implementation	2.1 Implementation Personnel
	2.2 Acquisition
	2.3 Initial Training
	2.4 Travel and Other Direct Costs
3.0 Operations and Maintenance	3.1 Hardware
	3.2 Software
	3.3 Operations and Maintenance Personnel
	3.4 Network Operations
	3.5 Security
	3.6 Recurring Training
	3.7 Facilities
	3.8 Travel and Other Direct Costs
	3.9 Other

The *NG9-1-1 Uniform Scenario* deployment alternative is based on a repeatable, scalable architecture deployed across the defined segments based on population served

- Estimates show that for each call-taker position, approximately $164,000 is required for planning, acquisition, and installation/implementation to upgrade to NG9-1-1
- Data Services and Network costs have been scaled to support 120 PSAPs*
  - Initial Data Services costs (hardware/software acquisition costs plus implementation labor costs) are estimated at $5.8 million, with acquisition estimated at approximately $2.8 million
  - Network initial costs are estimated to be approximately $6.4 million, with acquisition estimated at approximately $3.0 million

NG9-1-1 Uniform Deployment Investment Profile, Per Unit Cost (Point Estimate) ($2007)

	Average Cost Per Call Taker	Average Cost Per PSAP Unit	Average Cost Per Data Services (10 PSAP Units)	Average Cost Per Network (10 PSAP Units)
Total	**$164K**	**$4.8M**	**$5.8M**	**$7.8M**

**See slide 30-31 for supporting documentation on uniform unit sizing*

NG9-1-1 Uniform Scenario: National deployment total costs are estimated at $60 billion over the 20-year lifecycle in nominal dollar terms

NG9-1-1 Uniform*, Point Estimate Costs ($ Million, Nominal)

Cost Elements	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014–2028†	Total
1.0 Program Planning and Research and Development	$13	$16	$19	$21	$22	$84	$175
2.0 Acquisition and Implementation	$243	$298	$344	$381	$406	$7,042	$8,714
3.0 Operations and Maintenance	$1,982	$2,035	$2,121	$2,218	$2,306	$40,484	$51,147
Total Lifecycle Cost (Nominal)	$2,238	$2,349	$2,484	$2,621	$2,734	$47,610	$60,036
Total Lifecycle Cost (Discounted)‡	$2,238	$2,235	$2,249	$2,257	$2,241	$26,305	$37,525

**Costs based on deployment/rollout strategy, slides 35 and 36. Cost = unit cost (see slide 61 for details) x number of units deployed per year*

†FY2014–2028 represents the sum of the 15-year period for presentation purposes

‡Base Year estimates are in 2007 Constant Dollars, Discount Rate: 5.10 percent, Inflation Rate: 2.24 percent (per Office of Management and Budget [OMB] Circular A-94, Appendix C)

For definitions of Lifecycle, Nominal, and Discounted costs, please see Appendix D: Glossary/Acronyms

Definition of Point Estimate Cost is given in slide 75

For a complete breakdown of lifecycle costs, see Appendix B, slides 140-141

The *NG9-1-1 Hybrid Scenario* centers on three varying cost builds based on the size of the varying networks and data centers

- Preliminary estimates show that for each call-taker position, approximately $164,000 is required for planning, acquisition, and installation/implementation to upgrade to NG9-1-1
- For the "Base Unit," data services and network costs have been scaled to support 120 PSAPs*
  - Initial Data Services costs are estimated at $6.5 million, with acquisition estimated at approximately $3.2 million
  - Initial Network costs are estimated at between $7.8 million and $8 million, with acquisition estimated at approximately $3.8 million
- Base "Unit" size is equivalent to that for the NG9-1-1 Uniform scenario for both PSAP and Data/Network units

NG9-1-1 Hybrid Deployment Investment Profile, Point Estimate Costs ($2007)

	Population Served Per Unit	PSAP Total Cost Per Call Taker	Total Cost Per PSAP Unit	Data Services Cost Per Unit	Network Cost Per Unit
Micro Unit	**625K**	**$171K**	**$5.0M**	**N/A†**	
Base Unit	**6.25M**	**$164K**	**$4.8M**	**$5.8M**	**$7.8M**
Macro Data/Network Unit	**35.1M**	**$164K**	**$4.8M**	**$13.3M**	**$19.7M**

**See slides 30 & 32 for supporting documentation on unit sizing*

† Data and Network costs are outsourced, and, as such, are considered recurring costs bundled with labor (etc.) A detailed build of micro-unit data and network function costs is included in Appendix B, slides 134-138

NG9-1-1 Hybrid Scenario: National deployment total costs are estimated at $58.3 billion over the 20-year lifecycle in nominal dollar terms

NG9-1-1 Hybrid Deployment*, Point Estimate ($ Million, Nominal)

Cost Elements	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014–2028†	Total
1.0 Program Planning and Research and Development	$10	$13	$17	$19	$23	$85	$167
2.0 Acquisition and Implementation	$184	$246	$304	$346	$421	$7,552	$9,054
3.0 Operations and Maintenance	$1,974	$2,018	$2,069	$2,135	$2,199	$38,754	$49,149
Total Lifecycle Cost (Nominal)	$2,168	$2,278	$2,390	$2,499	$2,643	$46,391	$58,370
Total Lifecycle Cost (Discounted)‡	$2,168	$2,168	$2,164	$2,153	$2,166	$25,608	$36,427

**Costs based on deployment/rollout strategy, slides 36 and 38. Total cost = unit cost (see slide 61 for details) x number of units deployed per year*

†FY2014–2028 represents the sum of the 15-year period for presentation purposes

‡ Base Year estimates are in 2007 Constant Dollars, Discount Rate: 5.10 percent, Inflation Rate: 2.24 percent (per Office of Management and Budget [OMB] Circular A-94, Appendix C)

For definitions of Lifecycle, Nominal, and Discounted costs, please see Appendix D: Glossary/Acronyms

Definition of Point Estimate Cost is given in slide 75

For a complete breakdown of lifecycle costs, see Appendix B, slides 142 and 143

Estimated lifecycle costs for the NG9-1-1 scenarios fall close to the lower bound of the Baseline cost range

- The cost of current 9-1-1 environment (Baseline scenario) is estimated to range between **$55.7 billion and $79.0 billion** over a 20-year lifecycle
- The cost of the NG9-1-1 Uniform deployment scenario is estimated to be **$60.0 billion** over the 20-year lifecycle
- The cost of the NG9-1-1 Hybrid deployment scenario is estimated to be **$58.4 billion** over the 20-year lifecycle
- The range of outcomes indicates that changing over to an NG9-1-1 deployment scenario could result in lifecycle cost savings of $20.6 billion, in the best case, to a lifecycle cost increase of $4.3 billion, in the worst

Cost Analysis Point Estimate Results *($ Million, Nominal)*

	Baseline 9-1-1 (Low)	Baseline 9-1-1 (High)	NG9-1-1 Uniform	NG9-1-1 Hybrid
1.0 Planning	$-	$-	$175	$167
2.0 Acquisition and Implementation	$9,273	$13,152	$8,714	$9,054
3.0 Operations and Maintenance	$46,399	$65,814	$51,147	$49,149
Total Lifecycle Costs (Point Estimate)*	**$55,672**	**$78,966**	**$60,036**	**$58,370**

**For definition of "Nominal Value," see Appendix D, Glossary/Acronyms. Definition of Point Estimate Cost is given in slide 75*

Note: For this report, PSAPs are treated in a consistent manner between the Baseline and the NG9-1-1 scenarios. The cost estimates above reflect maintenance of the status quo in this regard. Baseline Labor use is assumed constant in the NG9-1-1 environment

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Eight key risk categories were identified that serve as a basis to develop the risk inventory for the 9-1-1 environment

- Risks may degrade performance, impede implementations, and/or increase costs. Risk that is not identified cannot be mitigated or managed, and may cause new (NG9-1-1) or existing (current 9-1-1) organizations to miss performance targets, or to fail either in the pursuit of funding or during implementation. The greater the attention paid to mitigating and managing risk, the greater the probability of success
- Based on working sessions with team SMEs*, eight key risk categories were developed to serve as the underpinnings to the risk structure
- The risk inventory was developed in conjunction with the eight defined risk categories. The risk categories and inventory were designed to capture the full spectrum of risks that may be realized in the 9-1-1 environment and industry in order to estimate the likelihood of occurrence and the impact of those identified risks on value and costs

	Risk Categories
1	Project Resources/Acquisition
2	Technology
3	Security and Privacy
4	Political/Strategic
5	Organizational and Change Management
6	Business/Industry
7	Funding
8	Public

Input acquired from subject matter experts

Note: Risk measured and stated in this document is specific to this document and will vary when applied to any specific 9-1-1 system

Program resources and acquisition, technology, and security and privacy risks are the first risks considered in the analysis

Risk Structure and Descriptions (1, 2, and 3)

	Risk Category	Risk Definition	Risk Description
1	Program Resources and Acquisition	Increasing costs or incomplete/untimely design and standards owing to monopolies in the supply chain	Key areas of the supply chain are dominated by firms with monopolistic characteristics, thus driving up project costs significantly
2	Technology	Inability of system to meet functional requirements	Mis-estimation of technology capabilities leads to failure to meet functional requirements
		Use of proprietary standards (open standards not developed)	9-1-1 authorities set up their own systems that may not interface correctly with other 9-1-1 systems
		Failure of vendors' systems to keep pace with required system goals, use of workarounds that prevent system development and evolution	Vendor design does not meet acceptable 9-1-1 service levels, either through differing goals or use of workarounds
3	Security and Privacy	Loss of public confidence over time because of Inadequate security levels due to bandwidth limits, internal controls, or degradation of security performance	People outside of the system gain access to confidential information or overload the system, or the system degrades over time, allowing unauthorized users access
		Loss of public confidence over time as result of unauthorized access to confidential information	Authorized personnel use confidential data inappropriately or unauthorized personnel gain access and use confidential data

Political and strategic and organizational and change management define the people-related risks associated with NG9-1-1

Risk Structure and Descriptions (4 and 5)

	Risk Category	Risk	Risk Description
4	**Political/Strategic**	Inadequate federal, state, and local legislative or regulatory support (does not include funding—see risk category 7)	Regulations and mandates are not sufficient to facilitate adoption across all jurisdictions
5	**Organizational and Change Management**	Minimal stakeholder adoption of new technologies and processes	Established processes and regulations will not be fully embraced or adopted by all local jurisdictions and employees
		Increased call processing time because of the volume and complexity of incoming data	Mismanagement of data leads to inability of call takers to identify the key issue, process the call, and initiate a timely response
		Loss of human capital	The efficiencies brought about by new processes, procedures, training requirements, systems, and configuration (governance, location, etc.) results in voluntary employee attrition, a reduction in force (RIF) of experienced employees (including those at the local, state, and federal levels), and/or complicates organized labor negotiations
		Unwillingness of jurisdictions to set aside traditional or historical parochial interests to collaborate with one another	Jurisdictional turf issues limit data sharing, interfaces, resource sharing, etc.

Because of the heavy reliance of 9-1-1 telecommunications infrastructure on the private sector, risk related to business and industry must be accounted for as well

Risk Structure and Descriptions (6)

	Risk Category	Risk	Risk Description
6	Business/Industry	Lack of vendor 9-1-1 expertise	Access to 9-1-1 is reduced commensurate with the consumer adoption of alternative communications media because of an incomplete understanding of the 9-1-1 market by new vendors
		Unwillingness or inability of current private sector service providers to keep up with changing service level requirements	Access to 9-1-1 is reduced commensurate with the consumer adoption of alternative communications media because of slow adaptation by private sector

Funding and public risks are the final two that must be considered to fully capture 9-1-1 specific risks

Risk Structure and Descriptions (7 and 8)

	Risk Category	Risk	Risk Description
7	Funding	Unwillingness to share costs (e.g., backbone, interfaces) with other jurisdictions	Risk includes funding conflicts between service providers and 9-1-1 authorities, counties and other counties, states and other states, private sector and public sector, and 9-1-1 and the other public safety organizations
		Inability of funding models to meet project needs because of surcharge assessment and remittance inadequacies	Funding does not keep pace with technology upgrade or operations costs because of decline or obsolescence of funding sources, while emerging service providers do not contribute significantly to alleviating the funding burden, leading to lack of buy-in by all necessary parties and resulting funding shortages
		Inequity in service resulting from urban-rural funding disparities	Surcharge, tariff, or other revenues may differ from one area to another, leading to zones of funding shortfalls and inadequacy of service
8	Public	Lack of public knowledge and awareness of 9-1-1 system capabilities and functionality	Outreach efforts do not adequately inform the general public on how to use the full range of 9-1-1 services

Risk probability and impact are measured based on a qualitative scale of High, Medium, and Low

- The probability and impact of identified risks were determined on a qualitative scale with SME* input and mapped to the identified values and costs for both the current 9-1-1 and NG9-1-1 environments
  - Once the risk structure was defined, the next step was to assess the probability that the risks would materialize during the lifecycle for the current and NG9-1-1 environments.
  - Each risk was given a value of High, Medium, Low, or None based on the Risk Probability Scale to the right
- Once probability was assessed, then impact was evaluated for both value and cost
  - Impact is determined to be High, Medium, Low or None using the Value and Cost scales to the right
  - Impact is applied to a value or cost independently (i.e., not every value or cost was affected by every risk factor, or each may be affected to varying degrees by a given risk)
- Finally, impact is multiplied by probability for each cost and value and applied to the appropriate factors

Risk Probability Scale

Scale	Probability
High	50%
Medium	30%
Low	10%
None	0%

Cost Impact Scale

Scale	Cost Impact
High	10%
Medium	5%
Low	2%
None	0%

Value Impact Scale

Scale	Value Impact
High	-10%
Medium	-5%
Low	-2%
None	0%

**SME input provided by project team*

Note: A detailed assessment of risk probability and impact for the defined scenario alternatives is provided in Appendix C, slides 146-158

The final phase of the risk analysis involves incorporating uncertainty analysis

- Uncertainty analysis assumptions are based on Association for the Advancement of Cost Engineering (AACE) International Cost Estimating Guidance*
- Order of magnitude estimates are calculated where project phase is defined as the *Concept Screening* phase
  - Low end range of -15 percent to -30 percent
  - High end range of +2 percent to +50 percent
- For the NG9-1-1 uncertainty analysis, a **-25 percent to +50 percent** range was applied to the following factors:
  - Personnel Salaries (Current and NG9-1-1 environments)
  - NG9-1-1 Hardware
  - NG9-1-1 Software
  - Labor Costs for Installation and Operations and Maintenance
- Five hundred trials/iterations were run to arrive at the defined resultant ranges

Illustrative

Uncertainty Range Example:	*Low Cost Bound: $650,000 x -25% + $650,000 = $487,500*
IP ACD Cost:	*High Cost Bound: $650,000 x 50% + $650,000 = $975,000*
Original Cost Estimate: $650,000	*Each trial randomly generates a cost within this range.*
Uncertainty Range: -25% to +50%	*The "most likely" estimates cited in this report are costs generated from the average of 500 independent random trials*

**AACE standardized guidance for uncertainty analysis ranges*

Risk Adjustment is defined as applying risk factors to cost and value elements

- The calculations used to adjust lifecycle costs (after uncertainty analysis) and value scores for risk are presented below:

Risk Calculation Approach

Risk Adjustment Type	Calculation
Risk Impact on Total Value (Benefits) for a Given Alternative	The risk-adjusted benefit score is the sum of the following calculation for all benefits across all risks: ***Benefit^n Score – (Benefit^n Score x Risk^n Probability x Risk^n Impact)***
Risk Impact on Total Lifecycle Cost for a Given Alternative	The risk-adjusted cost is the sum of the following calculations for all three top-level Cost Element Structure (CES) categories across all applicable risks: ***Cost Element^n + (Cost Element^n x Risk^n Probability x Risk^n Impact)***

Adjusting for risk and uncertainty in the cost analysis presents a range of potential cost outcomes

Lifecycle Cost Analysis Outcomes Definitions

Cost Output Type	Definition
Low-End Lifecycle Cost	The lowest total cost calculated after cost uncertainty is factored in. By definition, cannot include risk adjustment (since risk adjustment inflates costs)
Point Estimate Cost	Lifecycle cost estimate resulting from detailed cost estimates, before cost uncertainty or risk adjustment is factored in
Risk-Adjusted Expected Lifecycle Cost	Expected Mid-Point Lifecycle Cost, including uncertainty factors and using the average cost increase magnitude from risk over 500 simulations
Risk-Adjusted High-End Lifecycle Cost	By definition, the combination of the highest costs generated from the uncertainty analysis, with the highest risk adjustment magnitude possible. This represents the highest possible cost figure generated over the course of 500 simulations

Results of the uncertainty analysis and risk adjustment yield a varying increase in lifecycle costs and decrease in value for all scenarios

Risk-Adjusted Value Scores *

	9-1-1 Baseline (Low and High)	NG9-1-1 Uniform	NG9-1-1 Hybrid
Estimated Value Score	50.0	90.2	86.6
Total Risk Adjusted Value Score	**38.4**	**59.6**	**57.2**

Risk-Adjusted Lifecycle Cost Summary
($ Billion, Nominal)

Lifecycle Estimate†	Basis	9-1-1 Baseline (Low)	9-1-1 Baseline (High)	NG9-1-1 Uniform	NG9-1-1 Hybrid
Low-End Lifecycle Cost	*Uncertainty Analysis*	$53.0	$74.7	$58.9	$57.2
Lifecycle Cost (Point)	*Point Estimate*	$55.7	$79.0	$60.0	$58.4
Risk Adjusted Expected Lifecycle Cost (Mid-point)	*Uncertainty and Risk Adjusted*	**$66.1**	**$94.2**	**$86.3**	**$82.0**
Risk Adjusted High-End Lifecycle Cost	*Uncertainty and Risk Adjusted*	$73.7	$104.5	$96.1	$92.5

**For an definition and overview of "value score" calculation, please see slides 46-49*

†Low-End estimates reflect cost uncertainty but not risk adjustment impacts. Risk-adjusted costs (Expected and High-End) reflect both cost uncertainty and risk impacts

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A summary of risk adjusted lifecycle cost and values indicates that the NG9-1-1 Uniform and Hybrid scenarios represents the highest ratio of risk-adjusted value to cost

Lifecycle Cost and Value Summary ($ Billion, Nominal)

Analysis Summary	Baseline 9-1-1 (Low)	Baseline 9-1-1 (High)	NG9-1-1 Uniform	NG9-1-1 Hybrid
Lifecycle Cost Summary (Risk Adjusted Expected $ Billion, Nominal)				
Total Lifecycle Costs	**$66.1**	**$94.2**	**$86.3**	**$82.0**
Lifecycle Cost Breakdown (Risk Adjusted Expected $ Billion, Nominal)				
1.0 Planning	$-	$-	$0.238	$0.230
2.0 Acquisition and Implementation	$10.3	$14.7	$11.8	$11.9
3.0 O&M	$55.8	$79.5	$74.3	$69.9
Value Summary				
Value Risk Scores	50.0		90.2	86.6
Risk Adjusted Value Scores	**38.4**		**59.6**	**57.2**

This analysis does not account for many of the opportunities for cost savings, including labor and PSAP optimization

- Labor in the current 9-1-1 environment accounts for approximately 70 percent of the total costs and was held constant in the NG-9-1-1 scenarios
- Through PSAP optimization and the creation of "virtual" PSAP locations, the overall number of call takers required and facilities maintained may be reduced. In addition, the consolidation of data centers into larger, more centralized units may generate economies of scale, with associated monetary savings
- Considering only labor, a recent study, *IP Telephony and the Contact Center**, found that by upgrading systems and reducing facilities in operation, additional savings could be achieved on the scale of—
  - Total staffing—3 percent to 8 percent
  - Staff efficiencies—3 percent to 9 percent

  If these staffing changes (first reduction, then efficiency) were to occur, potential savings could range up to $378 million per year based on current 9-1-1 environment labor estimates

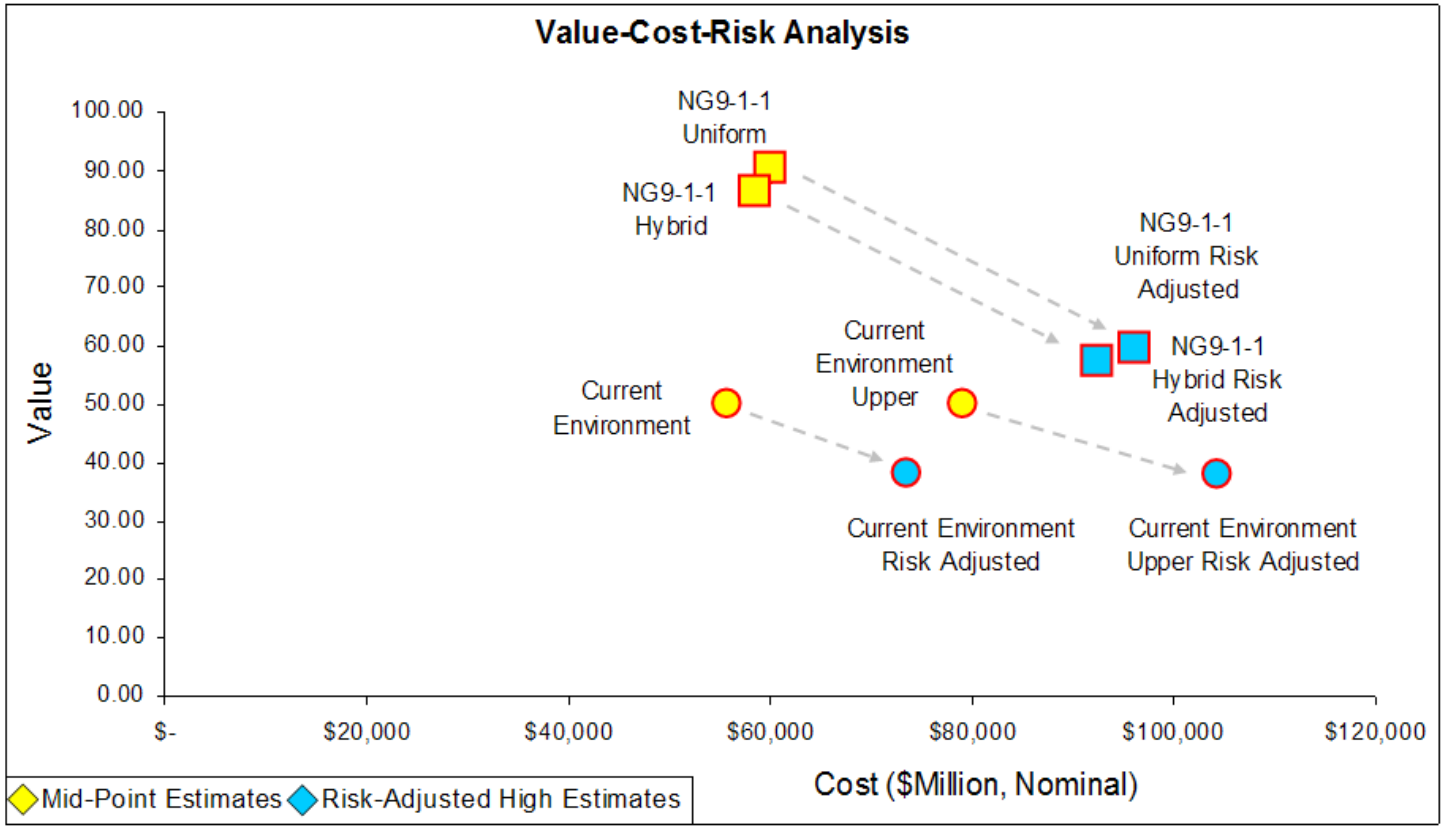
**White Paper: Dave Bengston, Global Strategic Solutions Team, Avaya, Inc., September 2004, Issue 2 available at: http://assets.devx.com/avaya/14662.pdf (last accessed March 4, 2009)*

A discussion of additional "indirect" benefits is provided in the appendix

While this analysis focuses on total lifecycle costs, it is likely that the cost of various components will be shared at various levels

- It is expected that the total lifecycle costs will be shared not only with other non-9-1-1 services, but also with non-public safety applications. It is the nature of IP networking that those functions that make such networking possible can be grouped or "layered" by purpose, some of which is generic to those applications resident on the network involved
- A high level cost share analysis was considered. Key assumptions include:
  - Assume that the broader responder and public safety community (e.g., police, fire, emergency medical services, dispatch) will contribute to the development of the network
  - Cost sharing is estimated at 50 percent of network acquisition, implementation, and recurring costs over the lifecycle, and 20 percent of Data Services acquisition, implementation, and recurring costs over the lifecycle
- Preliminary cost sharing analysis indicated that for 9-1-1 authorities, overall cost savings were in the range of 3.9 percent to 6.6 percent when data and network hardware, software, and labor were shared with stakeholders operating on different budgets
  - Cost sharing could reduce the total lifecycle costs to the 9-1-1 authorities by $5.2 billion to $5.7 billion for the Uniform deployment scenario and between $3.2 billion and $4.1 billion for the Hybrid deployment scenario
  - While data and network components contribute to total cost, the majority of costs are incurred by the 9-1-1 authority are at the PSAP level
  - This analysis did not consider any additional costs or risks that may result from establishing and supervising more complicated cost sharing systems

Plotting value, cost, and risk together can help identify key relationships across the NG9-1-1 scenario alternatives



- NG9-1-1, regardless of deployment strategy, offers significantly higher value for comparative costs in the point estimates
- **NG9-1-1 continues to deliver significantly greater value when risk adjusted in comparison with the current environment. However, if risks are fully realized, lifecycle costs increase significantly, and the full range of NG9-1-1 lifecycle costs surpasses costs of the current environment**

Conclusion: The greater value of NG9-1-1 in contrast to the current environment outweighs the risks

- After adjusting for the risks inherent in the upgrade to an NG9-1-1 scenario, both the Uniform or Hybrid deployment scenarios have total lifecycle costs that are within the range of the current 9-1-1 environment's lifecycle costs
  - Choosing between the NG9-1-1 and the current environment scenarios becomes primarily a function of the value provided by each
- NG9-1-1 has the potential to provide significantly greater value than current 9-1-1 technology during the next 20 years. This conclusion is based on several trends identified over the course of the value analysis:
  - NG9-1-1 provides greater opportunities for cost savings, cost avoidance, and increased operational efficiencies than the current 9-1-1 environment
  - NG9-1-1 has greater potential to meet the public's expectations for accessibility than the current 9-1-1 environment
  - NG9-1-1 has greater scalability and flexibility than the current 9-1-1 environment
  - NG9-1-1 has greater potential to increase public and responder safety through interconnectivity and interoperability than the current 9-1-1 environment

Appendices

Direct User value outlines the value of improving the network for any and all people and organizations that use 9-1-1 systems and processes

Value Structure: Direct User Value Measures and Metrics (1 of 2)

Value Measure	Measure Definition	Performance Metric
Direct User	**Direct Users include callers, special needs communities, public service answering point (PSAP)/9-1-1 Authority Management, PSAP call takers, public safety dispatchers, and first and support responders**	
Accessibility	9-1-1 system is equally accessible to all members of the general public. The system is also equally accessible to all PSAP call takers	Overall percentage of the population with 9-1-1 service
		Number of types of communications devices or services that enable the general public to make a 9-1-1 call (including event devices)
		Number of PSAPs where call takers can transfer and receive 9-1-1 calls to or from beyond their local system to facilitate correct 9-1-1 call delivery and dispatch
Call-Taker Timeliness	9-1-1 calls are received and processed by PSAP call takers and handed off to emergency responders in a timely manner	Call set-up times (from gateway to Next Generation 9-1-1 (NG9-1-1) network to PSAP) for call delivery and associated data
		Time to process data at PSAP (Action Control Number [ACN], queuing)
		Call-taker processing (receive, process, and release call to dispatch)

Direct user value outlines the value of improving the network for any and all people and organizations that use 9-1-1 systems and processes (cont'd)

Value Structure: Direct User Value Measures and Metrics (2 of 2)

Value Measure	Measure Definition	Performance Metric
Direct User	**Direct Users include callers, special needs communities, PSAP/9-1-1 Authority Management, PSAP call takers, public safety dispatchers, and first and support responders**	
Reliability of Service	9-1-1 system has no single point of failure and has established redundancy to minimize service disruptions and limit susceptibility to failure and/or natural disaster	Percentage of calls identified by system, but not processed
		Capability of system to route calls appropriately (regardless of path) in times of PSAP evacuation and overload
Ease of Use	Information can be effectively obtained, organized, and delivered in a format to the PSAP that supports proper and effective call processing	Calls are documented and received in a straightforward and comprehensible manner
		Percentage of calls received/distributed with data/information in a standard data format
		Number of discrepancies documented and reported by call takers

Operational/foundational value includes benefits and efficiencies associated with improving federal, state, and local government 9-1-1 operations

Value Structure: Operational/Foundational Value Measures and Metrics (1 of 2)

Value Measure	Measure Definition	Performance Metric
Operational/ Foundational	**Includes federal, state, and local jurisdiction 9-1-1 end-to-end operations**	
Scalability and Adaptability of System Functionality and Usage	Ability to expand system functionality to accommodate new types of users, complementary functionality, and volume of usage without affecting system performance	Level of hardware and software scalability and adaptability to accommodate increased carrying capacity and address future capacity requirements
Information Accuracy	Information, services, and systems validate, process, and use the incoming data (e.g., location, call type, service provider identification, etc.)	Ability to validate accuracy of location data received
		Percentage of calls misrouted
		Frequency of PSAP failures
Data Management and Sharing	Data archiving and management services/systems can monitor, restore, assign access or distribution privileges, and perform database recovery for all 9-1-1 databases. Also can share archived data	Number of PSAPs and jurisdictions that can access and share multiple forms of data

Operational/foundational value includes benefits and efficiencies associated with improving federal, state, and local government 9-1-1 operations (cont'd)

Value Structure: Operational/Foundational Value Measures and Metrics (2 of 2)

Value Measure	Measure Definition	Performance Metric
Operational/ Foundational	**Includes federal, state, and local jurisdiction 9-1-1 end-to-end operations**	
Operational Efficiency	Services/Resources/Equipment that are part of the 9-1-1 system are maintained and operated in a streamlined and unified manner. Staff resources across the 9-1-1 system are appropriately trained, hours appropriately distributed, and resources are located optimally	Workforce is optimized across the system to ensure that 100 percent of 9-1-1 calls are answered
		System resources are sufficient to receive and forward supplemental data from third-party service providers
Security and Privacy	Security adequately sets up, manages, authenticates, and maintains a secure environment; provides adequate data and service protection to mitigate unauthorized access, service exploitation, and leakage of confidential or sensitive information; and provides audit capabilities for activity traceability and accountability across all 9-1-1 systems	End-to-end security processes and systems between the 9-1-1 Authorities are in place

Strategic/political value includes the benefits of achieving government (federal, state, or local) strategic goals and their perception by the public

Value Structure: Strategic/Political Value Measures and Metrics (1 of 2)

Value Measure	Measure Definition	Performance Metric
Strategic/Political: Contributions to achieving both public (federal, state, and local governments) and private sector strategic goals and priorities		
Alignment of Strategic Goals	Strategic goals for 9-1-1 are aligned across federal and state entities	Level of shared vision in the implementation of strategic plans moving forward
Technology Standards, Laws, and Regulations	Technology standards, laws, and regulations facilitate a standardized 9-1-1 system and service operations across federal, state, and local authorities	Number of systems that are based on open and defined standards
		Number of states planning or implementing revised 9-1-1 laws, policies, and regulations that support or promote interconnected institutional arrangements and architecture

Strategic/political value includes the benefits of achieving government (federal, state, or local) strategic goals and their perception by the public (cont'd)

Value Structure: Strategic/Political Value Measures and Metrics (2 of 2)

Value Measure	Measure Definition	Performance Metric
Strategic/Political: Contributions to achieving both public (federal, state, and local governments) and private sector strategic goals and priorities		
Coordination Between PSAPs at Local, State, and International Levels, as Well as With Other Public Services	System enables strategic partnerships, cooperation, and goodwill between PSAPs across local, state, and federal borders. Governance structure of 9-1-1 system is facilitated by coordination of PSAPs. System enables interoperability and sharing of information and databases and infrastructure, as well as the level of institutional relationships established with public service entities such as N-1-1 call centers, poison control centers, traffic management centers, and emergency operations centers	Number of PSAPs able to send and receive 9-1-1 calls, share data, and provide services to another state, county, or country
		Number of public service agencies with which the system interacts
Value to Industry	Level of strategic partnerships, cooperation, and goodwill between the system operators and the private sector	Number of contracts for data and resources between states/counties and private companies

Social value captures the greater benefit of 9-1-1 by defining value in terms of the impact of the initiative on indirect stakeholders

Value Structure: Social Value Measures and Metrics

Value Measure	Measure Definition	Performance Metric
Social: Benefits related to non-direct users (i.e., those not immediately involved in specific 9-1-1 incident), communities of stakeholders, the larger economy and society as a whole		
Public Safety	The system provides for the general safety of the public (e.g., reduced congestion, increased communications in the case of public emergencies, etc.)	Percentage of affected public that can be reached in case of large-scale public emergency
Energy and Environment	Incident management response effectiveness directly affects energy use/the environment	Level of traffic congestion resulting from incident management response
Safety to Responders	The team responding to automated emergency calls has all of the information necessary to address the situation appropriately	Automated 9-1-1 calls, such as Hazmat, provide a clear indication of incident cause/full information on nature of incident

Stakeholders provided input in a structured format during facilitated sessions to determine the relative merits of each value in comparison to others

Value Structure Input Form

NG9-1-1 VALUE ANALYSIS		Weights	
Value Factor / Measure	Value Measure Description	Factor Weight	Measure weight
Direct User			
Accessibility	9-1-1 System is equally accessible to all members of the general public. The system is also equally accessible to all PSAP call takers		
Call-Taker Timeliness	9-1-1 calls are received and processed by PSAP call takers and handed off to emergency responders in a timely manner		
Reliability of Service	9-1-1 System has no single point of failure and has established redundancy to minimize service disruptions and limit susceptibility to failure and / or natural disaster		
Ease of Use	Information can be effectively obtained, organized, and delivered in a format to the PSAP that supports proper and effective call processing		
Operational/Foundational			
Scalability and Adaptability of System Functionality and Usage	Ability to expand system functionality to accommodate new types of users, complementary functionality, and volume of usage without affecting system performance		
Information Accuracy	Information / services / systems validate, process and utilize the incoming data (e.g. location, call type, service provider identification, etc.)		
Data Management and Sharing	Data archiving and management services / systems can monitor, restore, assign access or distribution privileges, and perform database recovery for all 9-1-1 databases. Also can share archived data		
Operational Efficiency	Services / Resources / Equipment that are part of the 9-1-1 System are maintained and operated in a streamlined and unified manner. Staff resources across the 9-1-1 system are appropriately trained, hours appropriately distributed, and located optimally		
Security and Privacy	Security adequately sets up, manages, authenticates, and maintains a secure environment; provides adequate data and service protection to mitigate unauthorized access, service exploitation, and leakage of confidential or sensitive information; and provides audit capabilities for activity traceability and accountability across all 9-1-1 systems		
Strategic/Political			
Alignment of Strategic Goals	Strategic goals for 9-1-1 are aligned across Federal and State entities		
Technology Standards, Laws and Regulations	Technology standards, laws & regulations facilitate a standardized 9-1-1 system and service operations across Federal, State and Local authorities		
Coordination Between PSAPs at Local, State and International Levels As Well As With Other Public Services	System enables strategic partnerships, cooperation, and goodwill between PSAPs across local, state and federal borders. Governance structure of 9-1-1 system is facilitated by coordination of PSAPs. System enables Interoperability and sharing of information and databases and infrastructure as well as the level of institutional relationships established with Public Service entities such as N-1-1 Call Centers, Poison Control Centers, Traffic Management Centers, and Emergency Operations Centers		
Strategic Use of Resources and Data	Ability to leverage existing and new/emerging emergency information, data, and resources across PSAPs and related communications centers outside of PSAPs (i.e. for disaster planning purposes (etc.)		
Value to Industry	Level of strategic partnerships, cooperation and goodwill between the system operators and the private sector		
Social			
Public Safety	The system provides for the general safety of the public (e.g. reduced congestion, increased communications in the case of public emergencies, etc.)		
Safety to Responder	The team responding to automated emergency calls has all of the information necessary to address the situation appropriately		
Energy and Environment	Incident management response effectiveness directly impacts energy use/the environment		

Stakeholders weighed the relative merits of each value factor and measure on a 1–100 percent scale using this form during facilitated sessions. These weights were then averaged across all participating stakeholders to form the basis of the weighted values provided in the “Values Analysis” section of this report

Results were aggregated and used as a proxy for the Analytical Hierarchy Process (AHP)

Overall, 30 stakeholders provided input

Illustrative

NG[illegible]E ANALYSIS		Survey 1		Survey 2	
[illegible] Factor / Measure	Value Measure Description	Factor Weight	Measure weight	Factor Weight	Measure weight
[illegible]rect User		25%		35%	
Accessibility	9-1-1 System is equally accessible to all members of the general public. The system is also equally accessible to all PSAP call takers		35%		20%
Call-Taker Timeliness	9-1-1 calls are received and processed by PSAP call takers and handed off to emergency responders in a timely manner		20%		40%
Reliability of Service	9-1-1 System has no single point of failure and has established redundancy to minimize service disruptions and limit susceptibility to failure and / or natural disaster		20%		15%
Ease of Use	Information can be effectively obtained, organized, and delivered in a format to the PSAP that supports proper and effective call processing		25%		25%

- The above example of the “Direct User” section illustrates how the stakeholders provided input to the task primarily during facilitated sessions
  - The average of the Value Factor weights given, in this case 30 percent, would be the weight applied to the scores allocated to the factor category by the NG9-1-1 project team
  - The average of the individual Value Measure weights given would the values used to calculate the individual weight that should be applied to each value measure
- This aggregation of stakeholder input gathered during facilitated sessions was used as a proxy for AHP, since it was deemed prohibitively difficult to gather all of the stakeholders to one meeting to employ Expert Choice

Direct user value measures were then scored on a 1–5 scale for each metric based on a combination of 9-1-1 data and subject matter expert (SME) input

Direct User Value Measures Performance Estimating (1 of 2)

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Accessibility			
Overall percentage of population with 9-1-1 service	3	5	4.5
Number of types of communications devices or services that enable the general public to make a 9-1-1 call (including event devices)	3	5	5
Number of PSAPs where call takers can transfer and receive 9-1-1 calls to or from beyond their local system to facilitate correct 9-1-1 call delivery and dispatch.	3	5	4.5
Call Taker Timeliness			
Call set-up times (from gateway to NG9-1-1 network to PSAP) for call delivery and associated data	3	5	5
Time to process data at PSAP (ACN, queuing)	3	5	5
Call taker processing (receive, process, and release call to dispatch)	3	4	4.5

Direct user value measures were then scored on a 1–5 scale for each metric based on a combination of 9-1-1 data and SME input (cont'd)

Direct User Value Measures Performance Estimating (2 of 2)

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Reliability of Service			
Percentage of calls identified by system, but not processed	3	5	4.5
Capability of system to route calls appropriately (regardless of path) in times of PSAP evacuation and overload	3	5	4.5
Ease of Use			
Calls are documented and received in a straightforward and comprehensible manner	3	5	5
Percentage of calls received/distributed with data/information in a standard data format	3	5	5
Number of discrepancies documented and reported by call takers	3	5	5

Operational and foundational value measures were also scored on a 1–5 scale based on a combination of 9-1-1 data and SME input

Operational and Foundational Value Measures Performance Estimating (1 of 2)

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Scalability and Adaptability of System Functionality and Usage			
Level of hardware and software scalability and adaptability to accommodate increased carrying capacity and address future capacity requirements	3	5	5
Information Accuracy			
Ability to validate accuracy of location data received	3	3	3
Percentage of calls misrouted	3	4	4
Data Management and Sharing			
Number of PSAPs that can receive multiple forms of data from other PSAPs and interface with internal and external databases	3	5	4.5

Operational and foundational value measures were also scored on a 1–5 scale based on a combination of 9-1-1 data and SME input (cont'd)

Operational and Foundational Value Measures Performance Estimating (2 of 2)

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Operational Efficiency			
Workforce is optimized across the system to ensure that 100 percent of 9-1-1 calls are answered	3	5	4.5
System resources are sufficient to receive and forward supplemental data from third-party service providers	3	5	5
Security and Privacy			
Impermeability of system to unlawful access	3	1	1
End-to-end security processes and systems between the 9-1-1 Authorities are in place	3	2	2

Strategic and political benefits were then scored on a 1–5 scale based on a combination of 9-1-1 data and SME input

Strategic and Political Value Measures Performance Estimating (1 of 2)

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Alignment of Strategic Goals			
Level of shared vision in the implementation of strategic plans moving forward	3	4	4
Technology Standards, Laws, and Regulations			
Number of systems that are based on open and defined standards	3	5	4.5
Number of states planning or implementing revised 9-1-1 laws, policies, and regulations that support or promote interconnected institutional arrangements and architecture	3	5	5
Coordination Between PSAPs at Local, State, and International Levels as Well as With Other Public Services			
Number of PSAPs able to send and receive 9-1-1 calls, share data, and provide services to another state, county, or country	3	5	4.5
Number of public service agencies with which system interacts	3	5	5

Strategic and political benefits were then scored on a 1–5 scale based on a combination of 9-1-1 data and SME input (cont'd)

Strategic and Political Value Measures Performance Estimating (2 of 2)

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Strategic Use of Resources and Data			
Number of agreements for data and resource sharing between states/counties and federal/not-for-profit agencies	3	5	4.5
Amount of new useful public-safety-related data created through sharing of resources	3	5	4.5
Value to Industry			
Number of contracts for data and resources between states/ counties and private companies	3	5	5

Finally, social value measures were assessed on the 1–5 scale across the alternative scenarios

Social Value Measures Performance Estimating

Value Measure/Metric	9-1-1 Baseline (Current Environment) Expected	NG9-1-1 Uniform Expected	NG9-1-1 Hybrid Expected
Public Safety			
Percentage of the affected public that can be reached in case of large-scale public emergency	3	4.5	4.5
Safety to Responder			
Automated 9-1-1 calls, such as Hazmat, provide a clear indication of incident cause / full information on nature of incident	3	5	5
Energy and Environment			
Level of traffic congestion resulting from incident management response	3	5	5

A normalized scale is used to convert individual metric performance rankings to raw value scores

Normalized Score Conversion Table				
1	2	3	4	5
0	**25**	**50**	**75**	**100**

Once the rankings given to each metric are converted to their equivalent normalized value, they can be weight adjusted and summed to give an overall value for each measure and ultimately each scenario

To calculate the overall value score, the weights for both factors and measures and the scores allocated to each alternative must be considered

Factor Weight X ***Measure Weight*** = ***Overall Measure Weight (as % of Total Value)***

Overall Measure Weight (as % of Total Value) / ***Number of Metrics in Value Measure Category*** X ***Value of Metric Score on Normalized 0–100 Scale (1 = 0, 5 = 100)*** = ***Metric Score***

Sum of all Metric Scores = ***Overall Value Score for Given Scenario***

Example: Information Accuracy, NG9-1-1 Uniform

Factor Weight: 28.9% , Measure Weight: 23.7%, Number of Metrics: 2, Metric Scores: 3, 4

Normalized Metric Scores = 50, 75

28.9% x 23.7% = 6.8% of overall value

6.8% / 2 Metrics = 3.4% of overall value per metric

3.4% x 50 = 1.70 , 3.4% x 75 = 2.55

1.70 + 2.55 = ***4.25 = Value Score for Information Accuracy***

Appendices

Several key cost assumptions were defined as a basis for Baseline, Uniform and Hybrid lifecycle cost estimates

Global Assumptions

Assumption	Basis	Source
Inflation	2.24%	The inflation and discount rates used are defined in Appendix C of the OMB Circular A-94 (Revised January 2007), *Discount Rates For Cost-Effectiveness, Lease Purchase, And Related Analyses*. For clarification of discounting procedures, please see OMB A-94 at: http://www.whitehouse.gov/omb/assets/omb/circulars/a094/a094.pdf *(last accessed March 4, 2009).*
Discount Rate	5.1%	
Project Start Year	2009	For the purpose of this analysis, day one is defined as January 1, 2009
Base Year	2007	Constant year costs are estimated in 2007 dollars
Lifecycle	20 years	10 years after full operational capability (FOC)
Hardware Maintenance	15%	Booz Allen Estimate
Software Maintenance	20%	Booz Allen Estimate
Hardware Refresh	4 years	Hardware is assumed to be refreshed every four years over the lifecycle
Rounding	+/-2%	Because of rounding included in the cost tables, some cost figures could differ slightly (+/- 2 percent)
Funding	In place	It was assumed that an authorized funding activity would be identified before Day One of planning (CES 1.0)

Baseline segmentation was derived based on population served and the current operating environment at the county level

- Segments are created by grouping counties based on population and their current level of 9-1-1 service. These profiles provide a basis from which to estimate the costs, value, and risk of moving to the defined alternatives
- Segmentation also considers the seven states that have statewide systems and state administration components that are not included in the table below
  - State systems are assumed to be Wireless Phase I or II

County Segmentation for Cost Profile Development*

	RCF	Basic	E-9-1-1	Wireless†	Total
Fewer than 50,000	98	114	304	1,684	*2,200*
50,001 to 250,000	0	2	62	588	*650*
250,001 to 1,000,000	0	0	4	175	*175*
More than 1,000,000	0	0	2	25	*25*
Total	**98**	**116**	**366**	**2,472**	**3,052‡**

** For this analysis, it is assumed that a county is equivalent to a 9-1-1 Authority*
† Includes Phase I and Phase II, as well as counties that have started wireless deployments as of July 7, 2007
‡ Does not include counties participating in statewide systems

Source: Wireless Deployment Profile maintained and updated by the National Emergency Number Association (NENA). Additional information available on NENA's website at: www.nena.org/pages/Contentlist.asp?CTID=6 (last March 4, 2009)

Segment 1 Assumptions and Costs: Remote Call Forwarding (RCF) (no local 9-1-1 service), Population Served of fewer than 50,000

Baseline Segment 1: RCF Serving Population <50,000

Cost Assumptions	
Labor	
Calls per day	2
Duration of calls (in minutes)	10
Total time on phone in one year (hours)	120
Cost per hour of calls	$10
Cost of telephone line per month	$12.50
Cost of staff training per year	$500
Cost of labor per hour	$10

3.0 Annual O&M Cost	PSAP	Total
3.1 Hardware	-	-
3.2 Software	-	-
3.3 O&M Personnel	$1,200	$1,200
3.4 Network Operations	$150	$150
3.5 Security	-	-
3.6 Recurring Training	$500	$500
3.7 Facilities	-	-
3.8 Travel and Other Direct Costs	-	-
Total Annual O&M Costs	**$1,850**	**$1,850**

Segment 2 Assumptions: Basic 9-1-1 Service (no wireless), Population Served of fewer than 50,000

Baseline Segment 2: Basic Serving Population <50,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Network**	
Customer premises equipment (CPE) costs (includes both hardware and software) per month	$250	Full-time equivalents (FTE) (9-1-1 coordinators)	1	Number of trunks needed	2
Facility costs per square foot	$15	Annual salary of 9-1-1 coordinator	$50,000	Cost of trunks per month	$60
Facility size	600 sq. ft	Facility size for coordination office	100 sq. ft		
		Number of telecommunicators	5		
		Annual salary of telecommunicators	$30,000		
		Average time per day devoted by each telecommunicator to 9-1-1 only	50%		
		Annual training costs	$250		

Segment 2 Costs: Basic 9-1-1 Service (no wireless), Population Served of fewer than 50,000

Baseline Segment 2: Basic Serving Population <50,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$3,000	-	-	$3,000
3.2 Software	$0	-	-	-
3.3 O&M Personnel	$75,000	-	$50,000	$125,000
3.4 Network Operations	$1,440	-	-	$1,440
3.5 Security	$0	-	-	-
3.6 Recurring Training	$1,250	-	$500	$1,750
3.7 Facilities	$9,000	-	$1,500	$10,500
3.8 Travel and Other Direct Costs	$1,000	-	$1,000	$2,000
Total Annual O&M Costs	**$90,690**	**$0**	**$53,000**	**$143,690**

Segment 3 Assumptions: E9-1-1 Phase 0 (some wireless capability installed), Population Served of fewer than 50,000

Baseline Segment 3: E-9-1-1 Phase 0 Serving Population <50,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Network**	
Cost of CPE hardware and software (includes recording and other equipment)	$700	Number of call-taker positions	2	Cost of trunks plus automatic location identification (ALI) and network monitoring/maintenance costs per month	$260
Database hardware costs per month	$500	Database managers (FTE)	1	Number of trunks	2
9-1-1 Authority hardware costs per month	$100	Database manager annual salary	$40,000		
9-1-1 Authority software costs per month	$100	9-1-1 coordinator (FTE)	1		
Facility cost per square foot	$15	Annual salary of 9-1-1 coordinator	$50,000		
Facility size for telecommunications office	600 sq. ft.	Number of telecommunicators	7		
Facility size for coordinator office	100 sq. ft.	Annual telecommunicator salary	$30,000		
		Training costs per telecommunicator per year	$500		

Segment 3 Costs: E9-1-1 Phase 0 (some wireless capability installed), Population Served of fewer than 50,000

Baseline Segment 3: E-9-1-1 Phase 0 Serving Population <50,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$16,800	$6,000	$1,200	$24,000
3.2 Software	$1,200	$600	$1,200	$3,000
3.3 O&M Personnel	$210,000	$40,000	$50,000	$300,000
3.4 Network Operations	$3,840	-	-	$3,840
3.5 Security	$0	-	-	$0
3.6 Recurring Training	$3,500	$1,000	$500	$5,000
3.7 Facilities	$9,000	$1,500	$1,500	$12,000
3.8 Travel and Other Direct Costs	$2,000	$1,000	$1,000	$4,000
Total Annual O&M Costs	**$246,340**	**$50,100**	**$55,400**	**$351,840**

Segment 4 Assumptions: E9-1-1 Basic (some wireless capability installed), Population Served between 50,001 and 250,000

Baseline Segment 4: E-9-1-1 Phase 0 Serving Population 50,001–250,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Labor (cont'd)/Network**	
Cost of CPE hardware, software (includes recording and other equipment) per month	$700	Number of call-taker positions	5	Number of telecommunicators	12
9-1-1 Authority hardware costs per month (per staff member)	$100	Number of 9-1-1 Authority staff positions	2	Telecommunicator supervisors	2
9-1-1 Authority software costs per month (per staff member)	$100	Telecommunicator supervisor annual salary	$35,000	Telecommunicator annual salary	$30,000
PSAP software costs per call-taker position per month	$50	Database managers (FTE)	1.5	Number of trunks	3
Hardware costs for database per month	$500	Database manager annual salary	$40,000	Cost of trunks plus ALI and network monitoring/maintenance costs per month	$260
Database software costs per month	$50	9-1-1 coordinators (FTE)	1	Network costs at 9-1-1 Authority per month	$200
Facility costs per square foot	$15	9-1-1 coordinator annual salary	$50,000	Training costs per telecommunicator and supervisor per year	$500
Facility size for database office	150 sq. ft.	9-1-1 coordinator administrator (FTE)	1		
Facility size for telecommunicator office	2,000 sq. ft.	9-1-1 Coordinator administrator annual salary	$30,000		
Facility size for coordinator office	100 sq. ft				

Segment 4 Costs: E9-1-1 Phase 0 (some wireless capability installed), Population Served between 50,001 and 250,000

Baseline Segment 4: E-9-1-1 Phase 0 Serving Population 50,001–250,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$42,000	$6,000	$2,400	$50,400
3.2 Software	$3,000	$600	$2,400	$6,000
3.3 O&M Personnel	$430,000	$60,000	$80,000	$570,000
3.4 Network Operations	$4,560	-	$2,400	$6,960
3.5 Security	-	-	-	-
3.6 Recurring Training	$7,000	$1,500	$500	$9,000
3.7 Facilities	$30,000	$2,250	$1,500	$33,750
3.8 Travel and Other Direct Costs	$5,000	$1,500	$1,000	$7,500
Total Annual O&M Costs	**$521,560**	**$71,850**	**$90,200**	**$683,610**

Segment 5 Assumptions: E9-1-1 Phases I and II (full wireless capability installed), Population Served of fewer than 50,000

Baseline Segment 5: E-9-1-1 Phases I and II Serving Population <50,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Network**	
Cost of CPE Hardware, Software (now includes recording and other equipment) and geographic information system (GIS) functionality per month	$1,000	Number of call-taker positions	2	Number of trunks	2
Database hardware costs per month	$1,000	Number of 9-1-1 Authority staff positions	2	Cost of trunks plus ALI and network monitoring/maintenance costs per month	$260
9-1-1 Authority hardware costs per month per staff member	$100	Database manager (FTE)	1	Network costs at 9-1-1 Authority Level per month	$200
PSAP software costs per position per month	$75	Database manager annual salary	$40,000		
Database software costs per month	$250	9-1-1 coordinators (FTE)	1		
9-1-1 Authority software costs per person	$100	9-1-1 coordinator annual salary	$50,000		
Facility costs per square foot	$15	Facility size for coordinator office	100 sq. ft.		
Facility size for telecommunicator office	600 sq. ft.	Number of telecommunicators	7		
		Telecommunicator annual salary	$30,000		
		Training costs per telecommunicator and supervisor	$750		

Segment 5 Costs: E9-1-1 Phases I and II (full wireless capability installed), Population Served of fewer than 50,000

Baseline Segment 5: E-9-1-1 Phases I and II Serving Population <50,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$24,000	$12,000	$1,200	$37,200
3.2 Software	$1,800	$3,000	$1,200	$6,000
3.3 O&M Personnel	$210,000	$40,000	$50,000	$300,000
3.4 Network Operations	$3,840	-	-	$3,840
3.5 Security	-	-	-	$0
3.6 Recurring Training	$5,250	$2,000	$500	$7,750
3.7 Facilities	$9,000	$1,500	$1,500	$12,000
3.8 Travel Other Direct Costs	$2,000	$1,000	$1,000	$4,000
Total Annual O&M Costs	**$255,890**	**$59,500**	**$55,400**	**$370,790**

Segment 6 Assumptions: E9-1-1 Phases I and II (full wireless capability installed), Population Served between 50,001 and 250,000

Baseline Segment 6: E-9-1-1 Phases I and II Serving Population 50,001–250,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Labor (cont) / Network**	
Cost of CPE hardware, software (now includes recording and other equipment) per month	$1,000	Number of call-taker positions	5	Number of telecommunicators	12
Database hardware costs per month	$1,500	9-1-1 Authority staff positions	2	Telecommunicator annual salary	$30,000
9-1-1 Authority hardware costs per month per staff member	$100	Database managers (FTE)	1.5	Number of telecommunicator supervisors	2
PSAP software costs per position per month	$75	Database manager annual salary	$40,000	Telecommunicator supervisor salary per year	$35,000
Database software costs per month	$350	9-1-1 coordinators (FTE)	1	Number of trunks	3
9-1-1 Authority software costs per person	$100	9-1-1 coordinator annual salary	$50,000	Cost of trunks plus ALI and network monitoring/maintenance costs per month	$260
Facility costs per square foot	$15	Number of 9-1-1 coordinator administrators	1	Network costs at 9-1-1 Authority level per month	$200
Facility size for database office	150 sq. ft.	9-1-1 coordinator administrator annual salary	$30,000	Training costs for telecommunicator and supervisor per year	$750
Facility size for coordinator office	150 sq. ft.			Facility size for telecommunicator office	2,000 sq. ft.

Segment 6 Costs: E9-1-1 Phases I and II (full wireless capability installed), Population Served between 50,001 and 250,000

Baseline Segment 6: E-9-1-1 Phases I and II Serving Population 50,001–250,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$60,000	$18,000	$2,400	$80,400
3.2 Software	$4,500	$4,200	$2,400	$11,100
3.3 O&M Personnel	$430,000	$60,000	$80,000	$570,000
3.4 Network Operations	$4,560	-	$2,400	$6,960
3.5 Security	-	-	-	-
3.6 Recurring Training	$10,500	$2,000	$500	$13,000
3.7 Facilities	$30,000	$2,250	$2,250	$34,500
3.8 Travel and Other Direct Costs	$5,000	$1,500	$1,000	$7,500
Total Annual O&M Costs	**$544,560**	**$87,950**	**$90,950**	**$723,460**

Segment 7 Assumptions: E9-1-1 Phases I and II, Population Served between 250,001 and 1,000,000

Baseline Segment 7: E-9-1-1 Phases I and II Serving Population 250,001–1,000,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Network**	
Cost of CPE hardware, software (now includes recording and other equipment) per month	$1,000	Number of 9-1-1 Authority staff positions	3	Number of telecommunicators	30
Database hardware costs per month	$1,667	9-1-1 Authority hardware costs per month per staff member	$100	Telecommunicator annual salary	$30,000
PSAP software costs per position per month	$75	Database managers (FTE)	2	Telecommunicator supervisors	4
Database software costs per month	$417	Database manager annual salary	$40,000	Telecommunicator supervisor annual salary	$35,000
9-1-1 Authority software costs per person per month	$100	9-1-1 coordinator (FTE)	1	Telecommunications center managers (FTE)	1
Facility size for database office	200 sq. ft.	9-1-1 coordinator annual salary	$75,000	Telecommunications center manager annual salary	$60,000
Facility size for coordinator office	500 sq. ft	Deputy coordinators (FTE)	1	Number of trunks	10
Facility costs per square foot	$15	Deputy coordinator annual salary	$60,000	Cost of trunks per month	$60
Facility size for telecommunications office	6,000 sq. ft.	9-1-1 coordinator administrator (FTE)	1	ALI and network maintenance costs per year	$2,800
Number of call-taker positions	10	9-1-1 coordinator administrator annual salary	$30,000	Network costs at 9-1-1 Authority level per month	$400
Number of call-taker software licenses	10			Training costs per telecommunicator, supervisor, and center manager per year	$750

Segment 7 Costs: E9-1-1 Phases I and II (full wireless capability installed), Population Served between 250,001 and 1,000,000

Baseline Segment 7: E-9-1-1 Phases I and II Serving Population 250,001–1,000,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$120,000	$20,000	$3,600	$143,600
3.2 Software	$9,000	$5,000	$3,600	$17,600
3.3 O&M Personnel	$1,100,000	$80,000	$165,000	$1,345,000
3.4 Network Operations	$10,000	-	$4,800	$14,800
3.5 Security	-	-	-	-
3.6 Recurring Training	$26,250	$2,500	$1,000	$29,750
3.7 Facilities	$90,000	$3,000	$7,500	$100,500
3.8 Travel and Other Direct Costs	$7,000	$2,000	$2,000	$11,000
Total Annual O&M Costs	**$1,362,250**	**$112,500**	**$187,500**	**$1,662,250**

Segment 8 Assumptions: E9-1-1 Phases I and II (full wireless capability installed), Population Served above 1,000,000

Baseline Segment 8: E-9-1-1 Phases I and II Serving Population >1,000,000

Cost Assumptions					
Hardware/Software/Facilities		**Labor**		**Network**	
Cost of CPE hardware, software (now includes recording and other equipment) per month	$1,000	Number of call-taker positions	30	Number of telecommunicators	100
Database hardware costs per month	$2,083	Number of 9-1-1 Authority staff positions	3	Telecommunicator annual salary	$30,000
9-1-1 Authority hardware costs per month per staff member	$100	Database managers (FTE)	3	Telecommunicator supervisors	6
PSAP software costs per position	$75	Database manager annual salary	$40,000	Telecommunicator supervisor annual salary	$35,000
Database software costs per month	$583	9-1-1 coordinators (FTE)	1	Number of telecommunications center managers	1
9-1-1 Authority software costs per person per month	$100	9-1-1 coordinators annual salary	$75,000	Telecommunications center manager annual salary	$70,000
Facility costs per square foot	$15	Deputy coordinators (FTE)	1	Number of trunks	30
Facility size for database office	300 sq. ft.	Deputy coordinator annual salary	$60,000	Cost of trunks per month	$60
Facility size for coordinator office	500 sq. ft.	9-1-1 coordinator administrator (FTE)	1	ALI and network maintenance costs per year	$2,800
		9-1-1 coordinator administrator annual salary	$30,000	Network costs at 9-1-1 Authority level per month	$400
				Training costs per telecommunicator, supervisor, and center manager per year	$750
				Facility size for telecommunicator office	2,000 sq. ft

Segment 8 Costs: E9-1-1 Phases I and II, Population Served above 1,000,000

Baseline Segment 8: E-9-1-1 Phases I and II Serving Population >1,000,000

3.0 Annual O&M Cost	PSAP	Database	9-1-1 Authority	Total
3.1 Hardware	$360,000	$25,000	$3,600	$388,600
3.2 Software	$27,000	$7,000	$3,600	$37,600
3.3 O&M Personnel	$3,280,000	$120,000	$165,000	$3,565,000
3.4 Network Operations	$24,400	-	$4,800	$29,200
3.5 Security	-	-	-	-
3.6 Recurring Training	$75,000	$3,000	$1,000	$79,000
3.7 Facilities	$300,000	$4,500	$7,500	$312,000
3.8 Travel and Other Direct Costs	$15,000	$2,500	$2,000	$19,500
Total Annual O&M Costs	**$4,081,400**	**$162,000**	**$187,500**	**$4,430,900**

Statewide Systems: Costs and Relevant Assumptions

- **Seven states incur costs on a statewide network basis:**
  - Total State 1 Costs: **$14,636,239** (Population Served: 853,476)
  - Total State 2 Costs: **$20,589,018** (Population Served: 1,321,574)
  - Total State 3 Costs: **$29,220,219** (Population Served: 3,510,897)
  - Total State 4 Costs: **$144,428,405** (Population Served: 6,437,000)
  - Total State 5 Costs: **$20,484,965** (Population Served: 1,314,895)
  - Total State 6 Costs: **$6,723,790** (Population Served: 623,908)
  - Total State 7 Costs: **$4,750,946** (Population Served: 1,067,610)
- Estimated total statewide system costs: **$240,833,581**
- Because state data were gathered first-hand, only two basic assumptions were needed in calculating total state system costs
  - Because data were unavailable for states 5 and 6, their total costs were estimated based on their population served and the costs of the system closest in nature to theirs
  - For all states but State 4, local authorities hire and train PSAP personnel, not state authorities. Therefore, personnel costs for these states were estimated based on the population served per county and the staffing costs estimated in the appropriate county segment

Many states have a state program coordinator's office to oversee inter-PSAP and interstate activities

- Thirty-eight states have offices that manage inter-PSAP and interstate 9-1-1 issues
- States that have a full state-system cost estimate are excluded from the calculations here (these costs are accounted for in the statewide system cost estimates)
- Each state is assumed to have the following FTE in place:

Staff	Loaded Annual Salary 2007*
State Coordinator	$63,068
Database Technician	$44,922
Technical Manager	$61,078
Administrative Staff	$30,000
Cost Per State	**$199,068**

- Facility costs and overhead are assumed to be split with other state offices and therefore are insignificant for purposes of this analysis
- Therefore, the total cost, nationwide, of 9-1-1 State Program Coordination is **$6,171,114 per annum**

**Salary data drawn from "NENA 2005 SWAT Analysis." Escalated at Office of Management and Budget annual salary inflation rate of 3.4 percent, and state-level staff members are assumed to be full time*

Total annual costs for the current 9-1-1 environment are estimated at approximately $2.2 billion

9-1-1 Baseline Operating Environment Total Annual Cost Estimate *($2007, Millions)*

Segment/State	Individual Segment Cost (B/A)	Number of Segments (A)	Annual Recurring Costs (B)	Annual Capital Costs* (C)	Total Annual Cost (B + C)
1	$ 0.0	98	$ 0.2	$ 0.0	$ 0.2
2	$ 0.1	114	$ 16.4	$ 3.3	$ 19.7
3	$ 0.4	304	$ 107.0	$ 21.4	$ 128.4
4	$ 0.7	62	$ 42.4	$ 8.5	$ 50.9
5	$ 0.4	1684	$ 624.4	$ 124.9	$ 749.3
6	$ 0.7	588	$ 425.4	$ 85.1	$ 510.5
7	$ 1.7	175	$ 290.9	$ 58.2	$ 349.1
8	$ 4.4	25	$ 110.8	$ 22.2	$ 132.9
Sub Total	$ 8.4	3050	$ 1,617.4	$ 323.5	$ 1,940.9
State 1	$ 14.6	1	$ 14.6	$ 2.9	$ 17.6
State 2	$ 20.6	1	$ 20.6	$ 4.1	$ 24.7
State 3	$ 29.2	1	$ 29.2	$ 5.8	$ 35.1
State 4	$ 144.4	1	$ 144.4	$ 28.9	$ 173.3
State 5	$ 20.5	1	$ 20.5	$ 4.1	$ 24.6
State 6	$ 6.7	1	$ 6.7	$ 1.3	$ 8.1
State 7	$ 4.8	1	$ 4.8	$ 1.0	$ 5.7
State Program	$ 0.2	31	$ 6.2	$ 1.0	$ 7.2
				Grand Total:	$ 2,237.1

** Research indicates 16%–18% of the total budget is attributable to capital costs*

Capital costs are factored in as a percentage in the Baseline because of the lack of available actual data for specific hardware/software refresh costs for all segments

- The capital cost of a refresh was assumed to be 20 percent
  - This is consistent with analogous system budgetary data assumptions
  - This assumption correlates to the five-year refresh schedule defined in the global assumptions for the NG9-1-1 scenarios
- By employing a 20-percent capital cost premium over all total recurring costs, the NG9-1-1 project team makes the inherent assumption that one out every five PSAPs will need to purchase new hardware, software, or other durable goods every year

Sample Cost Calculation for Baseline Costs

Cost of input (hardware, software, labor, etc.)	X	***Number of units purchased annually per county segment or state***	=	***Annual cost of hardware, software, or labor (etc.) within a segment or state***
Sum of all costs in an individual segment	X	***Number of segments/states of this type nationwide***	=	***Annual Overall Recurring Cost***

Sum of all Recurring Costs, Nationwide	+	***Sum of all Recurring Costs, Nationwide***	X	***20% Capital Goods Renewal Cost***	=	***Annual Overall Segment/State Cost***

Example Segment 1: Annual Cost

Labor: 2 calls per day x 10 min per call x 365 days a year = 7,300 minutes (120 hrs)

120 hrs x $10 per hr call-taker salary = $1,200 per year in Call-Taker Labor

Network: $12.50 per month for telephone connection x 12 months = $150 for network per year

Training: $500 annually to train call takers

Total Recurring: $1,850/year for Segment 1 x 98 counties in segment 1 = $181,300 per year nationally

Total Capital Refresh cost per year = $181,300 x 20% (1 of every 5 counties buy new hardware/software/other per year) = $36,250

Total Segment Cost Per Year, Including Capital Costs: $217,560

The adjustment to the Baseline High cost estimate was derived by using a 2004 industry estimate and adjusting it for inflation

Baseline High Premium Assumptions

Industry Estimate (2004$)	Baseline Profile Estimate (Calendar Year $)
$14.46	**$11.18**

Year	Average Inflation Rate*
2005	3.39%
2006	3.24%
2007	2.74%

Year	Escalation Rate Factor	Adj. Estimate
2005	103.39%	$14.95
2006	103.24%	$15.43
2007	102.74%	$15.86

Results of Adjustment

Industry Estimate Adjusted Rate (2007$)

$15.86

Cost Differential Between Profile Estimate and Industry Estimate (%)

-41.84%

*http://www.inflationdata.com/inflation/inflation_rate/HistoricalInflation.aspx *(last accessed March 4, 2009)*
Year 2007 data through November 2007.

Baseline Low: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2009–2018)

Total Baseline Low Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
1.0 Program Planning and Research & Development (R&D)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.0 Acquisition and Implementation	$ 373	$ 381	$ 390	$ 398	$ 407	$ 416	$ 426	$ 435	$ 445	$ 455
3.0 Operations and Maintenance	$ 1,864	$ 1,907	$ 1,949	$ 1,993	$ 2,038	$ 2,083	$ 2,130	$ 2,177	$ 2,226	$ 2,276
TOTAL LIFECYCLE COST	$ 2,237	$ 2,288	$ 2,339	$ 2,391	$ 2,445	$ 2,499	$ 2,555	$ 2,613	$ 2,671	$ 2,731
TOTAL LIFECYCLE COST (Discounted)	$ 2,237	$ 2,177	$ 2,117	$ 2,060	$ 2,004	$ 1,949	$ 1,896	$ 1,844	$ 1,794	$ 1,745

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

Baseline Low: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2019–2028)

Total Baseline Low Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	TOTAL
1.0 Program Planning and Research & Development (R&D)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.0 Acquisition and Implementation	$ 465	$ 475	$ 486	$ 497	$ 508	$ 519	$ 531	$ 543	$ 555	$ 567	$ 9,273
3.0 Operations and Maintenance	$ 2,327	$ 2,379	$ 2,432	$ 2,487	$ 2,542	$ 2,599	$ 2,657	$ 2,717	$ 2,777	$ 2,840	$ 46,399
TOTAL LIFECYCLE COST	$ 2,792	$ 2,854	$ 2,918	$ 2,983	$ 3,050	$ 3,118	$ 3,188	$ 3,260	$ 3,332	$ 3,407	$ 55,672
TOTAL LIFECYCLE COST (Discounted)	$ 1,698	$ 1,651	$ 1,606	$ 1,563	$ 1,520	$ 1,479	$ 1,438	$ 1,399	$ 1,361	$ 1,324	$ 34,863

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

Baseline High: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2009–2018)

Total Baseline High Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
1.0 Program Planning and Research & Development (R&D)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.0 Acquisition and Implementation	$ 529	$ 540	$ 553	$ 565	$ 578	$ 590	$ 604	$ 617	$ 631	$ 645
3.0 Operations and Maintenance	$ 2,644	$ 2,704	$ 2,765	$ 2,827	$ 2,890	$ 2,955	$ 3,021	$ 3,088	$ 3,158	$ 3,228
TOTAL LIFECYCLE COST	$ 3,173	$ 3,245	$ 3,318	$ 3,392	$ 3,468	$ 3,545	$ 3,625	$ 3,706	$ 3,789	$ 3,873
TOTAL LIFECYCLE COST (Discounted)	$ 3,173	$ 3,087	$ 3,003	$ 2,922	$ 2,842	$ 2,765	$ 2,689	$ 2,616	$ 2,545	$ 2,475

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

Baseline High: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2019–2028)

Total Baseline High Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	TOTAL
1.0 Program Planning and Research & Development (R&D)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2.0 Acquisition and Implementation	$ 660	$ 674	$ 689	$ 705	$ 721	$ 737	$ 753	$ 770	$ 787	$ 805	$ 13,152
3.0 Operations and Maintenance	$ 3,300	$ 3,374	$ 3,450	$ 3,527	$ 3,606	$ 3,687	$ 3,769	$ 3,853	$ 3,940	$ 4,028	$ 65,814
TOTAL LIFECYCLE COST	$ 3,960	$ 4,049	$ 4,139	$ 4,232	$ 4,326	$ 4,423	$ 4,522	$ 4,623	$ 4,727	$ 4,833	$ 78,966
TOTAL LIFECYCLE COST (Discounted)	$ 2,408	$ 2,342	$ 2,279	$ 2,217	$ 2,156	$ 2,097	$ 2,040	$ 1,985	$ 1,931	$ 1,878	$ 49,451

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

Two primary NG9-1-1 deployment scenarios were selected for analysis based on the issues raised in the NG9-1-1 Transition Plan

- Two potential NG9-1-1 deployment scenarios where selected for analysis:
  - **Uniform:** A standardized nation-wide approach
  - **Hybrid:** An approach that reflects a combination of:
    - Independent/unilateral deployment for 5 percent of the population
    - Uniform deployment serving approximately 60 percent of the population
    - Regional deployment in which three large regional networks service approximately 35 percent of the total population
- **Cost assumptions for each scenario are based on the Base, Macro, and Micro Unit as defined below**

Workload Assumptions for Scalable Units

	Base Unit	Macro Unit	Micro Unit
Uniform NG9-1-1 Scenario: ***Percentage of Population Served***	100%	0%	0%
Hybrid Alternative: ***Percentage of Population Served***	60%	35%	5%
Total Population Served by This Segment	180,600,000	105,350,000	15,050,000
Population Served Per Network	6,250,000	35,116,667	625,000
Number of Call Taker Positions Per PSAP Unit	320	1,798	32
Estimated Number of PSAPs	100–120	560–675	10–12
Total Calls Per Network*	3,840,000	21,575,680	384,000
Network Points of Presence (POP)†	5	10	N/A
Total Number of Networks	29	3	24

** Based on a projected call volume of 12,000 calls annually per call-taker position*

† Points of interconnection between networks, or access points

Cost estimating relationships (CER) were used for estimating planning, implementation, and recurring costs for the NG9-1-1 scenarios

Cost Estimating Relationship Assumptions

Assumptions	CES Link	Benchmark/CER	Source
1.0 Planning Cost as % of acquisition costs		10%	Booz Allen SME Input
2.0 Implementation Costs (% of acquisition costs)			
Project Management	Program Planning and Management	26%	Booz Allen IC, analogous studies
Engineering	Systems Requirements and Design	39%	Booz Allen IC, analogous studies
Staging	Systems Integration and Installation	2%	Booz Allen IC, analogous studies
Installation	Systems Integration and Installation	10%	Booz Allen IC, analogous studies
Certification and Accreditation	Security	15%	Booz Allen IC, analogous studies
Training	Training	3%	Booz Allen IC, analogous studies
3.0 Recurring Costs (% of acquisition costs)			
System Engineering	O&M Personnel	5%	ACEIT CER Library*
Program Management	O&M Personnel	5%	ACEIT CER Library
System Test and Evaluation	O&M Personnel	3%	ACEIT CER Library
Training	Training	1%	ACEIT CER Library
Data	O&M Personnel	1%	ACEIT CER Library
Support Equipment	Hardware	1%	ACEIT CER Library
Spares	Hardware	1%	ACEIT CER Library

**Automated Cost Estimating Integrated Tool (ACEIT) CER library references the Defense Information Systems Agency Cost and Planning Factors Manual (20 December 1994) as the source of the figure*

For the Base Unit NG9-1-1 deployment, hardware and software acquisition, and operating profiles were developed

Base Unit Deployment Cost Assumptions: PSAP Unit, Network, and Data Services* ($2007)

Architecture Component	Architecture Reference	Description	Units	Estimated Unit Cost	Acquisition Cost (Point)	Implementation Cost	Recurring Costs	Refresh Schedule
PSAP Unit (320 Call Takers)								
Hardware					**$ 2,631,306**	**$ 2,499,741**	**$ 434,166**	
NG9-1-1 BCF	NP-01	IPS and Firewall	24	$ 13,588	$ 326,102	$ 309,797	$ 53,807	5 year
PSAP IP Routing Function	NP-02	Router	12	$ 25,000	$ 300,000	$ 285,000	$ 49,500	5 year
PSAP IP ACD	NP-03	IP ACD (Assumed in Network)			$ -	$ -	$ -	10 year
NG9-1-1 Call Termination	NP-04	Workstations (with HMI)	32	$ 50,000	$ 1,600,000	$ 1,520,000	$ 264,000	10 year
		Peripherals	12	$ 20,000	$ 240,000	$ 228,000	$ 39,600	5 year
GIS	Legacy	Server	12	$ 13,767	$ 165,204	$ 156,944	$ 27,259	5 year
Software					**$ 34,260**	**$ 32,547**	**$ 5,653**	
PSAP IP ACD	NP-03	ACD Software (bundled in HW	0	$ -	$ -	$ -	$ -	
NG9-1-1 Call Termination	NP-04	HMI (bundled in CPE)	0	$ -	$ -	$ -	$ -	
GIS	Legacy	GIS Software	12	$ 2,855	$ 34,260	$ 32,547	$ 5,653	
Total PSAP Unit Estimate					**$ 2,665,566**	**$ 2,532,288**	**$ 439,818**	
Network (Serving 10 PSAP Units)								
Hardware					**$ 2,836,280**	**$ 2,694,466**	**$ 467,986**	
Legacy Data Gateway	NN01 - 03	Gateway	5	$ 20,000	$ 100,000	$ 95,000	$ 16,500	No Refresh
IP Network BCF	NN-07	IPS and Firewall	20	$ 63,348	$ 1,266,950	$ 1,203,603	$ 209,047	5 year
ESRP	NN-04	Server	2	$ 60,000	$ 120,000	$ 114,000	$ 19,800	5 year
NG9-1-1 IP Routing Function	NN-05	Router	10	$ 36,499	$ 364,990	$ 346,741	$ 60,223	5 year
		Switch	10	$ 9,434	$ 94,340	$ 89,623	$ 15,566	5 year
IP ACD	NN-06	ACD	1	$ 650,000	$ 650,000	$ 617,500	$ 107,250	10 year
Network Management Servers	NN-04	Servers	4	$ 60,000	$ 240,000	$ 228,000	$ 39,600	5 year
Software					**$ 175,000**	**$ 166,250**	**$ 70,625**	
ESRP	NN-04		1	$ 50,000	$ 50,000	$ 47,500	$ 50,000	
IP ACD	NN-06	IP ACD SW Bundled with HW	0	$ -	$ -	$ -	$ -	
Network Management Software	NN-04	Network Management System	2	$ 62,500	$ 125,000	$ 118,750	$ 20,625	
Total Network Estimate					**$ 3,011,280**	**$ 2,860,716**	**$ 538,611**	
Data Services (Serving 10 PSAP Units)								
Hardware					**$2,230,603**	**$2,119,073**	**$368,049**	
Database Management System	ND-01	Storage Area Network	2	$ 500,000	$ 1,000,000	$ 950,000	$ 165,000	10 year
		Peripherals	1	$ 200,000	$ 200,000	$ 190,000	$ 33,000	5 year
		Internal Networking Switch	8	$ 55,700	$ 445,603	$ 423,323	$ 73,524	5 year
Databases	ND-01 - 05	Servers	18	$ 30,000	$ 540,000	$ 513,000	$ 89,100	5 year
		Call Recording	1	$ 45,000	$ 45,000	$ 42,750	$ 7,425	
Software					**$560,000**	**$532,000**	**$560,000**	
Database Applications	ND-01	RDBMS	18	20000	$ 360,000	$ 342,000	$ 360,000	
Call Record	ND-01	Bundled with HW	0	0	$ -	$ -	$ -	
IDAM	ND-02	Identity Management	2	100000	$ 200,000	$ 190,000	$ 200,000	
Total Data Services Estimate					**$ 2,790,603**	**$ 2,651,073**	**$ 928,049**	

** All Unit costs were developed based on research conducted on GSA Advantage*

For the Large-Scale Unit, hardware and software acquisition and operating profiles were developed for the network and data services

Macro (Large-Scale) Unit Deployment Cost Assumptions*: Network and Data Services ($2007)

Architecture Component	Architecture Reference	Description	Units	Estimated Unit Cost	Acquisition Cost (Point)	Implementation Cost	Recurring Costs	Refresh Schedule
Network (Serving 56 PSAP Units)								
Hardware					**$ 7,878,636**	**$ 7,484,704**	**$ 1,299,975**	
Legacy Data Gateway	NN01 - 03	Gateway	10	$ 28,000	$ 280,000	$ 266,000	$ 46,200	No Refresh
IP Network BCF	NN-07	IPS and Firewall	40	$ 63,348	$ 2,533,900	$ 2,407,205	$ 418,094	5 year
ESRP	NN-04	Server	6	$ 60,000	$ 360,000	$ 342,000	$ 59,400	5 year
NG9-1-1 IP Routing Function	NN-05	Router	20	$ 44,196	$ 883,916	$ 839,721	$ 145,846	5 year
		Switch	20	$ 45,041	$ 900,820	$ 855,779	$ 148,635	5 year
IP ACD	NN-06	ACD	4	$ 650,000	$ 2,600,000	$ 2,470,000	$ 429,000	10 year
Network Management Servers	NN-04	Servers	4	$ 80,000	$ 320,000	$ 304,000	$ 52,800	5 year
Software					**$ 350,000**	**$ 332,500**	**$ 183,000**	
ESRP	NN-04		1	$ 150,000	$ 150,000	$ 142,500	$ 150,000	
IP ACD	NN-06	IP ACD SW Bundled with HW	0	$ -	$ -	$ -	$ -	
Network Management Software	NN-04	Network Management System	2	$ 100,000	$ 200,000	$ 190,000	$ 33,000	
Total Network Estimate					**$ 8,228,636**	**$ 7,817,204**	**$ 1,482,975**	
Data Services (Serving 56 PSAP Units)								
Hardware					**$6,335,452**	**$6,018,679**	**$1,045,350**	
Database Management System	ND-01	Storage Area Network	2	$ 1,250,000	$ 2,500,000	$ 2,375,000	$ 412,500	10 year
		Peripherals	1	$ 500,000	$ 500,000	$ 475,000	$ 82,500	5 year
		Internal Networking Switch	8	$ 90,682	$ 725,452	$ 689,179	$ 119,700	5 year
Databases	ND-01 - 05	Servers	36	$ 65,000	$ 2,340,000	$ 2,223,000	$ 386,100	5 year
		Call Recording	6	$ 45,000	$ 270,000	$ 256,500	$ 44,550	
Software					**$1,680,000**	**$1,596,000**	**$1,680,000**	
Database Applications	ND-01	RDBMS	64	$ 20,000	$ 1,280,000	$ 1,216,000	$ 1,280,000	
Call Record	ND-01	Bundled with HW	0	$ -	$ -	$ -	$ -	
IDAM	ND-02	Identity Management	4	$ 100,000	$ 400,000	$ 380,000	$ 400,000	
Total Data Services Estimate					**$ 8,015,452**	**$ 7,614,679**	**$ 2,725,350**	

**PSAP costs remain consistent with the Base Unit costs but are scaled to accommodate 1,798 call-taker positions compared with 320 call-taker positions in the Base Unit*

For the Micro Unit NG9-1-1 deployment, hardware and software acquisition and operating profiles were developed

Micro Unit Deployment Cost Assumptions*: PSAP Unit, Network, and Data Services ($2007)

Architecture Component	Architecture Reference	Description	Units	Estimated Unit Cost	Acquisition Cost (Point)	Implementation Cost	Recurring Costs	Refresh Schedule
PSAP Unit (32 Call Takers)								
Hardware					**$ 2,826,210**	**$ 2,684,900**	**$ 466,325**	
NG9-1-1 BCF	NP-01	IPS and Firewall	24	$ 13,588	$ 326,102	$ 309,797	$ 53,807	5 year
PSAP IP Routing Function	NP-02	Router	12	$ 25,000	$ 300,000	$ 285,000	$ 49,500	5 year
PSAP IP ACD	NP-03	IP ACD *(Micro Only)*	12	$ 16,242	$ 194,904	$ 185,159	$ 32,159	10 year
NG9-1-1 Call Termination	NP-04	Workstations (with HMI)	32	$ 50,000	$ 1,600,000	$ 1,520,000	$ 264,000	10 year
		Peripherals	12	$ 20,000	$ 240,000	$ 228,000	$ 39,600	5 year
GIS	Legacy	Server	12	$ 13,767	$ 165,204	$ 156,944	$ 27,259	5 year
Software					**$ 34,260**	**$ 32,547**	**$ 5,653**	
PSAP IP ACD	NP-03	ACD Software (bundled in HW	0	$ -	$ -	$ -	$ -	
NG9-1-1 Call Termination	NP-04	HMI (bundled in CPE)	0	$ -	$ -	$ -	$ -	
GIS	Legacy	GIS Software	12	$ 2,855	$ 34,260	$ 32,547	$ 5,653	
Total PSAP Unit Estimate					**$ 2,860,470**	**$ 2,717,447**	**$ 471,978**	
Network and Data Services(Serving 1 PSAP Units)								
Service Provider							**$ 595,089**	
Annual Recurring Cost Estimate			1	$ 595,089			$ 595,089	
Total Networkand Data Services Estimate							**$ 595,089**	

**With the assumption of a service provider for the network and data services, the Micro Unit requires the ACD to be in the PSAP rather than in the network as in the other deployment profiles*

To estimate the data storage costs of the Micro Unit, we used a two step process

Micro-Unit Data Storage Calculation

- Estimated data storage requirements for a Micro Unit to be 1.59 TB per year (Slide 53)
- Calculated the one-time and annual recurring costs for a Micro Unit by scaling an analogous example requiring 3 TB of storage per year (Slide 54)

Step 1: Calculation of Micro Unit data storage requirements

Size Requirements (per 10 minute call):			
SIP Message	0.0029	MB	
Audio Recording size	4.8	MB	
Video Recording size	54	MB	

Call Assumptions:			
Total Calls per Year	384,000		
Total Calls in 90 days	94,945		
80% assumed Audio or Text	75,956		
20% assumed Video	18,989		

Calculations:			
Total Audio storage per year (in MB)	364,812	MB	Number of Audio or Text Calls X (SIP Message size + Audio Recording Size)
Total Video storage per year (in MB)	1,025,462	MB	Number of Video Calls X (SIP Message size + Video Recording Size)
5% Annual Storage Saved Indefinitely	281,144	MB	
Total Storage Requirement (in MB)	1,671,418	MB	Sum of Audio storage, Video storage, and 5% saved storage
Total storage data per year (in G)	1,632	G	
Total storage data per year (in TB)	1.59	TB	

Notes:

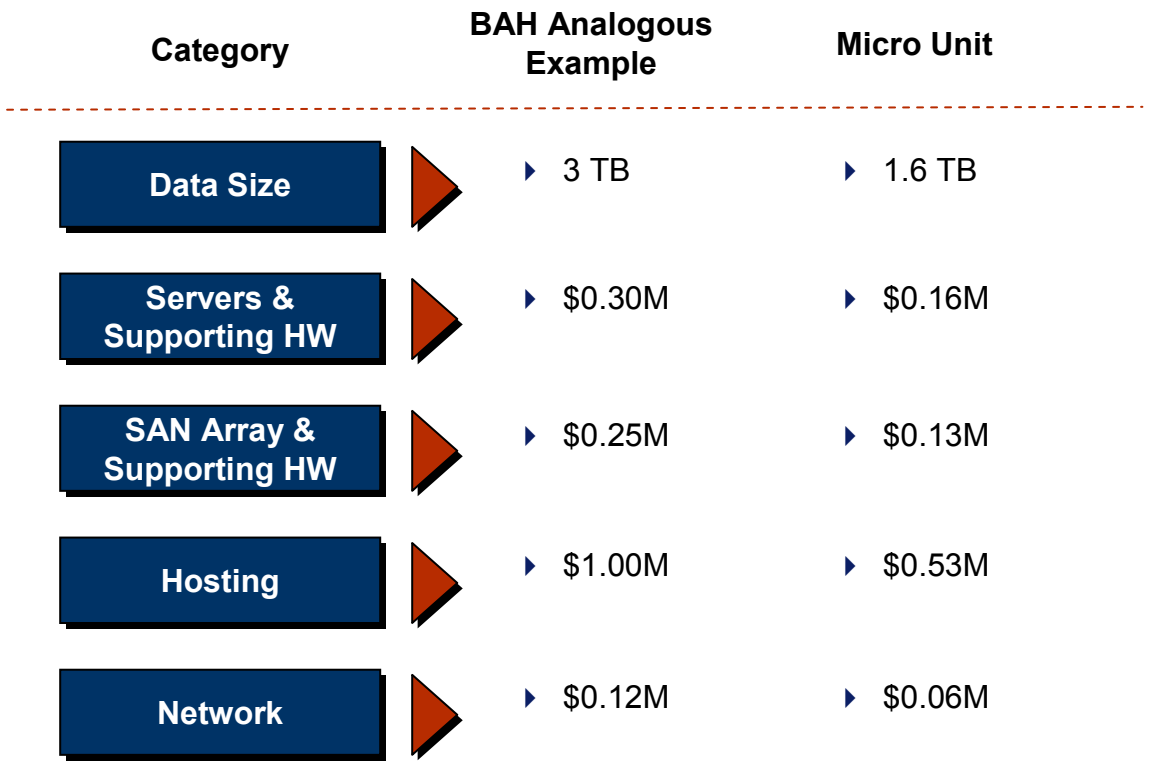
Assumes storage requirement of 90 days of rolling data

Assumes 5% of annual storage will be saved indefinitely

Step 2: Calculation of Micro Unit Data Storage Costs

Calculation of Costs		Analogous Example		Micro-Unit
Size		3 TB		
Factor to Micro Unit		0.53 x		
Costs:				
One-Time:				
Server & Supporting HW	$	300,000	$	159,399
Vendor 1 SAN Array and Supporting HW	$	250,000	$	132,832
Total One-Time	**$**	**550,000**	**$**	**292,231**
Annual Recurring:				
Vendor 2 Hosting	$	1,000,000	$	531,329
Circuit Costs	$	120,000	$	63,760
Total Annual Recurring	**$**	**1,120,000**	**$**	**595,089**

Comparison unit costs using BAH analogous example*



Based on Booz Allen prior engagements and subject matter expertise

NG9-1-1 Additional Considerations

- For this analysis, in the NG9-1-1 scenarios, labor and facilities remain constant with the Baseline
- In addition to leveraging the CERs defined, Change Management/Outreach and Communications were estimated for planning and implementation

PSAP Unit Change Management/Outreach Estimate ($2007)

Change Management/ Outreach	People	Percentage of Time	Months	FTE	Cost Per FTE	Total Cost
Planning						**$33,666**
Government	2	100%	2	0.2	$ 81,995	$13,666
Contractor	2	50%	2	0.1	$ 240,000	$20,000
Implementation						**$33,666**
Government	2	100%	2	0.2	$ 81,995	$13,666
Contractor	2	50%	2	0.1	$ 240,000	$20,000

Data services and network staff and facility costs were estimated based on SME input

Data Services FTE and Facilities Summary ($2007)

Cost Element	Base Unit FTE	Large-Scale Unit FTE	Total Cost
Staff positions (FTE)*			
Network engineers	6	16	$117,579
Applications engineers	6	16	$96,330
Database administrators	6	16	$96,330
System administrators	6	16	$96,330
Security engineers	6	16	$96,330
Other	6	16	$81,995
Total Base Unit			**$3,509,365**
Total Large Scale Unit			**$9,358,306**
Facilities			
Cost Per Square Foot			**Range: $22 to $30**
Estimated Square Feet			**Range: 1,000 to 2,000**

**FTE are assumed to staff the data services and network facility on a 24/7 basis*

Network connectivity costs were estimated based on points of presence (POP) for given network areas and network access costs for each connection type

Network Connectivity Assumptions ($2007)

PER UNIT Assumptions:	
Mid: 5 Points of Presence, 10 PSAP units	
115	PSAP Connections
235	POP to POP Connections
1	Data to Data Connections
PSAP to POP/POP to POP Connections: 10 Mbps Ethernet (IPVPN, CONUS)	
Data to Data connection: 100MB Critical	
Macro: 10 Points of Presence, 56 PSAP units	
662	PSAP Connections
1224	POP to POP Connections
1	Data to Data Connection
PSAP to POP/POP to POP Connections: 10 Mbps Ethernet (IPVPN, CONUS)	
Data to Data connection: 100MB Critical	

Network Connectivity Cost Build Per Data/Network Unit:		
Mid Unit:		
PSAP to POP connection	$	134,850
POP to POP connection	$	275,562
Data to Data Connection	$	168,000
Annual Total:	$	578,412
Macro Unit:		
PSAP to POP connection		$776,265
POP to POP connection		$1,435,268.52
Data to Data Connection	$	336,000
Annual Total:		$2,547,533

Note: PSAP locations assumed to co-host POPs were subtracted from connectivity counts, POP-to-POP connections doubled for redundancy purposes. Costs based on Networx Unit Pricer: https://releasedprices.networx.gov/unit/ (last accessed March 4, 2009)

The development of NG9-1-1 lifecycle costs can be segmented into four stages

1. *Cost of input (hardware, software, labor, etc.) per PSAP/Data or Network "Unit"* X *Number of each item purchased, labor hours worked (etc.)* = *Annual cost of hardware, software, or labor (etc.) within a PSAP/Data/ Network "Unit"*

2. *Sum of all initial costs within PSAP/Data/Network "Unit"* X *Number of PSAP/Data/Network "Units" deploying in a given year* = *Annual Total Initial Cost of all PSAP/Data/Network "Units" deploying to 9-1-1*

3. *Sum of all Recurring Costs per PSAP/Data/Network "Unit" (Delayed 2 years after start of implementation)* X *Number of PSAP/Data/Network "Units" in operation* = *Annual Total Recurring Cost of all PSAP/Data/Network "Units" fully upgraded to NG9-1-1*

4. *Total Recurring Cost/Year* + *Total Initial Cost Per Year* + *Legacy PSAP Cost (phased out over time)* = *Annual Total Cost*

NG9-1-1 Uniform: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2009–2018)

Total NG9-1-1 Uniform Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
1.0 Program Planning and Research & Development (R&D)	$ 13	$ 16	$ 19	$ 21	$ 22	$ 22	$ 19	$ 17	$ 14	$ 12
2.0 Acquisition and Implementation	$ 243	$ 298	$ 344	$ 381	$ 406	$ 474	$ 443	$ 426	$ 400	$ 383
3.0 Operations and Maintenance	$ 1,982	$ 2,035	$ 2,121	$ 2,218	$ 2,306	$ 2,340	$ 2,408	$ 2,459	$ 2,492	$ 2,519
TOTAL LIFECYCLE COST	$ 2,238	$ 2,349	$ 2,484	$ 2,621	$ 2,734	$ 2,835	$ 2,870	$ 2,902	$ 2,907	$ 2,915
TOTAL LIFECYCLE COST (Discounted)	$ 2,238	$ 2,235	$ 2,249	$ 2,257	$ 2,241	$ 2,211	$ 2,129	$ 2,049	$ 1,952	$ 1,863

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

NG9-1-1 Uniform: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2019–2028)

Total NG9-1-1 Uniform Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	TOTAL
1.0 Program Planning and Research & Development (R&D)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 175
2.0 Acquisition and Implementation	$ 329	$ 368	$ 395	$ 418	$ 457	$ 555	$ 586	$ 591	$ 596	$ 620	$ 8,714
3.0 Operations and Maintenance	$ 2,561	$ 2,610	$ 2,668	$ 2,728	$ 2,789	$ 2,851	$ 2,915	$ 2,980	$ 3,047	$ 3,115	$ 51,147
TOTAL LIFECYCLE COST	$ 2,890	$ 2,978	$ 3,063	$ 3,146	$ 3,247	$ 3,406	$ 3,501	$ 3,572	$ 3,643	$ 3,735	$ 60,036
TOTAL LIFECYCLE COST (Discounted)	$ 1,758	$ 1,723	$ 1,686	$ 1,648	$ 1,618	$ 1,615	$ 1,580	$ 1,533	$ 1,488	$ 1,452	$ 37,525

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

NG9-1-1 Hybrid: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2009–2018)

Total NG9-1-1 Hybrid Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
1.0 Program Planning and Research & Development (R&D)	$ 10	$ 13	$ 17	$ 19	$ 23	$ 22	$ 21	$ 17	$ 14	$ 12
2.0 Acquisition and Implementation	$ 184	$ 246	$ 304	$ 346	$ 421	$ 477	$ 484	$ 451	$ 419	$ 416
3.0 Operations and Maintenance	$ 1,974	$ 2,018	$ 2,069	$ 2,135	$ 2,199	$ 2,211	$ 2,293	$ 2,344	$ 2,391	$ 2,416
TOTAL LIFECYCLE COST	$ 2,168	$ 2,278	$ 2,390	$ 2,499	$ 2,643	$ 2,709	$ 2,797	$ 2,811	$ 2,825	$ 2,844
TOTAL LIFECYCLE COST (Discounted)	$ 2,168	$ 2,168	$ 2,164	$ 2,153	$ 2,166	$ 2,112	$ 2,075	$ 1,985	$ 1,897	$ 1,818

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

NG9-1-1 Hybrid: Full breakdown of annual costs by cost element, pre-uncertainty analysis and risk adjustment (FY2019–2028)

Total NG9-1-1 Hybrid Costs by Year ($ Millions, Nominal)

Cost Elements ($ Millions, Inflated)	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	TOTAL
1.0 Program Planning and Research & Development (R&D)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 167
2.0 Acquisition and Implementation	$ 351	$ 406	$ 434	$ 446	$ 507	$ 585	$ 638	$ 636	$ 627	$ 674	$ 9,054
3.0 Operations and Maintenance	$ 2,456	$ 2,502	$ 2,558	$ 2,615	$ 2,674	$ 2,734	$ 2,795	$ 2,857	$ 2,921	$ 2,987	$ 49,149
TOTAL LIFECYCLE COST	$ 2,806	$ 2,909	$ 2,992	$ 3,062	$ 3,180	$ 3,319	$ 3,433	$ 3,494	$ 3,548	$ 3,661	$ 58,370
TOTAL LIFECYCLE COST (Discounted)	$ 1,706	$ 1,683	$ 1,647	$ 1,604	$ 1,585	$ 1,574	$ 1,549	$ 1,500	$ 1,449	$ 1,423	$ 36,427

Note: This is an economic analysis conducted to generate a rough order of magnitude (ROM) cost of various 9-1-1 investment scenarios for the United States as a whole. It is not intended to help determine individual state or locality system requirements, budget needs, or to serve as a funding decision analysis tool

Uncertainty analysis was conducted to determine expected costs for the configuration of the architecture per deployment scenario

- Calculations are based on AACE International Cost Estimating Guidance
- Order of magnitude estimates are calculated where project is defined as the *Concept Screening* phase
  - Low end range of -15 percent to -3 percent
  - High end range of +2 percent to +50 percent
- For uncertainty analysis, a **-25% to +50%** range was applied to the following factors:
  - Personnel Salaries (Current and NG9-1-1 environments)
  - NG9-1-1 Hardware
  - NG9-1-1 Software
  - Labor Costs for Installation and Operations and Maintenance
- Five hundred trials/iterations were run to arrive at the defined resultant ranges
- There is a confidence level of 95 percent that sample results fall within one standard deviation of mean
- The lower bound, most likely, and upper bound cost results were then risk adjusted through the incorporation of risk factors derived in **Appendix C**, and used to provide the range of costs identified in this report

Appendices

The probability that the risks would materialize during the lifecycle of each alternative were evaluated

Risk Probability Estimation

Risk Structure	Probability		
Risk Input by Alternative	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**
1.0 Program Resources/Acquisition			
Increasing costs or incomplete/untimely design and standards owing to monopolies in the supply chain	High	Medium	Medium
2.0 Technology			
Inability of system to meet functional requirements	High	Low	Low
Use of proprietary standards (open standards not developed)	High	Low	Low
Failure of vendors' systems to keep pace with required system goals, use of workarounds that prevent system development and evolution	High	Medium	Medium
3.0 Security and Privacy			
Loss of public confidence over time because of inadequate security levels due to bandwidth limits, internal controls, or degradation of security performance	Low	Medium	Medium
Loss of public confidence over time as a result of unauthorized access to confidential information	Low	Medium	Medium
4.0 Strategic/Political			
Inadequate federal, state, and local legislative or regulatory support (does not include funding—see risk category 7)	Low	High	High

The probability that the risks would materialize during the lifecycle of each alternative were evaluated (cont'd)

Risk Probability Estimation

Risk Structure	Probability		
Risk Input by Alternative	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**
5.0 Organizational and Change Management			
Minimal stakeholder adoption of new technologies and processes	Medium	Medium	Medium
Increased call processing time because of volume and complexity of incoming data	Medium	High	High
Loss of human capital	Medium	Medium	Medium
Unwillingness of jurisdictions to set aside traditional/historical parochial interests to collaborate with one another	Medium	High	High
6.0 Business/Industry			
Lack of vendor 9-1-1 expertise	Medium	High	High
Unwillingness or inability of current private sector service providers to keep up with changing service level requirements	Medium	High	High
7.0 Funding			
Unwillingness to share costs (e.g., backbone, interfaces)	Low	High	High
Inability of funding models to meet project needs because of surcharge assessment and remittance inadequacies	Medium	High	High
Inequity in service resulting from urban-rural funding disparities	High	Medium	Medium
8.0 Public			
Lack of public knowledge and awareness of 9-1-1 system capabilities and functionality	Low	Medium	Medium

The impact of the realization of risks on costs and value over the lifecycle were evaluated for each alternative under study

Risk Impact Estimation on Cost and Value (1, 2, and 3)

Risk Structure	Cost Impact			Value Impact		
Risk Input by Alternative	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**
1.0 Program Resources/Acquisition						
Increasing costs or incomplete/untimely design and standards owing to monopolies in the supply chain	Low	Medium	Medium	Low	High	High
2.0 Technology						
Inability of system to meet functional requirements	Medium	Low	Medium	High	High	High
Use of proprietary standards (open standards not developed)	Low	Medium	Medium	Low	High	High
Failure of vendors' systems to keep pace with required system goals, use of workarounds that prevent system development and evolution	Medium	Medium	High	High	High	High
3.0 Security and Privacy						
Loss of public confidence over time because of inadequate security levels due to bandwidth limits, internal controls, or degradation of security performance	Low	Medium	Medium	Low	High	High
Loss of public confidence over time as a result of unauthorized access to confidential information	Low	Low	Low	Low	High	High

The impact of the realization of risks on costs and value over the lifecycle were evaluated for each alternative under study (cont'd)

Risk Impact Estimation on Cost and Value (4, 5, and 6)

Risk Structure	Cost Impact			Value Impact		
Risk Input by Alternative	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**
4.0 Strategic/Political						
Inadequate federal, state, and local legislative or regulatory support (does not include funding - see risk category 7)	Low	High	High	Low	High	High
5.0 Organizational and Change Management						
Minimal stakeholder adoption of new technologies and processes	Low	Medium	High	High	High	High
Increased call processing time because of volume and complexity of incoming data	Medium	High	High	Medium	Medium	Medium
Loss of human capital	High	High	High	High	Medium	Medium
Unwillingness of jurisdictions to set aside traditional/historical parochial interests to collaborate with one another	Low	High	Medium	Low	High	High
6.0 Business/Industry						
Lack of vendor 9-1-1 expertise	Medium	Low	Low	High	High	High
Unwillingness or inability of current private sector service providers to keep up with changing service level requirements	Medium	Low	Low	High	High	High

The impact of the realization of risks on costs and value over the lifecycle were evaluated for each alternative under study (cont'd)

Risk Impact Estimation on Cost and Value (7 and 8)

Risk Structure	Cost Impact			Value Impact		
Risk Input by Alternative	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**	**9-1-1 Baseline (Current Environment)**	**NG9-1-1 Uniform**	**NG9-1-1 Hybrid**
7.0 Funding						
Unwillingness to share costs (e.g., backbone, interfaces)	Low	High	Medium	Low	Medium	Medium
Inability of funding models to meet project needs because of surcharge assessment and remittance inadequacies	None	None	None	High	High	High
Inequity in service resulting from urban-rural funding disparities result in	High	High	High	High	Medium	Medium
8.0 Public						
Lack of public knowledge and awareness of 9-1-1 system capabilities and functionality	Medium	High	High	Low	Medium	Medium

For each risk, the cost element(s) that would be affected if that risk were realized were identified

Cost Risk Mapping (1, 2, and 3)

Risk Description	1. Planning	2. Acquisition and Implementation	3. O&M
1.0 Program Resources/Acquisition			
Increasing costs, incomplete/untimely design and standards, and inability of new competitors to enter markets owing to monopolies in the supply chain due to natural supply shortages or mergers and acquisitions		X	X
2.0 Technology			
Inability of system to meet functional requirements		X	X
Use of proprietary standards (open standards not developed)	X	X	X
Failure of vendors' systems to keep pace with required system goals, use of workarounds that prevent system development and evolution	X	X	X
3.0 Security and Privacy			
Loss of public confidence over time because of Inadequate security levels due to bandwidth limits, internal controls, or degradation of security performance			X
Loss of public confidence over time as a result of unauthorized access to confidential information			X

For each risk, the cost element(s) that would be affected if that risk were realized were identified (cont'd)

Cost Risk Mapping (4, 5, and 6)

Risk Description	1. Planning	2. Acquisition and Implementation	3. O&M
4.0 Political/Strategic			
Inadequate federal, state, and local legislative or regulatory support	X	X	X
5.0 Organizational and Change Management			
Minimal stakeholder adoption of new technologies and processes	X		X
Increased call processing time due to volume and complexity of incoming data	X		X
Loss of human capital		X	X
Unwillingness of jurisdictions to set aside traditional/historical parochial interests to collaborate with one another	X	X	X
6.0 Business Industry			
Lack of vendor 9-1-1 expertise	X	X	X
Unwillingness or inability of current private sector service providers to keep up with changing service level requirements		X	X

For each risk, the cost element(s) that would be affected if that risk were realized were identified (cont'd)

Cost Risk Mapping (7 and 8)

Risk Description	1. Planning	2. Implementation and Acquisition	3. O&M
7.0 Funding			
Unwillingness to share costs (e.g., backbone, interfaces)		X	X
Inability of funding models to meet project needs due to surcharge assessment and remittance inadequacies	X	X	X
Inequity in service resulting in urban-rural funding disparities			
8.0 Public			
Lack of public knowledge and awareness of 9-1-1 system capabilities and functionality			X

For each risk, the value factors that would be affected if that risk were realized were identified

Value Risk Mapping (1, 2 and 3)

Risk Description	Direct User	Operational/ Foundational	Strategic/ Political	Social
1.0 Program Resources/Acquisition				
Increasing costs, incomplete/untimely design and standards, and inability of new competitors to enter markets owing to monopolies in the supply chain due to natural supply shortages or mergers and acquisitions		X		
2.0 Technology				
Inability of system to meet functional requirements	X	X		X
Use of proprietary standards (open standards not developed)		X	X	
Failure of vendors' systems to keep pace with required system goals, use of workarounds that prevent system development and evolution	X	X	X	X
3.0 Security and Privacy				
Loss of public confidence over time because of inadequate security levels due to bandwidth limits, internal controls, or degradation of security performance	X			X
Loss of public confidence over time as a result of unauthorized access to confidential information	X			X

For each risk, the value factors that would be affected if that risk were realized were identified (cont'd)

Value Risk Mapping (4, 5, and 6)

Risk Description	Direct User	Operational / Foundational	Strategic /Political	Social
4.0 Political/Strategic				
Inadequate federal, state, and local legislative or regulatory support	X	X	X	X
5.0 Organizational and Change Management				
Minimal stakeholder adoption of new technologies and processes	X	X	X	X
Increased call processing time because of volume and complexity of incoming data	X	X	X	X
Loss of human capital	X	X	X	
Unwillingness of jurisdictions to set aside traditional/historical parochial interests to collaborate with one another	X	X	X	X
6.0 Business/Industry				
Lack of vendor 9-1-1 expertise		X	X	
Unwillingness or inability of current private sector service providers to keep up with changing service level requirements	X	X		

For each risk, the value factors that would be affected if that risk were realized were identified (cont'd)

Value Risk Mapping (7 and 8)

Risk Description	Direct User	Operational / Foundational	Strategic /Political	Social
7.0 Funding				
Unwillingness to share costs (e.g. backbone, interfaces)			X	X
Funding models cannot meet project needs because of surcharge assessment and remittance inadequacies			X	X
Urban-rural funding disparities result in inequity in service	X			X
8.0 Public				
Lack of public knowledge and awareness of 9-1-1 system capabilities and functionality	X			X

Risk probability and impact are measured based on a qualitative scale of High, Medium, and Low

- The probability and impact of identified risks were determined on a qualitative scale with SME* input and mapped to the identified values and costs for both the current 9-1-1 and NG9-1-1 environments
  - Once the risk structure was defined, the next step was to assess the probability that the risks would materialize during the lifecycle for the current and NG9-1-1 environments
  - Assessing the impact of risk on value and cost is a two-step process. First, the impact was measured; second, the impact was applied to a value. Not every value or cost was affected by every risk factor. Employing the defined scale, the team assigned and impact of high, medium, low, or none to each risk factor. Then, the impact was applied to the affected value and cost factors
- The likelihood of a risk occurring is weighed, and then the magnitude of its effect on the identified value or cost is assigned based on the table below

Probability and Cost and Value Impact

Scale	Probability	Cost Impact	Value Impact
High	50%	10%	-10%
Medium	30%	5%	-5%
Low	10%	2%	-2%
None	0%	0%	0%

**SME input provided by project team*

Risk adjustments were made by combining the probability of a risk occurring with the magnitude of its likely impact on both benefit and cost, and then mapping it to the appropriate areas of the value and risk structures

Probability of risk happening (%)	*X*	***Likely Impact on Cost (+) should risk occur (%)***	=	***Total Risk adjustment to be made to cost category***
Probability of risk happening (%)	*X*	***Likely Impact on Value (-) should risk occur (%)***	=	***Total Risk adjustment to be made to Value Factor Categories***

Example: Monopolies in the Supply Chain, NG9-1-1 Uniform, Total Cost

In looking at this risk, it was determined that the likeliest areas of impact were on Operational/Foundational Value and Implementation and Acquisition and O&M costs

The weighted value score for Operational/Foundational Value: ***21.48***

Total Cost for I&A: **$8,714 Billion** *Total Cost for O&M:* ***$51,147 Billion***

Risk Probability of Occurrence: Medium *Value Impact: Medium* *Cost Impact: High*

Probability Factor x Value Impact = 30% x -5% = -1.5% , Probability Factor x Cost Impact = 30% x 10% = +3%

Risk Adjusted Value = 21.48 x -1.5 + 21.48 = ***21.15***

Risk Adjusted I&A cost = $8,714 x 3% + $8,714 = ***$8,975 Billion*** *, Risk Adjusted O&M Cost = 51,147 x 3% + 51,147 =* ***$52,681 Billion***

Appendices

Glossary/Acronyms (in alphabetical order)

- AACE: Association for the Advancement of Cost Engineers
- AHP: Analytic Hierarchy Process (Saaty TL, 1980, The Analytic Hierarchy Process, NY, McGraw Hill)
- (IP) ACD: (Internet Protocol) Automatic Call Distributor
- ACN: Action Control Number
- ALI: Automatic Location Identification
- ANI: Automatic Number Identification
- ASP: Application Service Provider
- C&A: Certification and Accreditation
- CER: Cost Estimating Relationship
- CPE: Customer Premises Equipment
- CY: Current Year
- DBA: Database Administrator
- DBMS: Database Management System
- Discounted Costs: Discounting future benefits and costs reflects the time value of money. Benefits and costs are worth more if they are experienced sooner
- Erlang: A measure of intensity of traffic on a circuit, equal to the average number of circuits in use
- ESRP: Emergency Services Routing Proxy
- E9-1-1 or "Wireless": Enhanced 9-1-1 system
- FCC: Federal Communications Commission
- FTE: Full-Time Equivalent
- FY: Fiscal Year
- GIS: Geographic Information System
- IP: Internet Protocol
- IT: Information Technology
- MPC/VPC: Mobile Positioning Center/ Voice over IP Positioning Center
- Kimball: L. Robert Kimball and Associates (consulting firm)
- LAN: Local Area Network
- Lifecycle Cost: The overall estimated cost for a particular program alternative over the time period corresponding to the life of the program, including direct and indirect initial costs plus any periodic or continuing costs of operation and maintenance.

Glossary/Acronyms (continued)

- NENA: National Emergency Number Association
- NG9-1-1 or NG: Next Generation 9-1-1 system
- Nominal Value: Economic units measured in terms of purchasing power of the date in question. A nominal value reflects the effects of general price inflation.
- NPRM: Notice of Proposed Rulemaking
- O&M: Operations & Management
- ODC: Other Direct Cost
- OMB: Office of Management and Budget
- POC: Proof of Concept
- POP: Point of Presence
- PSAP: Public Safety Answering Point
- RCF: Remote Call forwarding
- R&D: Research & Development
- RDBMS: Relational Database Management System
- RIF: Reduction in Force
- ROM: Rough Order of Magnitude
- SDO: Standards Development Organization
- SME: Subject Matter Expert
- TN: Telephone Number
- TY: Then Year
- USDOT: United States Department of Transportation
- "Unit": a population size that could be used as a building block for national deployment
- VMM: Value Measuring Methodology
- VoIP: Voice over IP
- WAN: Wide Area Network

NENA's Master Glossary of 9-1-1 Terminology is available for download at:
http://www.nena.org/pages/ContentList.asp?CTID=68

Key non-9-1-1 References:

- *Booz Allen IC: Booz Allen Intellectual Capital pulled from previous, related work*
- *ACEIT: Automated Cost Estimating Integrated Tool: a widely used cost estimating tool. More information is available at: http://www.aceit.com*

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