SAFECOM

2006 National Interoperability Baseline Survey

December 2006

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EXECUTIVE SUMMARY

In May 2006, the Department of Homeland Security (DHS) announced plans to conduct a landmark study of public safety wireless communications interoperability in the Nation. Commissioned as part of the ongoing efforts of the SAFECOM program to improve public safety wireless communications, and building upon past work in this subject area, this study brings a new scope and breadth to the subject matter. Specifically, this study is unique in its:

- *Inclusiveness of first responder groups.* This study surveyed both fire response/emergency medical services (EMS) and law enforcement agencies in all 50 states and the District of Columbia.

- *Size of sample.* The survey was issued to about 22,400 agencies nationwide. The size of our respondent pool, 6,819 agencies, allows findings to be reported at a 99-percent confidence level and +1.46-point confidence interval, based on the national population of first responders. Figure ES-1 presents a comparison of the distribution of first responder disciplines in the national population and in our baseline respondent pool.
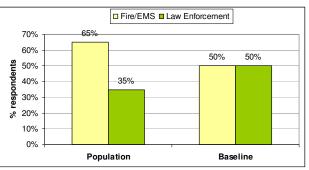

Figure ES-1—Comparison by Discipline

- *Comprehensive definition of interoperability.* Although interoperability studies have often focused on equipment and some planning, this survey used, as its foundation, the SAFECOM Interoperability Continuum (Figure 1, page 1). The Continuum accounts for the elements of governance, policy, technology, training, and usage that are required for building and sustaining the capacity to interoperate. Each element was divided into component sub-elements, for which specific questions were devised.

- *Scaled measurement of interoperability.* Each Continuum-based question employed a response scale that defined early, moderate, full, or advanced stages of development (see sidebar for definitions).

- *Recognition that the capacity for interoperability may vary among different responders.* First responders interviewed while developing this project agreed that the ability to interoperate may vary according to what agencies are involved in incident response. This study accounted for three "levels" of interoperability. These levels include interoperability across disciplines (i.e., between law enforcement and fire response within the same jurisdiction), across jurisdictions (i.e., between agencies of the same discipline across local jurisdictions), and between agencies of the same discipline across state and local government.

> **Definitions**
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> **Early**—Little or no activity in the sub-element
> **Moderate**—Some progress in the sub-element
> **Full**—Substantially complete progress in the sub-element
> **Advanced**—Efforts to sustain and assure continuous improvement of interoperability into the future.

All these points combine to create a report with greater measurement precision and statistical confidence than any studies on this issue to date. The major findings are summarized below:

- *About two-thirds of agencies report using interoperability to some degree in their operations.* According to our frequency of use and familiarity question, which addresses how often and in what situations interoperability are used, about one-third of agencies use interoperability

primarily for out-of-the-ordinary events, and another third interoperate both for out-of-the-ordinary events and in their day-to-day operations.

- ***Technology and some governance sub-elements response results demonstrated the highest stages of development on the Continuum***. SAFECOM's survey findings indicate the Nation as a whole falls largely into the early stages for most of the Continuum-based sub-elements, with two notable exceptions. Under the technology element, a full third or more of agencies fall into the full stage. In addition, the governance element contained the only question (decision making groups) in which a majority of agencies indicate progress that equates to the moderate stage of development.

- ***The smallest agencies, as a group, tend to be at earlier stages of development than larger agencies***. For any given sub-element question, agencies serving small populations (2,500 or fewer residents) are more likely than agencies serving more than 2,500 to indicate progress that equates to early development. Conversely, those agencies serving large populations (more than 25,000) are more likely than are other agencies to respond in the moderate, full, and advanced stages. This same pattern is evident when evaluating individual disciplines by size, although there are a few topics for which this pattern does not hold for fire response/EMS agencies.

- ***Fire response/EMS and law enforcement agencies tend to show the same level of development in most areas of the Continuum.*** Conversations with law enforcement and fire response/EMS personnel during survey development uncovered many operational differences between the two disciplines, leading to a hypothesis that they would differ significantly in their development of interoperability capabilities. However, differences between the disciplines were fewer and less dramatic than anticipated. Of the 32 Continuum-based questions in the survey, only one-quarter showed statistically significant differences between the two disciplines.

- ***Cross-discipline and cross-jurisdiction interoperability tends to be at a more advanced stage than state-local interoperability***. Agencies reported more progress in achieving interoperability across disciplines and across jurisdictions; interoperability between state and local government agencies tended to be in the early stages.

- ***Agencies that operate on large, shared systems tend to be at more advanced stages of development than those that operate on stand-alone systems.*** Agencies that use a multi-agency, multi-jurisdictional shared communications system are more likely than the survey population as a whole to be in moderate, full, or advanced stages of development. Agencies that own and operate their own systems are more likely than the survey population as a whole to be in the early stage.

  Agency size also plays a role in shared system participation. The smallest agencies are more likely (43 percent) than larger agencies (34 percent) to be part of a large shared system. Conversely, agencies serving populations greater than 10,000 or more have a greater likelihood than smaller agencies of operating on stand-alone systems (26 percent versus 17 percent). This makes sense, in that larger jurisdictions are likely to be better funded and capable of procuring their own communications systems.

  However, this finding is also somewhat counter-intuitive—if small agencies are more likely to be on large shared systems, they should also more likely be in more advanced stages of the Continuum. Further analysis shows that while small agencies on shared systems appear to have an advantage over those on stand-alone systems, they are not as advanced as the larger agencies on the shared systems. Both size and system appear to contribute to the stage of development.

- *Five significant predictors of frequency of use and familiarity emerge from the analysis.* A logistical regression analysis of the data shows that a high score on five questions—approaches, implementation, exercises, command and control, and standard operating procedures (SOPs)—significantly predicts a high score in frequency of use and familiarity, across the three interoperability levels. However, identifying these five questions as particularly related to usage does not imply that the other Continuum sub-elements are unimportant.

   Although the other Continuum-based questions are not statistically significant predictors of high interoperability use, the subjects they address do play a role in the pursuit of interoperable communications. Additional logistical regression analysis also identified statistically significant relationships with the five "predictor" sub-elements identified above that involved decision making groups, agreements, funding for capital investments, and strategic planning.

Taken together, these findings indicate that the capacity for interoperability is a complex issue that is likely affected by many variables. Nonetheless, these findings can provide important insights to policy makers and public safety officials on how interoperability is being addressed and by what types of agencies. The findings can be used to inform and tailor further plans to provide the education, incentives, and planning needed to continue improving interoperability capabilities across the Nation.

I.   INTRODUCTION

In May 2006, the Department of Homeland Security (DHS) announced plans to conduct a landmark *National Interoperability Baseline Survey*. Commissioned as part of the ongoing efforts of the SAFECOM program within DHS, the study represents the first comprehensive effort to survey public safety first responder agencies across law enforcement, fire response, and emergency medical services (EMS) disciplines in all 50 states and the District of Columbia.

Purpose

The goal of the *National Interoperability Baseline Survey* is to create a national and statistically valid snapshot of the capacity for and use of interoperability. The study plan engaged the public safety community to develop a descriptive and measurable definition of interoperable communications and a robust measurement methodology. In contrast to other studies on interoperability conducted over the past 10 years, this study is designed to assess the five critical elements—governance; policies, practices, and procedures; technology; training and exercises; and usage—that determine an organization's capacity for interoperability. These five critical elements of interoperability, as codified by the SAFECOM program in 2004 and published as the "Interoperability Continuum" (see Figure 1), were developed in partnership with the public safety community and used as a starting point in the development of the survey questions for this study (see Section II: Methodology).

This study provides data that will contribute to the following overall objectives:

- Determine the capacity for interoperable communications among law enforcement and fire response/EMS agencies across the Nation.

- Establish a process and mechanism to make it possible for agencies to regularly measure communications interoperability.

- Help emergency response officials make better-informed decisions about how to most effectively allocate resources for improving communications interoperability.

- Guide and measure the effectiveness of future communications interoperability improvement efforts that local, tribal, state, and Federal emergency response organizations execute.
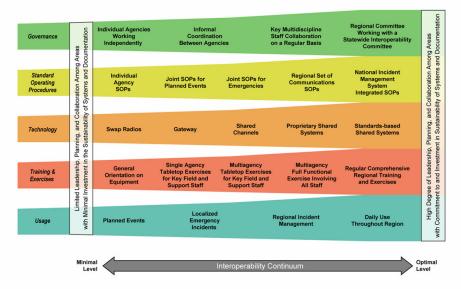

Figure 1—SAFECOM Interoperability Continuum

Background
Communications interoperability refers to the ability of first responders to communicate on demand, in real time, when needed, and as authorized. When interoperability is fully available, police, firefighters, and emergency medical personnel are able to talk to each other seamlessly to coordinate efforts during a routine incident, disaster situation, or special event.

Ten years ago, interoperability was considered an issue for radio technicians. Citizens, politicians, and the media assumed radios worked automatically and instantaneously as depicted in Hollywood movies and television. First responders in the field learned to work around the interoperability problem, as best they could, and depended on their own tenacity and creativity to bridge the communications gaps. However, in 1996, leaders in the public safety community and wireless industry came together in a special advisory committee sponsored by the Federal Communications Commission (FCC) to understand shortfalls in public safety wireless communications. They published a report[1] that noted the critical need for improvements to communications interoperability for public safety agencies operating at all levels of government across the Nation.

As a result of this report, two key studies were performed. In 1998, the National Institute of Justice (NIJ) published *State and Local Law Enforcement Wireless Communications and Interoperability*[2]. This report provided the first quantitative data on interoperability from state and local law enforcement agencies nationwide. The next year, the Public Safety Wireless Network (PSWN) Program published the results of a similar survey in *PSWN Program's Analysis of Fire and EMS Communications Interoperability*[3]. That survey centered on the firefighting and EMS agencies. Both studies focused on the first responders' current and planned use of communications equipment and their experience with interoperability. Based on these findings and advances in the wireless industry, the public safety community and Federal Government began investing millions of dollars to address the problem of communications interoperability. Some efforts were technical, some were financial, and some were related to fostering coordination and partnerships across levels of government.

> *Public Safety Interoperability Challenges and Issues*
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> - 60,000+ public safety agencies with more than 2.5 million personnel
> - Multiple disciplines (e.g., Law Enforcement, Fire Response, Emergency Medical Services)
> - Multiple tiers of government (e.g., township, city, county/parish, state)
> - Technology differences (e.g., multiple system manufacturers, different communication modes, varied frequency bands)
> - Operational differences between public safety disciplines
> - Differences in rural versus urban mission operations

While these efforts achieved some success, longstanding obstacles to interoperability—including turf battles, lack of funding and political will for the development of shared radio communications systems, lack of common standards, and shortfalls in spectrum available to public safety—continued to hamper public safety communications. Over the years, as these obstacles were addressed, lack of interoperability continued to result in the unnecessary loss of lives and property. As the *9/11 Commission Report* stated, many of the first responders that responded to the attacks in New York City "lacked access to a [common] radio channel on which the Port Authority police evacuation order was given."[4] As the catastrophic events of September 11, 2001 showed the entire Nation, direct correlation exists between effective communications interoperability and first responders' ability to save lives. These shortfalls in the ability of public safety agencies to communicate with each other heightened the political and public will to

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[1] *Final Report of the Public Safety Wireless Advisory Committee (PSWAC Final Report)*, September 11, 1996.
[2] *State and Local Law Enforcement Wireless Communications and Interoperability: A Quantitative Analysis.* National Institute of Justice. January 1998.
[3] *PSWN Program's Analysis of Fire and EMS Communications Interoperability*. Public Safety Wireless Network Program. April 1999.
[4] *9/11 Commission Report*, released July 22, 2004, p. 323.

increase funding and coordination at the highest levels of the Federal Government. To coordinate interoperability efforts across the government, OMB formed the SAFECOM program as part of the President's electronic government initiative in 2001. DHS assumed management of SAFECOM in 2003. SAFECOM provides research, development, testing and evaluation, guidance, tools, and templates on communications-related issues to local, tribal, state, and Federal emergency response agencies.

In addition, starting in 2002, several national associations representing elected and appointed public safety officials formed the National Taskforce on Interoperability. According to the Task Force's final report published in February 2003, the public safety community agreed on the following key interoperability issues: incompatible and aging communications equipment, limited and fragmented budget cycles and funding, limited and fragmented planning and coordination, limited and fragmented radio spectrum, and limited equipment standards.

In August and September 2005, the ramifications of the lack of communications interoperability were once more brought to national attention in the aftermath of Hurricane Katrina. The massive damage to communications infrastructure alone wreaked havoc on the ability of any single agency to coordinate its own relief efforts in the Gulf Coast area. Establishing simple internal *operability* compounded problems with achieving *interoperability* with other agencies. The House of Representatives report on the response to Katrina[5] noted, "There was no voice radio contact with surrounding parishes or state and Federal agencies. Lives were put at risk and it created a direct operational impact on their ability to maintain control of a rapidly deteriorating situation within the city, carry out rescue efforts and control the evacuation of those who had failed to heed the call for evacuation." In addition, the report identified breakdowns in short- and long-term planning, in delays to system upgrades, as well as problems inherent in command and control when many levels of government are coordinating response. As the Task Force on Interoperability had revealed three years earlier, the reasons for the wholesale lack of interoperability around the Nation were numerous and complex, and continued to cause problems for the first responders in the field.

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[5] *A Failure of Initiative: The Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina.* Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, February 2006.

Approach

To better understand the Nation's capacity for and use of interoperability, SAFECOM developed a five-phase approach to accomplish the *National Interoperability Baseline Survey* (see Figure 2).
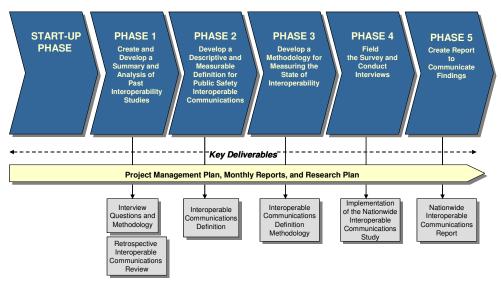

Figure 2—Phased Approach for the National Interoperability Baseline Survey

During Phase 1, SAFECOM summarized findings from past interoperability studies; developed an extensive list of the issues, obstacles, and factors that affect public safety in achieving interoperability; and compiled this information into a comprehensive and retrospective interoperability communications review.

During Phase 2, SAFECOM used the existing Interoperability Continuum as a starting point, and developed a more descriptive and measurable definition of interoperability for the public safety community. This definition was composed of 13 sub-elements of interoperability (aligned to the 5 critical elements), and codified into an Interoperability Continuum Measurement Tool (see Appendix A), which was designed as a foundation for the development of the survey instrument in Phase 3.

During Phase 3, SAFECOM identified the potential respondents that would receive the survey; researched various sampling methodologies and models; refined the characteristics for each sub-element in the Interoperability Continuum Measurement Tool to provide objective, complete, and mutually exclusive stages of interoperability; and developed the Interoperable Communications Survey Instrument, based on the refined Phase 2 Interoperability Continuum Measurement Tool.

During Phase 4, SAFECOM published the Survey Instrument through the required Office of Management and Budget (OMB) review process; conducted the survey among public safety agencies from across the Nation; and conducted 36 site visits in 9 regional areas to collect supplemental information to provide a practical interoperability perspective from the first responders in the field.

During Phase 5, SAFECOM analyzed and compiled the data from the survey and the site visits to the project reports.

Contents of the Report

This report presents an overall snapshot of interoperability across the Nation. Because this study is based on the SAFECOM Continuum, the report provides an independent assessment of each element and sub-element from the Continuum, rather than trying to reduce the findings to a single interoperability "score." In addition, because it is a national report, the findings are analyzed for the Nation as a whole and for demographic groups such a public safety disciplines and populations served. However, no attempt is made to compare any region (e.g., state, city, or Urban Area Security Initiative (UASI) area) with another. Finally, as a baseline of the capacity for interoperability, this report does not presume to evaluate current or past interoperability programs or grants, or to provide a listing of user requirements or equipment in use nationwide.

The report includes a brief explanation of the purpose of the study, a detailed description of the methodology employed in the study, a section on the overall findings that describes response patterns that emerged across all questions and demographic groups, and a presentation of the key findings, which are organized into the five critical elements. In addition, the report contains an analysis of how the Continuum elements cluster together to predict usage, a snapshot of equipment and solutions in use across the Nation, and the results of a separate survey of state homeland security directors.

II. METHODOLOGY

The SAFECOM Interoperability Baseline Survey was conducted online between May 22, 2006, and July 31, 2006. Before the release of the survey, however, significant work was required to identify the sample, complete the survey itself, and develop the online tool that would be used to administer it. Figure 3 depicts the process followed to complete the survey project.

Figure 3—SAFECOM Interoperability Survey Methodology

Identify Stakeholder Entities
In the Statement of Work (SOW) for the Interoperability Baseline Survey, SAFECOM identified law enforcement, fire response, and EMS as the intended targets for this project. While SAFECOM recognized that other parties play a critical role in emergency response, they were not to be included in this particular study. As survey design progressed, however, SAFECOM and the Practitioner Working Group (PWG) determined that the perspective of state homeland security directors would be valuable to the project. Thus, the following groups were identified as the appropriate survey population—

- Law Enforcement
- Fire Response

- EMS
- State Homeland Security Directors.

SAFECOM then purchased the Fire Response/EMS and Law Enforcement editions of the National Public Safety Database to obtain the sampling frame, contact information, and demographic information for these groups.

Determine Sampling Methodology
SAFECOM decided to use a stratified random sample approach, with the strata determined by a geographic factor. Other methodologies considered included random nationwide sampling, stratified sampling, and cluster sampling. Stratified random sampling was favored because it would contribute to statistical validity (i.e., the confidence with which survey findings could be generalized to the entire population) and, because it would be structured to ensure that all areas of the country were included in the sample, it would support acceptance of the findings within the public safety community.

SAFECOM next addressed the sampling model, e.g., what geographic unit would serve as the basis for sampling. Options included the United States as a whole, geographic regions (e.g., Federal Emergency Management Agency (FEMA) regions), states, and jurisdictions, with further sampling by jurisdiction size. In each of these options, law enforcement and fire response/EMS agencies were to be sampled separately as distinct populations. The discussions focused on the potential tradeoffs between what conclusions the specific sampling models could and could not support, the sample sizes (and related burden) they would create, and the likelihood that a particular geographic area (state or city) would be included.

SAFECOM decided to sample at the state level to ensure a national sample that had good geographic distribution. The original sample was based on a 95-percent confidence level and a ±5-point confidence interval,[6] and assumed a 50-percent response rate. Applying those criteria at the state level resulted in a

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[6] The **confidence level** is expressed as a percentage, and represents how often the true percentage of the population in question that would pick an answer lies within the confidence interval. The **confidence interval** is the plus-or-

sample population of 36,749 first responder agencies. Consultation with OMB during the Paperwork Reduction Act (PRA) review resulted in a higher confidence interval—7.5 points—and, therefore, a smaller (and less burdensome) sample of 22,416 first responder organizations.

Design Surveys

Continuum-Based Questions. Several methods were used to develop a survey instrument from the interoperable communications constructs. These methods included extensive use of the Phase 2 Interoperability Continuum Measurement Tool (see Appendix A) and related characteristics, a facilitator-lead subject matter expert (SME) meeting, and several follow-on SME discussions (including with the SAFECOM PWG). The content generated during all of these deliberations was crafted using best practices for survey design, resulting in a survey instrument that provided respondents with clear, unambiguous, and complete questions and response scales.

The constructs included 5 elements and 13 sub-elements of interoperability. Each sub-element was re-crafted as a survey question, with some split into two questions in those cases where more specificity was needed (e.g., Funding became Funding for Capital Investments and Funding for Operating Costs). To capture differences in interoperability with different parties, most topics[7] were measured on three interoperability "levels": interoperability with other disciplines, interoperability with other jurisdictions, and interoperability between levels of government. These levels are defined as follows:

- **With Other Disciplines**—Interoperable wireless communications with another first responder organization of a different discipline within the same jurisdiction (e.g., within a county, fire department A can communicate with police department A).

- **With Other Jurisdictions**—Interoperable wireless communications with other organizations of the same discipline outside the jurisdiction, but at the same level of government (e.g., sheriff's deputies in one county can communicate with a responding deputy from a bordering county). All non-state governments (including municipal, tribal, county, and special districts) were considered a local level of government. Special agencies, such as campus and airport or harbor departments, were also considered "local" for purposes of this survey. This definition also includes state-to-state communications.

- **Between State and Local Government**—Interoperable wireless communications with other organizations of the same discipline at a different level of government (e.g., local investigators can communicate with state police).

For each question, a response scale was developed that included four progressive stages: early, moderate, full, and advanced. The stages were used to ensure that response scales were consistent across survey questions in measuring interoperability approaches. The stages were defined as follows:

- **Early**—Little or no activity in the sub-element

- **Moderate**—Some progress in the sub-element

- **Full**—Substantially complete progress in the sub-element

- **Advanced**—Efforts to sustain and assure continuous improvement of interoperability into the future.

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minus figure that indicates the range of response that the surveyor can be "sure" the entire population would have picked if it had been surveyed.
[7] Some sub-elements, such as funding and training, do not lend themselves to measurement across interoperability levels.

To avoid prejudicing responses, these labels did not appear in the survey. Survey respondents were instructed that their interoperability approach must satisfy all of the elements in one level of response before they could appropriately select the next higher level of response. In addition, "Other" and "Don't Know" were added to the scales to allow respondents to select responses that best fit their situation.

Finally, follow-on questions were devised for some of the questions to gather more operational detail. For instance, the question on decision making groups was followed by a "select-all-that-apply" question on the nature of the respondent's most important interoperability decision making group. These supplemental questions provided interesting nuances and insights on the basic approaches to interoperability.

Equipment Questions. In addition to the Continuum-based questions, several questions were developed to capture separate findings about the nature and kinds of communications interoperability equipment that public safety agencies use. These questions were structured as Yes/No or select-all-that-apply. They focused on the specific types of wireless communications solutions used by public safety organizations, the characteristics of the primary wireless system used by the agency, and specific needs for radio frequency (RF) spectrum. They do not correspond to the Interoperability Continuum and are not organized according to interoperability levels.

State Homeland Security Survey. A separate survey was developed for the state homeland security directors. The questions focused on the specific governance roles and responsibilities of these survey respondents, and addressed these sub-elements: decision making groups, interoperability funding, and strategic planning. The structure of the questions was the same as that in the first responder survey described above.

Final Review. Both surveys were reviewed extensively by SAFECOM, its PWG, and other public safety experts. Some of the content was revised accordingly, including designing the survey tool to include definitions of important concepts and phrases with the survey questions.

The OMB PRA review resulted in additional questions on the planned or current use of mutual-aid channels, broadband data access, and 700 megahertz (MHz) implementations. Most significantly, two Continuum-based questions about leadership were deleted. It was agreed that asking leaders of first responder agencies questions about leadership could be awkward and would not necessarily yield objective responses.

Appendices B and C, respectively, contain copies of the first responder and homeland security director surveys.

Develop Data Collection Instrument
The survey was posted online using a ColdFusion Web application server with a Microsoft SQL Server relational database. The survey program was developed and tested to ensure Section 508 compatibility for user accessibility, as well as cross-browser compatibility. It was also designed to collect data one question at a time, thus allowing respondents to complete it over multiple sittings in case they were interrupted or needed information from another party. A progress bar appeared on each screen to indicate how much of the survey had been completed.

Publicize Surveys
An extensive outreach campaign was designed and conducted to alert first responders to the survey, its purpose, and its timeline. SAFECOM issued a press release and placed tailored, bylined articles about the survey in trade publications read by law enforcement, fire response, and EMS personnel. Targeted trade publications in which coverage was secured included *Mission Critical Magazine*, *Fire Chief*, *Mobile*

Radio Technology, and *Public Safety Communications Magazine.* Nationally recognized public safety officials representing fire response, law enforcement, and EMS authored these pieces. Coverage of the survey was also secured on the Web sites of *Fire Rescue Magazine*, *Law Officer Magazine, Journal of Emergency Medical Services,* and the National Association of State EMS Directors. In addition, DHS Secretary Michael Chertoff promoted the survey in one of his speeches,[8] and senior SAFECOM officials Dr. David Boyd and Anthony Frater addressed the survey in speeches and in interviews with several public safety publications.

Finally, an e-mail was sent to approximately 200 heads of state chapters or affiliates of the International Association of Fire Chiefs, International Association of Chiefs of Police, National Sheriff's Association, and National Association of State Emergency Medical Services Directors. The e-mail contained information about the survey, and asked the directors to forward that information to their state members via listservs or e-mail bulletins.

Administer Surveys
On May 10, 2006, an introduction letter, signed by Secretary Chertoff, was sent to all agencies in the survey sample. The purpose of the letter was to introduce the survey, and explain that the recipient had been asked to participate and would receive a postcard with a username and password. The postcard was issued a few days later.

A reminder letter was sent to those agencies that had not yet responded to the survey at the three-week mark. On June 23, 2006, the survey administration period was extended another month, and a call center engaged to contact non-respondents and to urge them to take the survey.

Conduct Field Visit Interviews and SME Review
The research plan also included face-to-face interviews with police and fire chiefs throughout the Nation. These interviews were designed to gather insights and contextual comments on the survey findings.

To ensure that the interviews covered a variety of geographic and demographic areas, SAFECOM selected the following nine regional areas in which to conduct on-site interviews:

- Charleston, South Carolina
- Denver, Colorado
- Los Angeles County, California
- Madison, Wisconsin
- Oklahoma City, Oklahoma
- Phoenix, Arizona
- Richmond, Virginia
- Seattle, Washington
- Suffolk County, New York.

Demographic data from each area were analyzed to select a group of interview candidates that represented various-sized agencies across all disciplines.

Following the completion of the online survey, the responses for each question were collated, and interview questions were drafted to elicit comment on them. The questions were designed to be open-ended and encourage interviewees to think from the perspective of public safety as a whole.

Each designated region was assigned one site visit team to administer the interviews. The site visit teams comprised two or three members—one SME to lead each interview and one or two note takers. Each site visit team member was required to attend a general training session that covered effective interviewing

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[8] http://www.dhs.gov/xnews/speeches/speech_0281.shtm

skills. The training addressed interview styles, listening skills, and communications between the interviewer and note takers to ensure that all important information would be captured.

On average, four one-hour interviews were conducted during each site visit.   The interviews were conducted during August 2006. The baseline team also conducted a supplemental interview at the Association of Public-Safety Communications Officials–International (APCO) Conference in Orlando, Florida.

Following the analysis of the field interviews, a SME review was held on October 3, 2006. SMEs included staff with broad backgrounds in firefighting/EMS and law enforcement, as well as staff from the John F. Kennedy School of Government at Harvard University. They reviewed question by question the findings, as well as site visit themes (items that were raised in at least three separate field visit interviews). All comments that achieved consensus were recorded and are included in this report as SME input.

Analyze Survey Data
Before any of the actual results of the survey could be determined, preliminary analysis of the respondents was conducted to assess the number and type of respondents, and the extent to which each had completed the survey. This analysis allowed SAFECOM to determine whether weighting techniques would be needed to bring the responses in line with the public safety population as a whole, and to purge the data set of substantially incomplete responses. In the end, it was determined that weighting was not necessary, and only a small portion of survey responses were purged.

Weighting Analysis. Of the 22,416 agencies that received the invitation to participate in the survey, 7,541 provided some level of response. The first analysis performed was to determine whether this group of respondents appropriately represented the overall population of first responders and whether weighting of the data would be required. If the groups within the survey respondent population were determined to be in different proportions than those within the nationwide first responder population, responses of the over-represented groups would "over influence" the total sample and therefore the findings themselves. Weighting procedures would then be applied to correct for the influence of a disproportionate number of respondents.

As discussed above, the Baseline Survey sample was based on two strata: state and discipline. It was therefore logical to determine the need for weighting based on these two variables.

To determine whether weighting was necessary, the distribution of states within the population (i.e., each state's contribution to the total population) was compared with the distribution of states within the sample obtained (each state's contribution to the total number of survey respondents). Weighting would have been necessary if these distributions were different to an important extent. The determination was made by creating a cross-tabulated table and employing a Cramer's V test of association.

A common measure of statistically significant differences, chi-square, was not relied on because the first responder populations and baseline sample sizes were relatively large. If chi-square were used, it was likely that the significant differences observed would not reflect important differences, but chance occurrences. The Cramer's V test, on the other hand, measures the strength of an observed relationship, and could be used to decide whether or not differences between the population and sample should be considered important differences.

The possible values for Cramer's V range from 0 to 1, where 0 represents no relationship and 1 represents a perfect relationship. The Cramer's V value for the state population/baseline sample was .142, suggesting a relatively weak relationship. Therefore, the decision was made not to weight the sample by state.

The second stratum in the sample was first responder's discipline. As can be seen in Figure 4, the proportion of fire response/EMS agencies in the national population is almost twice that of law enforcement agencies. The respondents in the baseline sample are split almost exactly equally by discipline. This is clearly disproportionate compared with the population. However, the decision was made not to weight on the basis of discipline for two reasons. First, because there are only two categories on which weighting would be applied (i.e., fire response/EMS versus law enforcement), the resulting weights would be a
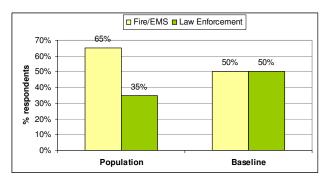

Figure 4—Comparison by Discipline

coarse correction of the resulting sample proportions. Second, the differences between the two disciplines can be better illustrated by presenting the un-weighted total sample, and then presenting each discipline sample separately. Potential implications of this response pattern are discussed in Section III, Overall Findings.

Missing Values Analysis. A missing values analysis determined that a sizable number of agencies failed to answer many of the 32 Continuum-based questions (see Figure 5). Those that failed to answer at least 90 percent of these questions were purged from the data set. This resulted in a total data set containing 6,819 agencies, which represents a 30 percent survey response rate. A sample of this size has a 99 percent confidence level and ± 1.46 point confidence interval (based on the national population of first responders).

Figure 5—Missing Values

Broken down by discipline, the fire response/EMS sample (3,389) has a 99 percent confidence level and ± 2.11 point confidence interval when compared with the national population of fire response/EMS agencies. The law enforcement sample (3,430) has a 99 percent confidence level and ± 1.99 point confidence interval when compared with the national population of law enforcement agencies.
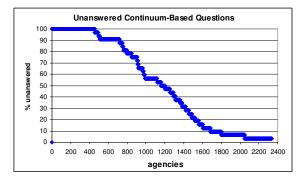
Basic descriptive and inferential statistics were used to compile the findings in this report. Statistical significance was assessed at the .001 level because of the large number of agencies responding to the survey. Within this framework, findings were deemed statistically significant if they displayed a residuals value greater than 2. Tables highlighting statistically significant findings are presented in Appendix D.

Non-Response Bias Analysis. In assessing the results of any survey, researchers must consider the possibility that non-respondents may differ significantly from respondents in areas critical to the issue under study. These potential differences can affect the confidence with which survey findings can be applied to the broader population. To address this concern, SAFECOM followed up its survey effort with a non-response bias analysis (NRBA) to determine whether any differences inherent to interoperability existed between responding and non-responding agencies.

A condensed version of the survey was created for this stage of the project. Regression analyses were conducted on the survey data to identify four sub-elements that were strongly predictive of actual use of

interoperability, and those questions were formatted into a faxable survey document. A random sample of 1,190 agencies was selected from the pool of non-responding agencies, and the agencies were asked whether they would participate in an abbreviated version of the survey. Those who agreed received the survey by fax and were asked to return their responses by fax. An insufficient number of agencies responded to this effort, and analysis of potential differences was therefore not possible.
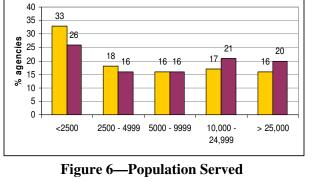
III.   OVERALL FINDINGS

Overall findings for this report fall into two categories: demographic findings concerning the respondents themselves, and overall patterns of how specific demographic groups within the sample responded to questions.

Demographic Analysis of Respondents

Agency size and discipline were two primary areas of analytical interest for this report, so the survey sample was examined from these perspectives. The number of agencies in the country and the number in the study sample are both extremely skewed toward jurisdictions with small populations. Conversely, the number of agencies representing very large jurisdictions is extremely low. Five size categories were developed that allowed a roughly equal distribution of respondents. These categories allowed for cross-tabulation analyses, which are sensitive to large discrepancies in the size of groups. As can be seen in Figure 6, the percentage of agencies in each of the size categories is fairly consistent between the national population and the survey sample.

Figure 6—Population Served

Two significant differences emerged from an examination of population served by discipline (see Figure 7). Although the two disciplines constituted equal proportions of the survey respondents, fire response/EMS agencies were more common in the smallest jurisdictions, and law enforcement agencies were more common in the largest jurisdictions.
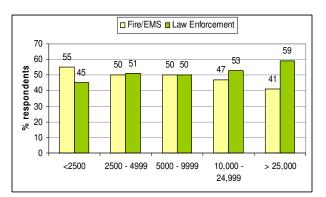

Figure 7—Population Served by Discipline

Baseline Findings

An overview of the data from the Continuum-based questions revealed that the capacity for interoperability varies among the Continuum elements. A review of previous studies on interoperability showed that those studies focused more on technology and governance issues than on operations. The SAFECOM survey findings support the concept that technology and governance may have received more attention from public safety groups. First responder agencies showed the highest levels of development in the area of technology, followed by certain sub-elements under governance. For the other elements of the Interoperability Continuum, a preponderance of agencies is in the early development stage. This pattern holds true only when all agencies are assessed together.

Data were next examined to identify differences between the sizes of organizations identified above and by discipline, as well as by interoperability level and type of wireless system used. Those overall findings are described below.

- *About two-thirds of agencies report using interoperability to some degree in their operations*. According to our Frequency of Use and Familiarity question, which addresses how often and in what situations interoperability is used, about one-third of agencies use interoperability primarily for out-of-the-ordinary events, and another third interoperate in their day-to-day operations.

- *Technology and some governance sub-elements response results demonstrated the highest stages of development on the Continuum*. A review of previous studies on interoperability showed greater emphasis on technology and governance issues than on operations. SAFECOM's survey findings support the concept that technology and governance have received more attention from public safety groups. Technology was the only element in which a plurality of agencies appears to have achieved full development. Governance contained the only question in which a majority of agencies indicate progress that equates to the moderate level of development. Data from the other elements of the Interoperability Continuum indicate early development.

- *The smallest agencies, as a group, tend to be at earlier stages of development than larger agencies*. As described above, agencies serving smaller populations dominate the sample. Chi-square analysis and adjusted standardized residuals indicated statistically significant findings that, across the Continuum, agencies serving the smallest populations (fewer than 2,500 residents) are more likely than agencies serving larger populations to fall in the early stage of development. The proportions of the two groups who respond in the early development stage, for any given question, differ by 5 to 17 percentage points.

  This analysis also found that agencies serving larger populations tend to fall more in the moderate, full, and advanced stages. This same pattern exists when evaluating discipline by size, although there are a few topics for which this pattern does not hold for fire response/EMS agencies. The cause of this interesting pattern remains to be explained, although it could be driven by need. Agencies in smaller jurisdictions may simply not need to interoperate with other agencies as much as those in larger jurisdictions.

- *Fire response/EMS and law enforcement agencies tend to show the same level of development across most areas of the Continuum.* The hypothesis that law enforcement and fire response/EMS agencies are so different operationally that the study would discover many statistical differences in their approach to interoperability was not demonstrated as dramatically as had been anticipated. Of the 32 Continuum-based questions in the survey, only one-quarter showed statistically significant differences between the two disciplines.

- *Cross-discipline and cross-jurisdiction interoperability tends to be at a more advanced stage than state-local interoperability*. Many of the Continuum sub-elements were measured along three scales of use: across disciplines, across jurisdictions, and between state and local government. First responders reported more progress in interoperability across disciplines and across jurisdictions; interoperability between state and local government had a greater tendency to be in the early stages. Again, this may be driven by need—state and local agencies may not work together frequently enough to encourage more advanced approaches to interoperability. It is also consistent with findings from previous studies.

- *Agencies that operate on large, shared systems tend to be at more advanced stages of development than those that operate on stand-alone systems*. Agencies that use a multi-agency,

multi-jurisdictional, shared communications system are more likely than the survey population as a whole to be in moderate, full, or advanced stages of development. Agencies that own and operate their own systems are more likely than the population as a whole to be in the early stage. There are also significant demographic findings associated with the type of system used. The smallest agencies are more likely (43 percent) than larger agencies (34 percent) to be part of a large shared system. Conversely, agencies serving 10,000 residents or more have a greater likelihood than smaller agencies of operating on stand-along systems (26 percent versus 17 percent). This difference makes intuitive sense, in that larger jurisdictions are likely to be better funded and capable of procuring their own communications system.

However, this finding is also somewhat counter-intuitive—the size effect described above (small agencies more likely to be in early stages of development) should be somewhat offset by the likelihood of small agencies participating in large shared systems, and thus to appear in the moderate and full stages. Further analysis shows that while small agencies on larger shared systems do display more advanced stages of development compared with small agencies on stand-alone systems, they are not as advanced as the larger agencies on the shared systems. Both size and system appear to contribute to the stage of development across the Continuum.

- ***Five significant predictors of frequency of use and familiarity emerge from analysis.*** The results of a logistical regression analysis show approaches, implementation, exercises, command and control, and standard operating procedures (SOPs) predict a high score in frequency of use and familiarity across all three interoperability levels.

  Although the other Continuum-based questions are not statistically significant predictors of high interoperability use, the subjects they address contribute to interoperability. Additional logistical regression analysis identified statistically significant relationships with the five "predictor" sub-elements identified above that involved decision making groups, agreements, funding for capital investments, and strategic planning.

These findings illustrate the challenges inherent in trying to define a simple "baseline" of interoperability. No one-dimensional scale can adequately define the current state of interoperability in the Nation, or the progress left to be made, because the capacity for interoperability is a complex issue that involves technological, political, operational, and human variables. However, this study does provide a landmark measurement of many of the elements of interoperability, and provides valuable data. As such, the report requires careful and deliberate reading, and the use and applicability of its findings depend on the policy interest or public service objective. For instance, when seeking to understand the public safety implications of the Nation's current capacity for interoperability, readers should consider that those agencies serving the largest population centers show more progress toward interoperability than those serving small populations. When assessing the interoperability capacity of agencies apart from considerations of population served, readers may want to note that these survey results may have a slightly optimistic bias: had responses been more proportionate among the disciplines (see Figure 4), it is possible that a greater proportion of responses per question could have fallen in the early category[9].

Caveats aside, these findings provide an unprecedented array of data to public safety and policy officials who want a multi-dimensional understanding of the capacity of public safety agencies to communicate and respond together. They can inform the process of tailoring future plans to provide the education, incentives, and planning needed to continue improving interoperability capabilities across the Nation.

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[9] Cross-tabulation analyses show the fire response/EMS agencies were more prevalent among agencies serving the smallest populations and, as noted in this section, agencies serving smaller populations are more likely to provide responses in the early stage.

IV.   QUESTION-LEVEL FINDINGS

Findings for specific survey questions are discussed in this section. The findings are organized by element and sub-element. Each section for a sub-element question contains a bar graph showing the entire distribution of responses by interoperability stage and interoperability level. The bars are clustered, left to right, to correspond with responses in the early, moderate, full, and advanced stages defined for each question. The graphs do not display the "don't know" and "other" responses because the percentages for each were uniformly low. Those data are provided in Appendix D.

Universal findings based on size and wireless system type reported in Section III are not repeated in this section. However, statistically significant differences between disciplines that are unique to specific questions *are* described here.

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Governance

</div>

The governance element includes the up-front planning and agreements that public safety leaders must address to ensure that their systems will interoperate. This element is essential or foundational to interoperability because governance decisions drive the conception, design, and implementation of interoperable capability. Interoperable communications cannot emerge on their own, nor can any single agency implement interoperability, without this collective leadership and support. Public safety officials who participated in working groups to define interoperability recognized this when they ranked governance as the most important of the five elements on the Interoperability Continuum. A report published in February 2003 by the National Task Force on Interoperability[10] cites five key obstacles to interoperability, two of which (limited and fragmented budget cycles and funding, and limited and fragmented planning and coordination) are governance issues. Moreover, the Government Accounting Office (GAO) has reported that, "The single greatest barrier to addressing the decades-old problems of interoperable communications has been the lack of effective, collaborative interdisciplinary and intergovernmental planning."[11]

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Governance: Decision Making Groups

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"Decision Making Groups" are the groups of public safety practitioners and leaders who bring together their expertise to improve public safety communications interoperability. Decision making groups are often foundational to public safety communications planning: achieving interoperability can be a complicated process, and agencies must discuss the issues involved together if they hope to move beyond ad hoc solutions. As the response stages progress from early to advanced stages, the formality, structure, and inclusiveness of these groups increase.

Definition
A "formal" decision making group is one with a published agreement that designates its authority, mission, and responsibilities.

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[10] *Why Can't We Talk? Working Together to Bridge the Communications Gap to Save Lives*. National Task Force on Interoperability, February 2003.

[11] *Catastrophic Disasters: Enhanced Leadership, Capabilities, and Accountability Controls will Improve the Effectiveness of the Nation's Preparedness, Response, and Recovery System*. General Accounting Office, GAC-06.618, September 2006, p. 42.
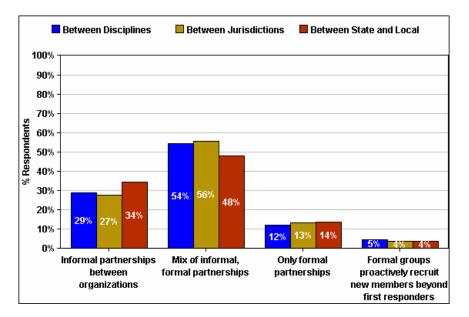
Figure 8—Decision Making Groups

Findings regarding decision making groups included:

- This is the only sub-element in the survey in which a majority of agencies fall into the moderate stage. More than half of the agencies report participating in a mix of formal and informal decision making groups, with membership that crosses disciplines and crosses jurisdictions. Slightly fewer, 48 percent, include state-level membership. (See Figure 8.)

- Across all interoperability levels, about 13 percent of agencies have only formal group structures.

- The formal groups in which agencies do participate have the following characteristics:[12]

  - Make recommendations on interoperability—65 percent.
  - Meet regularly—58 percent.
  - Take action on its own decisions—54 percent.
  - Have governance structure in place with rules—51 percent.
  - Send information to all members—49 percent.
  - Send information to public safety leaders outside the group as appropriate—48 percent.
  - Have consistent membership—46 percent.
  - Send information to political leaders outside the group as appropriate—34 percent.

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[12] Respondents could select as many characteristics as applied; therefore, these data do not total to 100 percent.

- One significant difference emerged between disciplines for decision making groups, and that was limited to groups including cross-discipline membership. Fire response/EMS agencies are far more likely to participate in formal groups that proactively recruit new members beyond first responders. This places them in the advanced stage. Law enforcement respondents were slightly more likely to report in the moderate stage. (See Figure 9.)
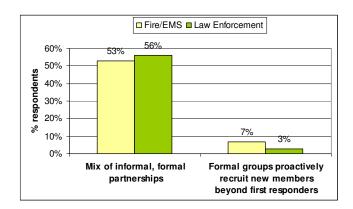

Figure 9—Decision Making Groups by Discipline— Cross-Discipline Membership

As noted above, this sub-element is the single one in which most agencies fall into the moderate stage. Agencies have taken steps to formalize the processes by which they work together to ensure interoperability. In recent years SAFECOM has promoted regional interoperability methodologies, and has tailored Federal grant guidance to include incentives for regional planning. Thus the development of at least some formal groups may be in response to that. Public safety officials interviewed provided some acknowledgement that the grant process did drive more participation in these groups, but also cited several other benefits: establishing ongoing dialogue with other organizations on interoperability, promoting new initiatives, and sharing guidance on grants and funding, as well as forming the relationships needed to obtain grants for regional interoperability.

Even so, some funding obstacles continue to work against some agencies, particularly smaller ones, from participating in these groups. Smaller agencies noted that it is difficult to spare the staff and resources to send people to participate in meetings. At least one interviewee cited city government opposition to participation, even when public safety groups themselves wanted to participate, owing to fear that participation would cede city control of city funds.

This question also showed the most dramatic instance of one discipline completely outdistancing the other in the advanced stage. SMEs reviewing these findings were not surprised to see fire response/EMS more likely to report in the advanced stage in this instance than law enforcement. One of the distinguishing characteristics of the advanced stage is reaching out to groups beyond traditional first responders, and it was agreed the fire response/EMS are often in contact with a wide variety of groups in their response efforts.

"Agreements" are mechanisms approved to ensure the availability and proper use of communications interoperability solutions for public safety. These may include agreements to share frequencies, to share dispatch services, or to maintain and distribute radio caches. As the response stages progress from early to advanced stages, the formality of the agreements and number of agencies with which they are in place increases.
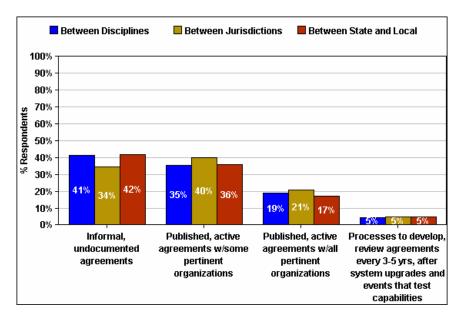

Figure 10—Agreements

Findings regarding agreements included:

- There is a roughly even distribution between the early (informal, undocumented agreements) and moderate (published, active agreements with some pertinent organizations) stages. This pattern holds for all three interoperability levels. The percentages of agencies that have formal agreements with all pertinent organizations are considerably smaller. (See Figure 10.)

- Only when reviewing cross-jurisdiction agreements do statistically significant differences emerge between disciplines. There, fire response/EMS responses were more likely to 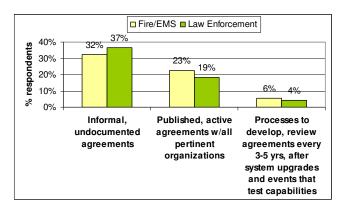indicate full and advanced levels of development for cross-jurisdiction agreements. (See Figure 11). Conversely, law enforcement agencies are more likely to be in the early stage of development.

Figure 11—Agreements by Discipline—Cross Jurisdiction

Agencies interviewed in the field offered differing perspectives on the findings. Few were surprised at the number of agencies that operate without formal interoperability agreements. There was also a sense

that small agencies in particular tended to work more informally. Crafting formal agreements requires significant time and resources, so agencies need strong incentives to do so. If agencies can interoperate adequately with informal agreements, they will likely do so. Additionally, political and turf issues can interfere with the formation of agreements, while sovereignty issues often emerged as obstacles for tribal agencies. Finally, some agencies also specified that although they do have formal mutual aid agreements with other agencies, those agreements do not necessarily address communications.

Concerning the differences between disciplines, SMEs noted that there are different drivers for agreements between the fire response/EMS and law enforcement disciplines. Law enforcement is organized along political jurisdictions, and much of its operations across jurisdictional lines are codified in local law. Fire response/EMS agencies, on the other hand, are not organized according to political jurisdictions, and their cooperation is consequently not codified in law. They would thus have a greater need to establish agreements for working across political jurisdictions.

Governance: Funding for Capital Investments

"Funding for Capital Investments" addresses the levels and reliability of funding available to acquire one-time capital investments, such as equipment and radios (as opposed to funding for recurring operating costs). As the response stages progress from early to advanced stages, funding becomes more consistent, sufficient, and reliable.

Funding questions were asked from the perspective of the responding agency only, as opposed to across the three interoperability levels, because it was not expected that any one agency would have insight into other agencies' budget situations.
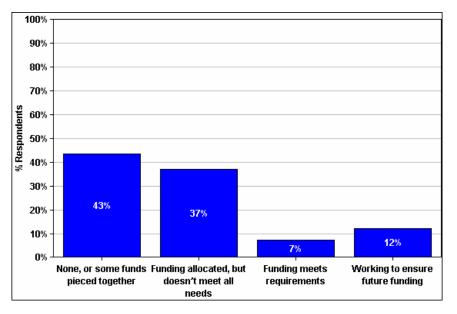

Figure 12—Funding for Capital Investments

Findings regarding funding for capital investments included:

- In keeping with the 2003 finding that "limited and fragmented funding" is a key obstacle to interoperability,[13] a plurality (43 percent) have no funding or have been able only to piece some funding together. Another 37 percent note that they do have some funding allocated, but that it does not meet their needs. Only 7 percent of agencies report that their funding for capital investments meets current requirements. (See Figure 12.)

- The smallest agencies, those serving populations of fewer than 2,500, are particularly hard hit on funding for capital investments costs. 55 percent of these agencies report having no or minimal funding, compared with 39 percent of agencies serving populations greater than 2,500.

- Agencies were asked whether they shared capital investment costs with other first responder agencies. The results are shown below, with percentages based on the number of respondents who answered any one of the questions.

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[13] *Why Can't We Talk? Working Together the Bridge the Communications Gap to Save Lives.* National Task Force on Interoperability, February 2003.

- My organization shares capital investment costs with other first responder disciplines—60 percent.
- My organization shares capital investment costs with other jurisdictions—41 percent.
- My organization shares capital investment costs with other levels of government—46 percent.

- Fire response/EMS are slightly more likely to report having a partial degree of dedicated funding, whereas law enforcement shows a slight edge in reporting full levels of funding. (See Figure 13.)

Figure 13—
Funding for Capital Investments by Discipline

Few of the agencies directly interviewed were surprised by the large number of agencies without dedicated funding for either capital expenses or maintenance. "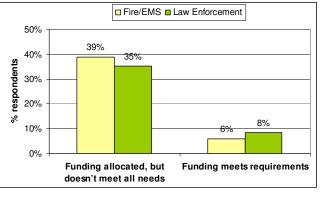We fight for it every year," said one police chief. Lack of funding as an obstacle has been documented in previous studies. Funding issues affect not only equipment, but agencies' ability to participate in decision making groups and exercises, both of which require more staff time. Interestingly, grant money was seen as a mixed blessing. On one hand, it was considered the best source of funds. On the other, small local agencies claimed that such funds tended not to trickle down to them. Agencies also recognized that their chances of getting DHS grants would be next to nothing if they did not create partnerships. Thus, there was some recognition that governance groups could serve to help in obtaining grant funds.

Governance: Funding for Operating Costs

"Funding for Operating Costs" addresses the levels and reliability of funding available to cover recurring operating costs for interoperability equipment (as opposed to funding available for one-time capital costs). As the response stages progress from early to advanced stages, funding becomes more consistent and reliable beyond the current budget cycle.

Funding questions were asked from the perspective of the responding agency only (as opposed to collectively across the three interoperability levels) because it was not expected that any one agency would have insight into other agencies' budget situations.
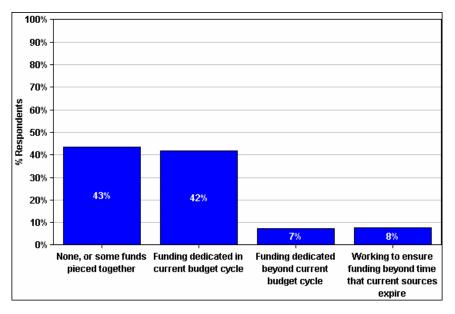

Figure 14—Funding for Operating Costs

Findings regarding funding for operating costs included:

- Only 7 percent of agencies report that they have funding dedicated for operating costs beyond the current budget cycle. The plurality (43 percent) has no dedicated funding or has been able to piece some funding together. Another 42 percent note that they some funding dedicated in the current budget cycle. (See Figure 14.)

- The smallest agencies, those serving populations of fewer than 2,500, are particularly hard hit on funding for operating costs. Fifty-four percent of them provided responses that equate to the early stage, compared with 39 percent of agencies serving populations greater than 2,500.

- Agencies were asked whether they shared operating costs with other first responders. The results are shown below, with percentages based on the number of respondents who answered any one of the questions:

  – My organization shares operating costs with other first responder disciplines—60 percent.
  – My organization shares operating costs with other jurisdictions—41 percent.
  – My organization shares operating costs with other levels of government—45 percent.

- There are no significant differences between disciplines for this question.

"Strategic Planning" refers to disciplined and documented efforts to produce fundamental decisions and processes designed to improve interagency communications in the future. As the response stages progress from early to advanced, strategic planning efforts draw closer to completion and are accepted by a greater number of participants.
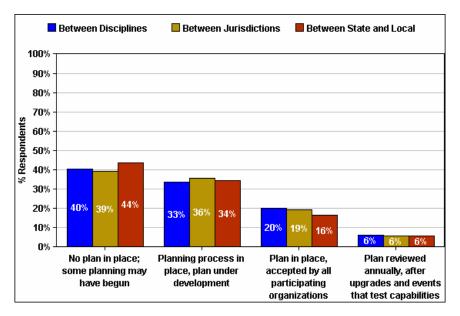

Figure 15—Strategic Planning

Findings regarding strategic planning included:

- Strategic plans for interoperability are the exception rather than the norm. Only 20 percent of agencies have strategic plans to ensure interoperability across disciplines, and 19 percent have plans to ensure interoperability across jurisdictions. For state-local interoperability, that proportion falls slightly, to 16 percent. (See Figure 15). Note that this is in contrast to results from the state homeland security directors; 11 of the 31 respondents report that a statewide plan that includes local governments is in place (see Section VII).

- For all levels of interoperability, the plurality says it has no strategic plans in place or, at most, some planning efforts may have begun.

- This is one area in which the prevalence of small agencies tends to push the overall results into the early stage. When looking only at agencies serving populations of *more than* 2,500, the number of agencies with some planning process in place across jurisdictions (moderate) slightly outnumber those with no such planning (early).

- There are no significant differences between disciplines for this question.

Policies, Practices, and Procedures

Policies, practices, and procedures are the accepted practices by which interoperable communications are engaged and used in incident response. A shared understanding of these practices is, of course, essential to smooth and continuous communications.

Policies, Practices, and Procedures: Standard Operating Procedures (SOPs)

Standard Operating Procedures (SOPs) are the methods that guide end users' facilitation of interoperability solutions and management of operational processes. As the response stages progress from early to advanced, policies are formalized and established for a greater variety of events.
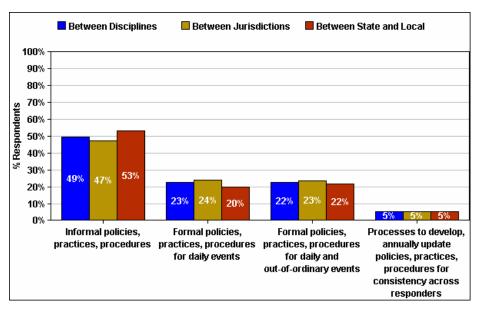

Figure 16—Standard Operating Procedures (SOPs)

Findings regarding SOPs included:

- Among all of the interoperability sub-elements, SOPs is one of three that displays a preponderance of agencies in the early stage. About half of all agencies either do not use SOPs or rely on informal SOPs to support interoperable communications. This pattern holds true across discipline (49 percent), across jurisdiction (47 percent), and across state-local government (53 percent). (See Figure 16.) This holds even when controlling for size by removing the smallest agencies from consideration—more than 45 percent of the remaining agencies report in the early stage.

- About 20 to 24 percent of agencies rely on formal policies to guide use of interoperable communications during planned and day-to-day events. Another 22 to 23 percent rely on these policies to guide use of interoperable communications in all situations, whether day-to-day or out-of-the-ordinary. These findings are also consistent across interoperability levels.

- There are no significant differences between disciplines for this question.

> **Definitions**
>
> A "formal" policy or procedure is one that is published and active.
>
> "Daily" events include vehicle pursuit and multiple station response.
>
> "Out-of-the-ordinary" events include mass casualties and flipped tanker on highway.

Given the low incidence of formalization for SOPs, it is perhaps not surprising that field interviewees had difficulty commenting on this finding, other than to confirm that it seemed plausible. As with agreements, it may be that the time and resources required to document, reach agreement on, and implement SOPs is cost-prohibitive. Agencies that rarely engage complex response events can pass along instructions and practices by word of mouth. It may be that the largest agencies, which handle larger events and coordinate the actions of larger staffs, benefit most from the effort of establishing SOPs. Nonetheless, advancing past the early stage has its rewards—this is one sub-element identified in which progress beyond the early stage is correlated with the full and advanced stages in frequency of use and familiarity—that is, with regular use of interoperability in all types of situations.

Command and control describes protocols put in place to manage the public safety communications environment during collective incident response. As the response stages progress from early to advanced, policies are formalized and established for a greater variety of events.
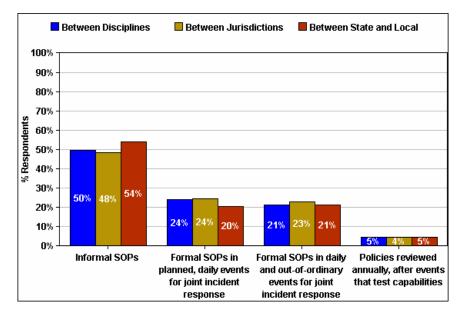

Figure 17—Command and Control

Findings regarding command and control procedures included:

- Command and control is one of three sub-elements with the highest occurrence of responses in the early stage. About half of all agencies either do not use command and control SOPs or rely on informal command and control procedures to support interoperable communications. This pattern holds true across discipline (50 percent), across jurisdiction (48 percent), and across state-local government (54 percent). (See Figure 17.) As with SOPs, this finding holds even when controlling for size by removing the smallest agencies from consideration— the responses of more than 46 percent of the remaining agencies indicate early development.

> **Definitions**
>
> A "formal" command and control policy or procedure is one that is published and active.
>
> "Daily" events include vehicle pursuit, multiple station response, etc.
>
> "Out-of-ordinary" events include mass casualties, flipped tanker on highway, etc.

- About 20 to 24 percent of agencies rely on formal policies to guide use of interoperable communications during planned and day-to-day events. Another 22 to 23 percent (depending on the specific interoperability level in question) rely on these policies to guide use of interoperable communications in all situations, whether day-to-day or out-of-the-ordinary.

- Seventy-four percent of those that do have formal command and control SOPs in place indicated that those procedures were National Incident Management System (NIMS)-compliant.[14]

- There are no significant differences between disciplines for this question.

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[14] The NIMS program provides a unified approach to incident management. Details on what is required of local governments for NIMS compliance in 2006 can be found at:
http://www.fema.gov/pdf/emergency/nims/nims_tribal_local_compliance_activities.pdf

Technology

Technology is a key element of interoperability. The radios of first responders are their communications lifeline—if the radios cannot interoperate, the first responders cannot interoperate. "Incompatible and aging communications equipment" was one of five key obstacles to interoperability cited in the 2003 National Task Force on Interoperability report.

Perhaps because technological issues have been placed at the forefront of interoperability problems, technology displays the highest level of development of any of the elements in the Continuum. Both approaches and implementation have the highest number of responses in the full stage—about one in three—of any of the questions in the survey. Nonetheless, responses to the funding questions, as well as anecdotal comments submitted by survey respondents, indicate that for many agencies, funding still poses a formidable obstacle to deploying needed systems and equipment.

Technology: Approaches

"Approaches" focuses on the technology deployed in the field that can be implemented to establish interoperability. As the response stages progress from early to advanced, the technological solutions that make up these interoperability approaches become more robust and, at the same time, integrate into more long-term elements. These features are evident in the move from temporary solutions, such as radio swaps, to more permanent infrastructure-based solutions, such as shared systems.
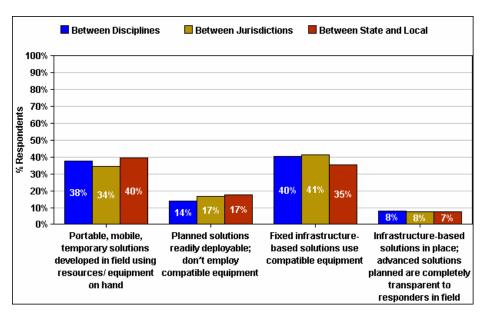

Figure 18—Approaches

Findings regarding approaches included:

- An interesting bimodal distribution of responses occurs between the early and full stages, with a smaller minority falling into the moderate stage. For establishing communications across disciplines, 38 percent of agencies use an approach in the early stage (e.g., radio swaps) while 40 percent use approaches in the full stage (e.g., fixed infrastructure). For cross-jurisdiction communications, the respective proportions are 34 percent and 41 percent, while for state-local communications, the respective values are 40 percent and 35 percent. Generally, half that percentage or less uses an approach in the moderate stage. (See Figure 18.)
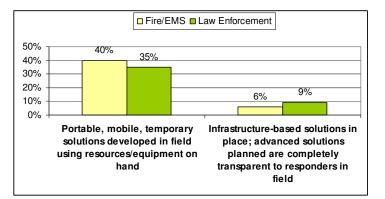
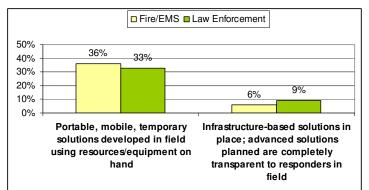**Figure 19—Approaches by Discipline for Cross-*Discipline* Communications**

Figure 20—Approaches by Discipline for Cross-*Jurisdiction* Communications

The findings are roughly the same for both firefighting/EMS and law enforcement groups. However, there are two points of departure from normal response patterns. Firefighting/EMS agencies respondents were more likely to report technical approaches in the early stage, both in cross-discipline and cross-jurisdictional communications. Conversely, law enforcement agencies were slightly more likely to employ approaches in the advanced stage. (See Figures 19 and 20.)

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"Implementation" concentrates on the manner and ease with which interoperability solutions are activated. As the response stages progress from early to advanced, the implementation of these solutions becomes easier, more seamless, and incorporates more natural control measures. The transition is characterized by a move from improvised solutions to solutions that are available as authorized and without any external intervention.
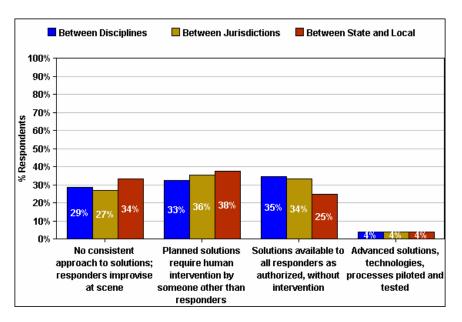

Figure 21—Implementation

Findings regarding implementation included:

- Although approach and implementation are somewhat linked (e.g., an agency that has access to a fixed system [approach] will probably not have to improvise a solution at the scene [implementation]), the response patterns for the two differ. Under approach, the majority of responses fall about equally in the early and full stages. In implementation, they fall under moderate and full stages for communications between disciplines and jurisdictions, and under the early and moderate stages for local-state communications. For establishing communications across disciplines, 33 percent of agencies use an approach in the moderate stage (e.g., connections through a dispatcher), and 35 percent use an approach in the full stage (solutions that allow immediate access to other responders, without third-party intervention). For cross-jurisdiction communications, the respective proportions are 36 percent and 34 percent. For state-local communications, however, 34 percent fall in the early stage (e.g., responders must improvise a solution on the scene), and 38 percent are in the moderate stage. (See Figure 21.)

- There are no significant differences between disciplines for this question.

Field interviews uncovered a range of opinions on the role of technology in ensuring interoperability. On the one hand, its critical nature is acknowledged—without radios, as without spectrum, there is no communication and thus no interoperability. This is confirmed in our analysis that shows that when approaches and implementation move past the early stage—that is, when they are become more formal, and first responders can rely on existing equipment and planned solutions rather than fashioning ad hoc

communications—the likelihood that agencies use interoperability more frequently increases. But several agencies also cautioned against relying on technology exclusively. The human dimension is critical—even with good equipment, interoperability is hampered without good working relationships and governance, or without a clear understanding of how the equipment works and how command and control is planned.

Agencies also indicated a preference for what the survey defined as full and advanced technology features. When asked how they defined interoperability, several agencies noted that seamlessness or ease of use were critical. Anything else, including human intervention, could consume needed time. As one police chief noted, "When you need it, you need it now." Similarly, there was consensus that shared systems were among the best solutions because of their seamless nature. Interviewees noted that this kind of seamlessness does not always occur on the ground, and that a variety of approaches are used to achieve interoperability.

Technology: Maintenance and Support

Maintenance and support addresses the reliability and performance of the interoperable communications. As the response stages progress from early to advanced, the maintenance and support plans increase the level of reliability and availability.
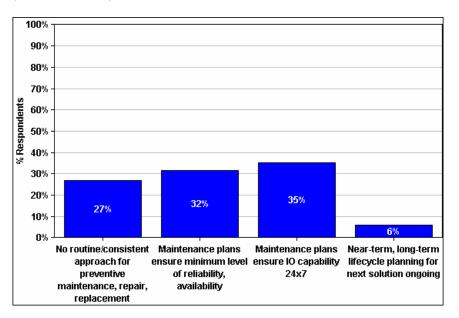

Figure 22—Maintenance and Support

Findings regarding maintenance and support included:

- Maintenance and support findings are fairly evenly spread, with a slightly greater likelihood that agencies fall in the full stage. Some 27 percent of agencies report having no routine maintenance plan, 32 percent have plans that ensure some level of reliability, and 35 percent have a plan that provides 24/7 support for interoperability equipment. (See Figure 22.)

- The smallest agencies show an almost reverse pattern of findings, 36 percent in the early stage and only 27 percent in full.
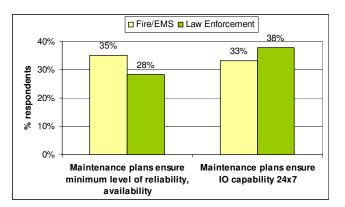

Figure 23—Maintenance and Support by Discipline

- Some differences in operational funding appear between disciplines. Fire response/EMS is more likely to report early-stage maintenance plans, while law enforcement agencies have a slight edge in reporting advanced plans. (See Figure 23.)

Training and exercises are essential to ensuring that personnel know how to set up and deploy interoperable communications at an incident. Often, training is needed simply to ensure that personnel are *aware* of the interoperability solutions available to them.

Training and Exercises: Training for Support Personnel

Training for support personnel addresses interoperability training for personnel who support the firefighters, emergency medical technicians (EMTs), and police officers in the field. These personnel often play a direct role in establishing and maintaining interoperable communications. During discussions with public safety agencies during Phase 2 of this study, first responders noted an especially urgent need for training. This is because training tends to be a near-term need and is often more difficult to arrange. As the response stages progress from early to advanced, training becomes more formalized and more of the support personnel who need this training receive it.

> **Definitions**
>
> "Support personnel" includes administrators, dispatchers, and other personnel who provide direct communications support to personnel in the field.
>
> "Formal" training includes a lesson plan and an assessment of student performance. "Informal" training does not include a lesson plan or student assessment. Both types of training may occur on the job.
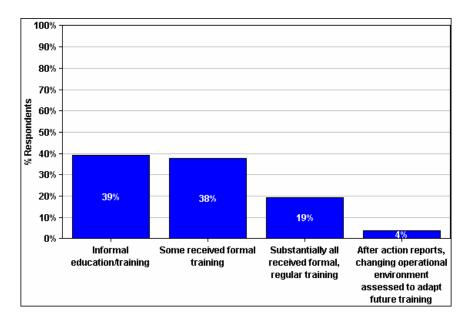

Figure 24—Training for Support Personnel

Findings regarding training for support personnel included:

- Nearly two in five agencies (39 percent) report that their support personnel have received, at most, informal training on interoperability. A similar number (38 percent) report that some of their personnel have received formal training. About one in five agencies (19 percent) report that substantially all personnel have received formal training. (See Figure 24.)

- The smallest agencies appear to face particular challenges. Almost half (47 percent) report that their support personnel have received, at most, informal training on interoperability. If they are

removed from the sample, the modal development stage for the rest of the group, by a very slight margin, moves into moderate.

- There are no significant differences between disciplines for this question.

Interoperability training comes in several guises. On-the-job training, whether formal or informal, can be the most common training in dispatch centers. Where solutions require dispatcher intervention, dispatchers often get the practice they need during the course of their duties. However, there was agreement that some level of formal training is needed whenever new communications equipment is installed.

Training for field personnel addresses interoperability training for firefighters, EMTs, and police officers in the field. Depending on the technology approach used to obtain interoperability, field personnel may play a direct or indirect role in establishing and maintaining interoperable communications. As the response stages progress from early to advanced, training becomes more formalized and more of the field personnel who need this training receive it.

Definitions

"Field Personnel" includes firefighters, EMTs, and law enforcement personnel who respond at the scene.

"Formal" training includes a lesson plan and an assessment of student performance, while "informal" training does not. Both types of training may occur on the job.
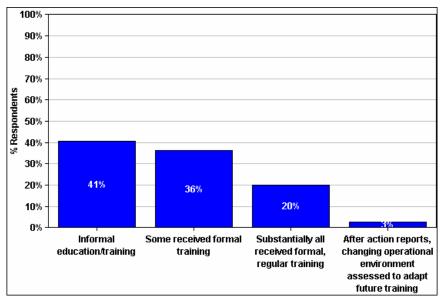

Figure 25—Training for Field Personnel

Findings regarding training for field personnel included:

• Agencies report similar patterns for training field personnel in interoperability compared to those for support personnel. Two in five agencies (41 percent) report that their field personnel have received, at most, informal training on interoperability. A slightly smaller number (36 percent) report that some of their personnel have received formal training. One in five agencies (20 percent) report that substantially all field personnel have received formal training. (See Figure 25.)

• There are no significant findings between disciplines for this question.

Many field sites noted that field personnel are trained on communications and interoperability when they start the job, and perhaps once a year thereafter. Law enforcement agencies often have so much required annual training (e.g., weapons training) that they have little time left for discretionary training in interoperability. As with support personnel, there was general agreement that new training must be provided when new communications systems are installed.

Exercises include a variety of activities that allow users to practice scenarios that involve interoperable communications. They uncover strengths and weaknesses of interoperability solutions and procedures. As the response stages progress from early to advanced, exercises demand more effort and participation.

Exercise planning conferences or workshops are conducted to discuss, develop, and finalize the exercise goals and objectives, the exercise plan (including scenario descriptions), as well as the schedule/timeline of events, venue locations, controller/evaluator roles, and other logistical information. This planning process involves exercise SMEs and the public safety first responders from multiple disciplines or multiple jurisdictions, depending on the scope of the exercise. In general, there are two types of exercises: 1) functional/tabletop exercise (simulated); and 2) full-scale exercise (performed in the field).
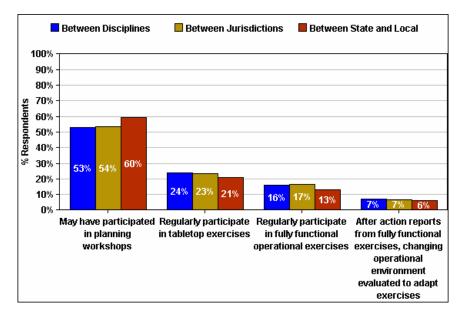

Figure 26—Exercises

Findings regarding exercises included:

• Of all the Continuum sub-elements, exercises has the highest percentage of responses in the early stage. Exercises are more time-consuming and resource-intensive than training, so it is perhaps not surprising that participation in various levels of exercises is less pervasive than interoperability training. (See Figure 26.) As with SOPs and command and control, this is a finding that cannot be attributed strictly to the prevalence of small agencies in the sample: when the smallest agencies are removed from consideration, a full 49 percent of remaining agencies still fall in the early stage.

• Eighty-four percent of agencies that have conducted some sort of exercise say that their exercises are NIMS-compliant.[15]

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[15] The NIMS program provides a unified response to incident management. Details on what is required of local governments for NIMS compliance in 2006 can be found at:
http://www.fema.gov/pdf/emergency/nims/nims_tribal_local_compliance_activities.pdf

- Differences between disciplines appear solely in exercises that involve both state and local agencies. In these, fire response/EMS agencies are slightly more likely to report, at most, early-stage planning. Conversely, law enforcement is more likely to report regular participation in tabletop exercises involving state and local governments. (See Figure 27.)
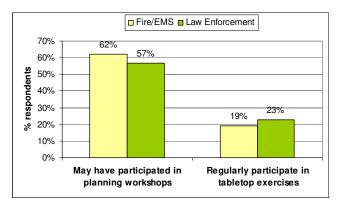

Figure 27—Exercises Between State and Local Agencies—by Discipline

Exercises allow groups of public safety agencies to test and practice with their communications equipment and procedures in a variety of simulated events. They can uncover unanticipated issues and provide valuable lessons for response. Exercises can consist of small efforts limited to a few local first responders, or they can extend to the Top Officials (TOPOFF) exercises conducted by DHS that involve locations, governments, first responders, and hospitals across the Nation.

Field agencies recognize the value of conducting exercises; however, note that they are resource-intensive. Staff members sent to planning meetings as well as to the exercises themselves are not available for duty, and must be backfilled. Overtime costs are often incurred. Some field respondents who had taken part in exercise planning activities were not sure whether interoperability was always tested in the exercises plans. Exercises certainly appear to be a predictor of frequent use of interoperability usage. It is not clear that exercises lead to interoperability; however, it may be that those agencies that are more likely to need and use interoperability are the ones who attend exercises.

Usage: Frequency of Use and Familiarity

Frequency of use and familiarity addresses the actual use of interoperable communications. As the response stages progress from early to advanced, usage becomes more pervasive in all types of operations and events (from day-to-day to out-of-the-ordinary).
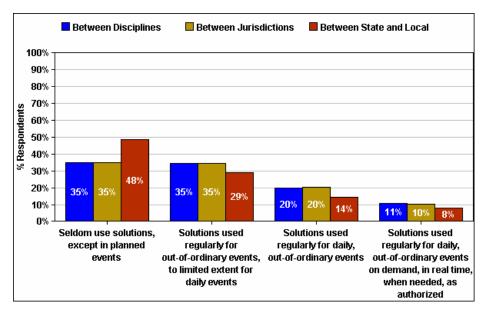

Figure 28—Frequency of Use and Familiarity

Findings regarding frequency of use and familiarity included:

- Usage shows some sharp distinctions between interlocal communications (cross-discipline and cross-jurisdiction) and state-local communications. For interlocal communications, the levels of response are the same for the early and moderate stages (35 percent each), with 20 percent in the full stage. However, when looking at communications between state and local agencies, responses are skewed more toward the early stage. Almost half (48 percent) of the responses of agencies place them in the early stage, with only 29 percent in moderate and 14 percent in full. (See Figure 28.)

- The responses of the smallest agencies do exert some downward pressure on the overall findings, at least for cross-discipline and cross-jurisdiction communications. In both instances, if the agencies serving populations under 2,500 are removed from this sample, the most highly reported stage changes, by a slight margin, to moderate.

- Agencies were also asked to indicate with which Federal agencies they interoperated. The results are listed below, with percentages based on the number of respondents who answered any one of the questions:

  - Department of Homeland Security—57 percent
  - Department of Justice—54 percent
  - Department of Agriculture—39 percent
  - Department of the Interior—21 percent
  - Department of Defense—12 percent

- − Department of Energy—5 percent
- − Other Federal Departments—27 percent

- • There are no differences between disciplines for these questions.

Overall, about 65 percent of agencies report that they interoperate with some degree of regularity at the cross-discipline or cross-jurisdiction level. The frequency of interaction between state and local agencies is somewhat lower, but in keeping with historical trends. Both the PSWN Program *Fire and EMS Communications Interoperability* study (1999) and the National Institute of Justice *State and Local Law Enforcement Wireless Communications and Interoperability* study (1998) echo the finding that local fire response/EMS and law enforcement interoperate with local agencies much more commonly than they do with state agencies.

Field agencies were asked to comment on how their operations would change if all barriers to interoperability were removed. While a few agencies thought little would change (citing either lack of a need to interoperate or satisfaction with current operations and tools for interoperability), many saw benefits. Several expected improved interoperability would lead to faster response time—removing intermediary communications and ensuring that all responders could communicate to the incident commander. Various agencies also provided examples of interoperability improving response, from enhancing the safety of ambulance crews in high-crime areas to the prevention of secondary accidents at incidents. Others noted that reduced barriers to interoperability would lead to greater trust and improved working relationships between neighboring agencies—an interesting comment, given that an often-cited barrier to interoperability specifically is lack of working relations. These agencies are suggesting that simply working more regularly together could overcome barriers that tend to inhibit agencies from working together. Finally, many agencies who could not cite a specific need for interoperability nonetheless noted that assured access to any other agency would improve their "peace of mind" in the course of their duties.

V.   RELATIONSHIPS BETWEEN CONTINUUM SUB-ELEMENTS

The basic statistical findings described in the preceding sections provided a foundation to delve further into potential relationships between the sub-elements of the Continuum. The outcome measure, or dependent variable, used for these inferential analyses was frequency of use and familiarity. This is the only question on the survey that assesses the actual degree of interoperability; all the others assess the extent of the capability and activities associated with it. Analysis was conducted not only in relation to this outcome measure (see the Primary Relationships section below), but among the other variables as well (see the Secondary Relationships section below).

Logistical regression was used to determine which of the other Continuum-based questions collectively predict a high assessment on frequency of use and familiarity. To assess "high" scores in that sub-element, the standard four-point, early through advanced scale was converted to a two-point scale, with "high" interoperability use defined by the full and advanced categories, and low interoperability use defined by the early and moderate categories. By contrast, the other predictor variables were converted into a two-point scale by defining high capacity for interoperability as moderate, full, and advanced, and low capacity as early. These predictor variables were dichotomized differently because the majority of the sample fell within the early stage across most of the predictor items, so that variance, and thus predictive power, was maximized by setting the early stage against all others (moderate, full, and advanced). In short, this pattern of separate dichotomies could demonstrate how merely moving beyond the early stage in the predictor variables could predict "high" levels of interoperability use.

It should be noted that "predictive" does not mean "causal." It means that collectively conducting a combination of certain activities is *likely* to be associated with the specified outcome.

Primary Relationships

The results of the first logistical regression analysis show that a high score in five questions significantly predicts (at the .001 level) a high score in frequency of use and familiarity, across the three interoperability levels. (All predictor variables conform to the interoperability level—other disciplines, other jurisdictions, state/local government—of the outcome variable with which they are listed.) Further, an "odds ratio" statistic indicates the relative strength of the predictive value of each, with a value of 1.000 indicating equal odds, and higher values indicating an increasing likelihood that a high score for that variable is related to a high score in frequency of use and familiarity. It is interesting to note that the relative strengths of the predictor variables are the same for other disciplines and other jurisdictions, but change for state/local government. (See Table 1.)

Table 1—
Continuum Sub-elements Predictive of Frequency of Use

Frequency of Use and Familiarity—With Other Disciplines		Frequency of Use and Familiarity—With Other Jurisdictions		Frequency of Use and Familiarity—Between State/Local Government	
Approaches	2.205	Approaches	2.177	Exercises	2.440
Implementation	1.993	Implementation	2.099	Approaches	1.843
Exercises	1.896	Exercises	1.975	Implementation	1.840
Command and Control	1.422	Command and Control	1.620	Command and Control	1.700
Standard Operating Procedures	1.398	Standard Operating Procedures	1.430	Standard Operating Procedures	1.630

Secondary Relationships

Although the other Continuum-based questions are not statistically significant predictors of high interoperability use, they are still important in the pursuit of interoperable communications. For example, SMEs reviewing the findings posited that governance issues are foundational to attaining interoperability even if, on their own, they are insufficient predictors of *high* interoperability use. To test that view, several hypotheses were developed on how the remaining elements would be related to the primary "predictor" sub-elements identified above. The same approach to logistical regression described above was used to identify statistically significant relationships involving:

- Decision Making Groups
- Agreements
- Funding for Capital Investments
- Strategic Planning.

The specific hypotheses and sub-elements found to have significant relationships (at the .001 level) are shown below. Only those hypotheses that predict at least 10 percent of the variance were judged to be supported. (See Table 2.)

Table 2—
Hypotheses Concerning Secondary Relationships

Hypothesis	Result
SOP—Decision making groups and agreements are involved in the development of joint SOPs for planned events or for emergencies because they assist the sharing of information across disciplines and jurisdictions.	**Hypothesis supported.** Decision making groups and agreements appear as significant predictors in all interoperability levels and across some interoperability levels.[16]
Technology Approaches—Decision making groups, strategic planning, and funding for capital investments are related to technology approaches because they help multiple agencies work together to define a vision for how they want to interoperate, and because funding is necessary for purchasing technology.	**Hypothesis mostly supported.** Hypothesis supported for cross-discipline and state/local interoperability, and partially confirmed for cross-jurisdiction interoperability (where decision-making groups did not show a statistically significant relationship).
Command and Control—Decision making groups and agreements are involved in the development of command and control SOPs for planned events or for emergencies because they assist the sharing of information across disciplines and jurisdictions.	**Hypothesis supported in part.** Hypothesis supported for cross-discipline interoperability only.
Technology Implementation—Strategic planning and capital funding are related to technology implementation because a vision is necessary for a new system or upgrade, and funding is necessary to acquire and implement it.	**Hypothesis not supported.** Hypothesis not supported at any interoperability level.
Exercises—Decision making groups and strategic planning are related to exercises because they build the necessary relationships and momentum.	**Hypothesis not supported.** Hypothesis not supported at any interoperability level.

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[16] It is interesting to note that this is the only hypothesis in which a sub-element (i.e., agreements) was a significant predictor across interoperability levels. This is understandable, given the nature of agreements—they should cross disciplines and jurisdictions, and state and local governments.

VI.   EQUIPMENT, SPECTRUM, AND FREQUENCY FINDINGS

The Baseline Survey concluded with a series of questions about respondents' primary wireless equipment, infrastructure, and spectrum used for communications interoperability.

Types of Primary Wireless Systems
The majority of agencies participate in some sort of shared communications system. Forty-two percent of respondents use a shared system that serves several agencies within their jurisdiction, and another 37 percent participate on larger, multi-agency, multi-jurisdictional shared systems. Primary wireless communications systems described as "independently owned and operated and used exclusively by our department" represent 21 percent of responding agencies. (See Figure 29.)
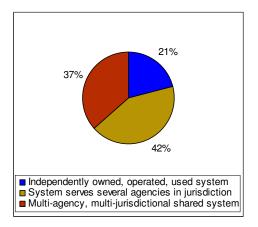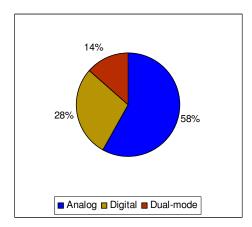

Figure 29—Primary Wireless System

Mode of Operation
Analog-based wireless communications systems are still the most common mode of operation for first responder agencies. Fifty-eight percent of the responding agencies indicated that their primary mode of operation is analog, while 42 percent of the respondents are using the digital mode, either exclusively or in concert with analog. (See Figure 30.)

Although analog mode has been the standard in public safety communications, more agencies in recent years have been replacing or upgrading these systems with digital equipment. Digital systems provide greater spectrum efficiency, have greater versatility for transmitting information over a variety of infrastructure, and allow for more effective monitoring, adjustment, and control of the overall system.

Figure 30—Mode of Operation

However, it is somewhat surprising that only 14 percent of agencies use dual mode (digital/analog) as their primary mode of operation. Because digital wireless communications systems can usually accommodate dual mode operation with appropriate programming, a higher number would have been expected. Given the large number agencies that are using only analog mode, it seems highly likely that digital users would need to communicate with analog-only users. Furthermore, it is easier for a digital user to establish interoperability with an analog user than the reverse because analog mode requires use of a signal translating device (e.g., gateway) to communicate with digital users.

Primary System Architecture

Almost three-quarters of communications systems used for interoperability are based on conventional (non-trunked) system architecture. Twenty-seven percent of agencies indicated their primary wireless system is based on trunked system architecture. (See Figure 31.)

Because trunked systems provide greater spectrum efficiency by routing users to an open channel[17], more first responder agencies have been replacing, or upgrading to, trunked systems. However, although trunking alleviates channel congestion, it does not necessarily solve interoperability problems. It may even introduce interoperability problems if the systems are based on proprietary technology. Consequently, a variety of interoperability solutions (e.g., gateways) is required and has been deployed by agencies to overcome the differences between the two types of systems.
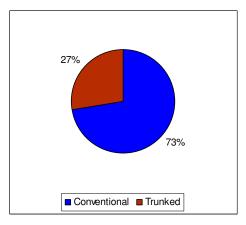

Figure 31—Architecture of Primary Wireless System

Age and Replacement Plans for Primary Wireless Systems

Among the responding agencies, roughly one-third of the agencies have systems that are either 2 to 5 years old, and another third (35 percent) indicated their primarily wireless systems are more than 10 years old. (See Figure 32.) The technology choices and interoperability problems of agencies vary with system age, and agencies do not purchase wireless radio systems as frequently as other IT technologies because wireless systems typically have a lifespan of 10 to 25 years.
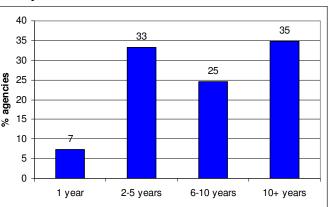

Figure 32—Age of Primary Wireless System

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[17] Conventional and trunked radio systems differ in how they access spectrum. Conventional systems users select a frequency and remain on that frequency for the duration of the conversation. Trunked systems continuously scan a given band of spectrum to automatically locate available frequencies for users. During pauses or other periods when no voice traffic is transmitted over a given frequency, that frequency can be assigned to other users, and the system will locate new frequencies as needed for any given conversation. This allows trunked systems, in most situations, to use spectrum more efficiently than conventional systems.

Almost half of agencies plan to replace their systems in the 2- to-5-year time frame, with another quarter looking to replace them in 6 to 10 years. (See Figure 33.)

With 87 percent of respondents planning upgrades in the next 10 years, the time is ripe to merge and strengthen systems. Typically, digital and trunking technologies are more prevalent in newer systems. As the current systems of agencies age, radio manufacturers are reducing technical support for analog systems, and agencies have been having greater difficulty finding parts and diagnosing problems for these older systems. Because most wireless systems are likely to be analog, many replacements should be
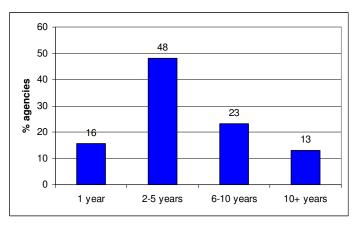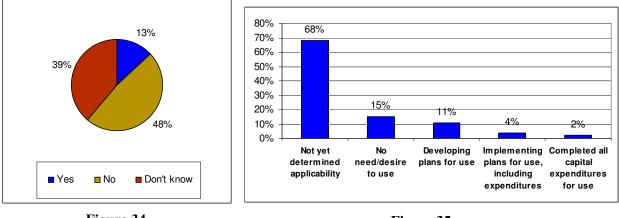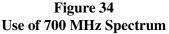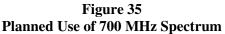

Figure 33—Time Frame to Replace or Upgrade Primary Wireless System

expected in the upcoming years. Agencies preparing to replace systems can consider many options, including subscribing to an existing shared system in the area or working with others to create a shared system with greater capability and shared costs.

Figure 34
Use of 700 MHz Spectrum

Figure 35
Planned Use of 700 MHz Spectrum

700 MHz Spectrum

Television broadcasters are scheduled to vacate analog broadcast channels in the 700 MHz band, and some of those channels have been reserved for public safety use. These channels are needed to relieve much of the congestion in public safety bands. Still, only 13 percent of first responder agencies currently use or plan to use this spectrum (located between 764 and 776 MHz), and almost one-half say they do not currently use it nor plan to use it. (See Figure 34.) The availability of this spectrum may be a factor in the responses to this question because broadcasters currently occupying the band are not required to cease operations until early 2009. This delay has created an element of uncertainty in the planning process for new 700 MHz public safety systems. In a related question, 68 percent indicated that their organization has not yet determined the applicability of this spectrum for their use. Of the responding agencies, 15 percent indicated no need or desire to use 700 MHz frequencies. (See Figure 35.)

Equipment, Solutions, and Spectrum

Of the responding agencies, 97 percent use portable radios as their primary device to achieve interoperability. Because public safety missions typically revolve around communications between responders in the field, this finding is not surprising. However, the vast majority of responding agencies indicated they also use commercial wireless telephones, wireless personal digital assistants (PDAs), or regular landline telephones/faxes to achieve interoperability. This demonstrates that first responders tend to use portable devices that are convenient and readily available in real time. For example, police officers prefer easy access to contact lists that typically are accessed using commercial wireless telephones and PDAs. The importance of portability is reinforced by the fact that mobile (vehicle-mounted) solutions were listed by only 7 percent of respondents. (See Table 3.)

Table 3—Equipment Used for Interoperability

Equipment Currently Used	% Agencies
Portable	97
PDA	79
Commercial Wireless Phone	68
Phone/FAX	65
Pagers	48
Mobile Laptop	27
Global Positioning System (GPS)	22
Mobile Data Terminal (MDT)	20
Amateur Radio	13
Satellite Phone	9
Mobile	7
Voice Over IP	6
Aircraft/Helicopter Radio	5
Citizens Band Radio	4
Other	3

Table 4 indicates that agencies use a variety of solutions to achieve interoperability. Shared channels or talk groups and radio reprograming are the most commonly used solutions. This result is not surprising because first responder agencies typically use existing features and operating procedures on their primary wireless system to achieve interoperability. Six percent of responding agencies indicated the use of National Public Safety Planning Commission (NPSPAC) channels as an interoperability solution. NPSPAC channels are typically preprogrammed on trunked radios, but not on conventional ones. The relatively low percentage of agencies employing these channels could reflect the prevalence of

Table 4—Solutions Used for Interoperability

Solutions Currently Used	% Agencies
Shared Channels/Talk Groups	53
Radio Reprogramming	47
Other Emergency Channels	42
Radio Exchange	42
Mobile Command Center	41
Shared System	30
Channel/Console Patch	27
Radio Cache	12
NPSPAC Channels	6
IP-Based System	5
Fixed Gateway Switch	5
Deployable Gateway Switch	4
Deployable Site Infrastructure	3

conventional systems in the field (see Figure 31) or indicate problems in programming or a lack of visibility for this solution. Another interesting finding is that very few agencies indicated the use of deployable solutions to achieve interoperability. Specifically, of the responding agencies, only 4 percent and 3 percent, respectively, indicated the use of a deployable gateway switch or deployable site infrastructure to achieve interoperability. These findings are in keeping with comments from field interviews that note a preference for seamless solutions as opposed to solutions that may be complex and time-consuming to establish.

Of the responding agencies, more than half operate high band very high frequency (VHF) systems for their primary system. In general, these systems use older analog technology to cover large geographic areas while deploying less infrastructure than required by systems that operate in higher spectrum bands. In addition, approximately one-quarter of public safety agencies use newer 800 MHz systems. Nineteen percent of agencies use low band ultra high frequency (UHF) frequencies, which include systems operating on frequencies in the 450–512 MHz range. (See Table 5.)

Table 5—Frequencies Used for Interoperability

Primary System/Network Frequencies	% Agencies
High Band VHF	62
800 MHz	25
Low Band UHF	19
Low Band VHF	9
Low Band UHF TV Sharing	7
Federal Band UHF	2
Other Bands	4

Of the responding agencies, over half indicated that they currently have sufficient spectrum to support mutual aid channels, while just 41 percent indicated that they have sufficient spectrum to support mutual aid channels for future operations. Additionally, nearly half of respondents indicated that they presently have sufficient spectrum for voice transmissions, and 39 percent that they have

Table 6—Sufficiency of Spectrum for Interoperability

Sufficient Spectrum	% Agencies	
	Currently	In Future
Mutual Aid Channels	55	41
Voice	49	39
Text Message	21	19
Broadband	19	18

sufficient spectrum for future voice operations. Only 21 percent of respondents indicated that they currently have sufficient spectrum for sending text messages, and a similar number, 19 percent, responded that they have sufficient spectrum to support future needs for text messages. Spectrum—both current and future availability—supporting broadband applications (e.g., sending photographs or e-mail) is deemed less sufficient. (See Table 6.)

VII.   HOMELAND SECURITY DIRECTOR SURVEY FINDINGS

Each state, plus the District of Columbia, has a homeland security director. Specific responsibilities and titles vary significantly from state to state because there is no federally mandated description of duties or tasks for these officials. Nonetheless, what they do have in common is a statewide perspective, which allows them to provide a broader view of emergency response than might be gleaned from individual fire response/EMS and law enforcement agencies. Therefore, a separate survey was developed for homeland security directors to add dimension to the initial study.

The interoperability survey for the state homeland security directors focused on governance at the state level. The questions were derived from those on the first responders' survey and are structured similarly, but rephrased to address statewide, rather than agency-focused, efforts.

Thirty-three of the 51 homeland security directors responded to the interoperability survey. This is a 65-percent response rate, and a 95-percent confidence level with a confidence interval of +10 points. Even though this response rate is relatively high, the confidence interval is large. Therefore, it is appropriate to consider these findings to be representative of only those states participating in this survey.

Governance: Decision Making Groups

Whereas the survey for first responders asked the types of decision making groups in which individual agencies participated, the homeland security director survey asks what types of groups exist within the state to address interoperability. As the response categories progress from early to advanced, the scope of the groups increases from localized to statewide, and the sponsorship increases until groups are founded by executive order or legislation.

The question about decision making groups was asked for four interoperability levels:

- **With fire response/EMS/law enforcement membership (with other disciplines)**
- **With local government membership (with other jurisdictions)**
- **With state and local government membership**
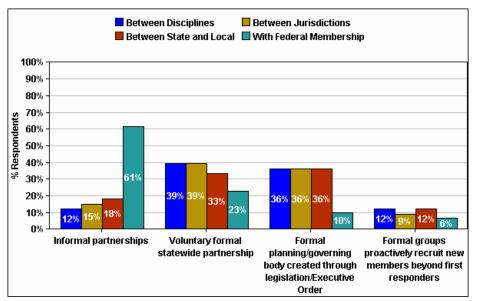- **With Federal Government membership**

Figure 36—
Decision Making Groups Within States

The response pattern for the first three of these levels is very similar, with virtually equal numbers of respondents, more than 70 percent, falling in the moderate and full categories combined. (The moderate stage represents formal, voluntary statewide groups, and the full stage represents groups created through legislation or executive order.) (See Figure 36.)
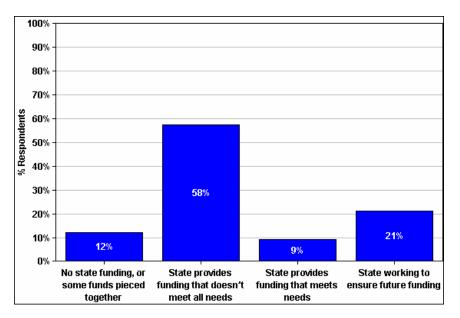
The responses for decision making groups with Federal Government membership show significantly less development. A full 61 percent of the responses are in the early stage, meaning that the Federal Government is included primarily in informal partnerships.
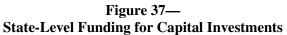
The formal groups in which agencies do participate have the following characteristics:[18]

- Makes recommendations concerning interoperability—82 percent.
- Has consistent membership—73 percent.
- Sends information to public safety leaders outside the group as appropriate—73 percent.
- Meets regularly—70 percent.
- Sends information to political leaders outside the group as appropriate—67 percent.
- Sends information to all members—64 percent.
- Takes action on its own decisions—64 percent.
- Has governance structure in place with rules—61 percent.

Governance: Funding for Capital Investments

Funding for capital investments addresses the degree to which state governments provide capital funding for investments in interoperability.

Figure 37—
State-Level Funding for Capital Investments

The majority of respondents—58 percent—indicated that their state provides some funding for capital investments, but in an amount that does not meet all the interoperability requirements. One-fifth indicated

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[18] Respondents could select as many characteristics as apply, so data do not total to 100 percent.

that not only does their state funding meet all the requirements, but their states are working to ensure future funding. (See Figure 37.)

State homeland security directors were also asked whether they shared capital investment costs with certain partners. The results are shown below[19]:

- − My state shares capital investment costs with local governments—82 percent.
- − My state shares capital investment costs with private entities—24 percent.
- − My state shares capital investment costs with other states—18 percent.

Governance: Funding for Operating Costs

Funding for operating costs addresses the degree to which state governments provide operating funds for interoperability.
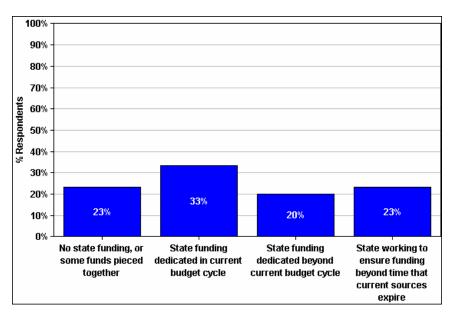

Figure 38—
State-Level Funding for Operating Costs

The plurality of respondents indicated that their states have provided dedicated funding or commitments for operating costs in the current budget year. Responses in the other response categories were virtually equal, and approximately 10 percent lower. (See Figure 38.)

Participants were asked whether their states shared interoperability operating costs with certain partners. The results are shown below[20]:

- − My state shares operating costs with local governments—82 percent.
- − My state shares operating costs with private entities—21 percent.
- − My state shares operating costs with other states—12 percent.

As can be seen, the level of funds sharing is virtually the same for capital investments and operating costs.

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[19] Respondents could select as many characteristics as apply, so these data do not total 100 percent.
[20] Respondents could select as many characteristics as apply, so these data do not total 100 percent.

Governance: Strategic Planning

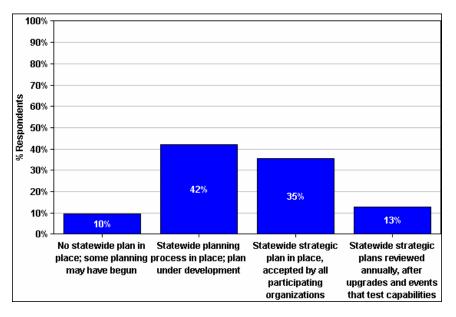Strategic planning addresses the extent of effort taken to develop a statewide plan for interoperability.

Figure 39—
State-Level Strategic Planning

A plurality of respondents (42 percent) indicates that their states have a statewide interoperability strategic planning process in place and plans under development. (See Figure 39.) It should be noted that 34 percent of local first responder agencies reporting have a strategic planning process in place that included both state and local government participation (refer to Figure 15).