Intelligent Transportation Systems
U.S. Department of Transportation

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

Executive Summary: Preliminary Analysis of Cost, Value, and Risk

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Access to emergency services provided by 9-1-1 in today's world is evolving. The U.S. Department of Transportation (USDOT) understands that 9-1-1 will ultimately become part of a broader array of interconnected networks supporting emergency services from public access to the delivery of emergency information to dispatchers and first responders. However, the decision to deploy a new, IP-based "Next Generation 9-1-1" (NG9-1-1), system is not a simple one, and is affected by many complex factors surrounding institutional and service arrangements, equipment and infrastructure, and funding.

The purpose of *The Next Generation 9-1-1 (NG9-1-1) System Initiative Preliminary Analysis of Cost, Value and Risk* report is to examine the costs, value, and risk associated with moving to a next generation environment. This analysis focuses on the estimation of the lifecycle costs, identification of key values and risks inherent in each alternative, and a comparison the risk-adjusted lifecycle costs and values. This *Preliminary Analysis of Cost, Value, and Risk* is consistent with the USDOT's NG9-1-1 Initiative's previous work, which includes the NG9-1-1 Concept of Operations, High Level Requirements, and Architecture Analysis.[1] **Our preliminary analysis shows that NG9-1-1 provides considerably more value while maintaining a total cost within the range of our baseline analysis.**

The four alternatives identified by the NG9-1-1 project team and analyzed were:

- **Alternative 1 – Baseline (Lower Bound)**: The costs, value and risks of continuing the current 9-1-1 environment (low-end estimate);
- **Alternative 2 – Baseline (Upper Bound):** The costs, value and risks of continuing the current 9-1-1 environment (high-end estimate);[2]
- **Alternative 3 - NG9-1-1 (Total Cost):** A total cost of ownership for a national deployment of the NG9-1-1 system alternative (high range);
- **Alternative 4 - NG9-1-1 (Cost Share):** A "cost-sharing" sharing scenario for the implementation and ongoing operations of the NG9-1-1 system where emergency system stakeholders share additional data center and network costs with other local government agencies.

METHODOLOGY

In conducting the preliminary analysis, the project team utilized the Value Measuring Methodology (VMM).[3] The objective of VMM is to capture the full range of cost and value provided by a particular alternative, while considering project risks that might

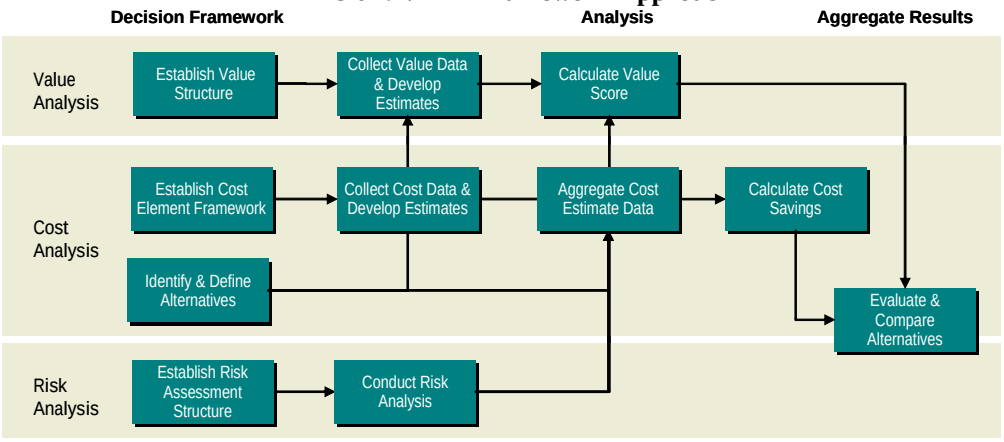
[1] *USDOT NG9-1-1 System Initiative Concept of Operations*, March 2007, *USDOT NG9-1-1 System Initiative High Level Requirements*, July 2007, and *USDOT NG9-1-1 System Initiative Architecture Analysis Report*, November 2007 are available at http://www.its.dot.gov/ng911/ng911_pubs.htm, (accessed on 01/16/2008)

[2] http://www.nena.org/media/files/NENASWATStaffingReport-5Jan04revpart3.pdf, (accessed on 01/18/2008)

[3] http://www.cio.gov/documents/ValueMeasuring_Highlights_Oct_2002.pdf, (accessed on 01/16/2008

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, while allowing the calculation of non-financial value that might be unaccounted for in traditional financial metric calculations. This allows for more rigorous comparison of alternatives than would be found under a basic lifecycle cost analysis.
The VMM framework approach is presented in Exhibit 1.

Exhibit 1: VMM Framework Approach



The major steps of the analysis are summarized below:

- **Cost Analysis**—A rough order of magnitude (ROM) cost estimate for each alternative was developed using a cost element structure (CES) that segmented costs into different stages of a national deployment program lifecycle;
- **Value Analysis**—Non-financial value measures were identified and evaluated in a structured decision framework. For the non-financial analysis, the project team established weighted value measures for use in estimating the ability of each alternative to meet key criteria;
- **Risk Analysis**—Risks were identified leveraging input from stakeholder representation and industry publications. The probabilities of both the occurrence and impact of these risks were evaluated and assessed for cost and non-financial value. Risk impacts were then determined and applied to develop risk-adjusted costs and a risk adjusted value score;
- **Aggregate Results**—The final recommendation regarding the best alternative to pursue was based on integration of the cost, value, and risk analysis for each defined alternative.

RESULTS

Cost, value, and risk were defined for each alternative and ultimately were used to formulate recommendations documented in this report.

Cost Analysis

High level cost range estimates are based upon the NG9-1-1 Concept of Operations, High Level Requirements, and Architecture Analysis, research studies conducted by industry experts, project team input, industry benchmarks, and Booz Allen intellectual capital.

Cost elements are segmented by Planning, Acquisition and Implementation, and Operations and Maintenance for the four alternative scenarios. Baseline costs are based on subject matter expert (SME) input and segmented by population and current 9-1-1 system technology levels on a county-by-county basis. An NG9-1-1 notional rollout strategy is defined for national deployment of the system from which to base cost estimates. The results of the cost analysis across all alternatives, presented in 2008 dollars, are summarized in the following table:

Exhibit 2: 9-1-1 System Lifecycle Cost Analysis (20 Year Lifecycle)

Values in Then Year $B	Baseline 9-1-1 (Low)	Baseline 9-1-1 (High)	NG9-1-1 Total Cost	NG9-1-1 Cost Share
1.0 Planning	-	-	$.55	$.35
2.0 Acquisition and Implementation	$9.27	$13.15	$10.33	$7.41
3.0 Operations and Maintenance	$46.39	$65.81	$52.85	$50.18
Total Lifecycle Costs (Point Estimate)	**$55.67**	**$78.97**	**$63.73**	**$57.94**

Each lifecycle cost aspect summarized in the table above represents a 20 year total cost estimate for the activity listed in the left hand column. For example, for the Baseline 9-1-1 (Low) alternative, the total cost over 20 years for the Acquisition and Implementation of system upgrades is estimated to be approximately $9 billion for national deployment. The analysis is based upon the assumption that the labor used and the geographic locations of the PSAPs remain consistent with those already in existence. Lifecycle costs indicate that the overall costs resulting from NG9-1-1 implementation over the 20-year period are comparable to those of today's 9-1-1 system.

Value Analysis

Key value elements of the 9-1-1 system overall were identified and weighed through an Expert Choice session, based upon the Analytical Hierarchy Process (AHP).[4] After defining the key values of the 9-1-1 system, the NG9-1-1 project team and key stakeholder representatives weighted key values separately and generated a consensus on the relative importance of each value in the decision-making process. Performance and effectiveness measures were identified for each of the key value elements (below) and evaluated across the alternatives (defined above) to arrive at a value score for each alternative. Results indicate that the greatest value of 9-1-1 relates to the direct user benefits, with accessibility and reliability of the service scoring the highest marks. Government foundational and operational benefits were determined to be of next importance. Value analysis findings are presented in the Exhibit 3.

[4] Saaty, T.L., The Analytic Hierarchy Process, McGraw Hill, New York, 1980. AHP is a structured technique for addressing complex problems and decisions, in which alternatives are identified and valued based on expert opinion.

Exhibit 3: 9-1-1 System Value Analysis Results

		Current Environment	NG9-1-1
Value Factors & Benefits	**Weight**	**Score**	**Score**
Direct User Benefits	**52%**	**25.90**	**44.17**
Accessibility	38%	9.87	19.74
Timeliness	20%	5.23	6.10
User Satisfaction	6%	1.42	2.14
Reliability of Service	26%	6.81	11.92
Ease of Use	10%	2.56	4.27
Social Value	**14%**	**6.80**	**10.14**
Public Safety	51%	3.46	5.19
Safety to Responder	20%	1.39	1.39
Efficient Use of Taxpayer Dollars	19%	1.26	2.53
Energy & Environment	10%	0.69	1.03
Government Foundational/Operational Value	**20%**	**10.10**	**12.62**
Scalability & Adaptability of System Functionality & Usage	16%	1.59	2.77
Information Accuracy	19%	1.93	2.89
Data Management	20%	2.05	2.05
Operational Efficiency	10%	1.00	2.00
Data Sharing	11%	1.15	2.30
Security and Privacy	24%	2.38	0.60
Strategic / Political Value	**8%**	**3.90**	**6.57**
Public Trust	6%	0.25	0.37
Coordination between 9-1-1 & Other Public Services	17%	0.68	1.36
Alignment of Strategic Goals	7%	0.26	0.39
Technology Standards	18%	0.70	1.05
Consistency and standardization of Laws & Regulations	8%	0.31	0.46
Coordination Between Domestic PSAPs	16%	0.62	1.25
Coordination Between US PSAPs on an International Basis	4%	0.15	0.30
Strategic Use of Resources & Data	16%	0.63	0.78
Coordination with Industry	8%	0.30	0.60
Government Financial Benefits	**7%**	**3.30**	**6.60**
Cost Savings	43%	1.42	2.84
Cost Avoidance	57%	1.88	3.76
Total	**100%**	**50.00**	**80.10**

The NG9-1-1 alternative consistently scored higher values than the current environment, especially benefits like accessibility, reliability of service, and general public safety. While security and privacy values in the NG9-1-1 environment scored lower than the current environment, these are driven by the issues surrounding moving to an IP-based system where data are potentially more accessible—a factor, in itself, that supports the value of being able to access new and additional data that may be beneficial to response and incident outcome. On the other side, the largest point differentials in favor of NG9-1-1 came in the categories of Accessibility and Reliability of Service, reflecting the increasing number of ways in which the 9-1-1 network can be accessed and the redundant nature of PSAP to PSAP linkages in an NG9-1-1 alternative, respectively.

Risk Analysis

The NG9-1-1 project team factored in the risk inherent to each alternative as a means of forecasting costs and values over the lifecycle. Thirty-five key risks were identified across eight categories that may be applicable to both the current and NG9-1-1 environments. Risks fell into categories including:

- Program Resources and Acquisition
- Technology
- Security and Privacy
- Political and Strategic
- Organizational and Change Management
- Business and Industry
- Funding
- Public

The probability of risks occurring under each alternative as well as the impact to both value and cost were evaluated to determine a risk factor for each cost and value element. Once risks were applied to the prospective values and costs of each alternative, results indicated that the NG9-1-1 system may have significant value in comparison to the current environment. The full range of the risk-adjusted costs and values are presented in the following tables, based on a range of uncertainty (± 25%) applied to those individual cost estimates whose actual future value may differ from the expected values attributed to them by the NG9-1-1 team. Specific costs that may vary in the future were identified by the team, and a Monte Carlo simulation run to identify the lowest, highest, and most likely outcomes of varying each uncertain cost within the range. The "Low-End" lifecycle cost represents the lowest possible cost for each alternative – it assumes that uncertain costs are actually lower than those estimated by the project team for each scenario (pre-risk adjustment). "Mid-Point" costs represent the expected costs identified by the project team for each alternative (both with and without risk adjustment) and "High-End" costs represent the most expensive possible case for each alternative (uncertain costs end up higher than the estimated values in each scenario). The "risk adjustments" are calculated based on the projected magnitude and impact of the risks identified in the list above. SME estimates were used in the formation of the risk ratings, and the effects summarized in the tables below:

Exhibit 4: 9-1-1 System Risk-Adjusted Lifecycle Costs (20-Year Lifecycle)

Costs in Then Year $B	Baseline 9-1-1 (Low)	Baseline 9-1-1 (High)	NG9-1-1 Total Cost	NG9-1-1 Cost Share
Risk Adjustment	**28%**		**56%**	
Low-End Lifecycle Cost	$53.07	$75.28	$61.74	$55.89
Mid-point Lifecycle Cost Estimate	$55.67	$78.97	$63.73	$57.94
Risk Adjusted Expected Lifecycle Cost (Mid-point)	**$71.25**	**$101.05**	**$98.82**	**$90.19**
Risk Adjusted High-End Lifecycle Cost	$79.39	$112.60	$110.69	$101.42

Exhibit 5: 9-1-1 System Risk-Adjusted Value Analysis

	Current 9-1-1 Environment (Low and High)	NG9-1-1 Total Cost And Cost Share
Estimated Value Score	50	80.10
Total Risk Adjusted Value Score	**32.82**	**43.06**

Note: "Estimated Value Scores" are totals from Exhibit 3 (above)

It is important to note that, after accounting for risks, the overall cost of an alternative will increase, while the value provided under that alternative will decline. For example, the overall value of the NG9-1-1 Total Cost alternative is higher than that of the Current 9-1-1 Environment, but because it is perceived as presenting significantly more risk overall to transition to a new system than to maintain the current one, the overall risk adjustment is greater for the NG9-1-1 alternative than it is for the Current 9-1-1 Environment. This trend is reflected in the scores presented in Exhibit 5.

CONCLUSIONS

Based upon this analysis, it can be concluded that:

- After adjusting for the risks inherent in the upgrade to an NG9-1-1 alternative, the NG9-1-1 Total Cost and Cost Share alternatives have total lifecycle costs that are within the range of the current 9-1-1 environment's lifecycle costs. This makes choosing between the NG9-1-1 and Current Environment alternatives mainly 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.

The second conclusion above is based on several trends identified during the value analysis process, primarily that:

- NG9-1-1 provides greater opportunities for cost savings 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; and
- NG9-1-1 has greater potential to increase public and responder safety through interconnectivity and interoperability than the current 9-1-1 environment.

Given the importance of 9-1-1 emergency response for public safety, national security and disaster relief purposes, it is critical that 9-1-1 systems continue to evolve with technology and public demands. This analysis indicates that the preferred solution is to migrate to the NG9-1-1 environment. Ideally, this migration will serve and benefit the entire public safety community. While significant risks are inherent to such a major initiative, the NG9-1-1 Total Cost alternative remains the most conservative alternative and clearly provides considerable value in improved service to all stakeholders through improved operations and redundancy in the system. Based on this preliminary analysis of cost, value, and risk for NG9-1-1, the Project Team will develop a final analysis document by soliciting additional stakeholder comments, refining cost assumptions, and incorporating any lessons learned from a Proof-of-Concept (POC) Demonstration System that USDOT will be implementing this year.