Visions of Law Enforcement Technology in the Period 2024–2034

Report of the Law Enforcement Futuring Workshop

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Preface

In support of the U.S. Department of Justice's National Institute of Justice (NIJ), the RAND Corporation, in partnership with the Police Executive Research Forum, RTI International, and the University of Denver, is carrying out a research effort to assess and prioritize technology and related needs across the criminal justice community. This initiative is a component of NIJ's National Law Enforcement and Corrections Technology Center (NLECTC) system and is intended to support innovation within the criminal justice enterprise.

This report is one product of that effort. It describes the results of a workshop held at the RAND Corporation's Washington Office in Arlington, Virginia, from July 22 to 25, 2014. The workshop was conducted as part of the NIJ/NLECTC Priority Criminal Justice Needs Initiative to explore future visions of law enforcement and identify and prioritize needs in technology, policy, and practice based on those visions. Participants consisted of a diverse group of law enforcement practitioners from municipal, state, and federal law enforcement organizations and representatives from academic institutions. The report describes future scenarios of law enforcement over a ten- to 20-year time horizon that were developed by the participants. It also provides a prioritized list of technology needs to enable the scenarios that the participants deemed desirable and to prevent or mitigate the effects of those they deemed undesirable.

This report should be of interest to NIJ and other government agencies involved in research on technologies for law enforcement, private-sector technology providers, agencies within the law enforcement community, and those looking at the future of law enforcement and technology more generally.

The opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the Department of Justice.

The RAND Safety and Justice Program

The research reported here was conducted in the RAND Safety and Justice Program, which addresses all aspects of public safety and the criminal justice system, including violence, policing, corrections, courts and criminal law, substance abuse, occupational safety, and public integrity. Program research is supported by government agencies, foundations, and the private sector.

This program is part of RAND Justice, Infrastructure, and Environment, a division of the RAND Corporation dedicated to improving policy and decisionmaking in a wide range of policy domains, including civil and criminal justice, infrastructure protection and homeland security, transportation and energy policy, and environmental and natural resource policy.

Questions or comments about this report should be sent to the project leader, Richard Silberglitt (Richard_Silberglitt@rand.org). For more information about the Safety and Justice Program, see http://www.rand.org/safety-justice or contact the director at sj@rand.org. For more information about the NLECTC Priority Criminal Justice Needs Initiative, see http://www.criminaljusticeneeds.org.

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Summary

The Law Enforcement Futuring Workshop was held at the RAND Corporation's Arlington, Virginia, offices from July 22 to 25, 2014. Participants were law enforcement practitioners and academics, selected to balance representation of different experiences and perspectives, e.g., geographical location, academic versus government, federal versus state and local agencies, size of agency, rank of individual, and type of job responsibility. (The list of participants is given in Appendix B.) This workshop was a visioning exercise to explore the range of possible future law enforcement methods and operations that may be enabled by, or may be required to respond to, technology developments and applications over the next two decades. The objective of the workshop was to explore a range of futures—which could be desirable or undesirable from the perspective of the balance between law enforcement and criminal offenders—and identify technology needs (including policy and practice related to technology) that would enable desirable futures or either avoid or mitigate the effects of undesirable ones. The specific research questions to be investigated were threefold:

1. How might technology and society evolve in the future?
2. How might the evolution of technology and society affect the use of technology by law enforcement?
3. What are the priority needs of law enforcement related to technology, including research and development, training, policy, and practice?

In the future, law enforcement will have to function in an environment in which advances in *technology* and the evolution of *society* may significantly affect both *the nature of laws and of their enforcement*. To achieve their missions, law enforcement organizations will need to utilize advanced technologies. The balance between law enforcement and those planning or committing crimes or endangering public safety and security will also be shaped by new technology, with the advantage in some cases going to law enforcement and in some cases to the perpetrators. The interaction between police and criminal offenders will play out within a *context set by society*—a context that may by its nature give the advantage to either party. The workshop provided an opportunity for its participants to grapple with such issues and collaborate to identify and evaluate potential paths for the future of law enforcement.

While the participants were a well-experienced and talented group, the results of the workshop necessarily reflect their subjective assessments. As with any exercise of this type, a different group may well have produced a different set of results. And, of course, in any visioning exercise, especially one that seeks to prioritize technology needs, unforeseen future events in society or technology may challenge or invalidate the results. Nonetheless, the findings of this workshop can provide a useful guide to researchers, research sponsors, technology provid-

ers, and law enforcement agencies when thinking about the future and law enforcement technology needs.

Trends That Will Affect the Future of Law Enforcement

Prior to the workshop, RAND staff reviewed the literature on law enforcement futures and the more general futures and trends literature, and considered the broad societal and technology trends that may affect the future environment. At the start of the workshop, the following trends were presented to the participants, together with questions for thought about their potential ramifications for law enforcement (description of these trends and the questions for thought can be found in Chapter One of this report):

- The dysfunction and uncertainty in the national political environment
- The aging of the population of the United States
- The legalization and decriminalization of formerly illegal drugs
- The changing expectation and capability to live anonymously
- The new risks and opportunities arising from new means of exchange for products and services through the Internet
- The free accessibility of information and knowledge that was historically difficult to obtain and interpret
- The increasingly dynamic nature of knowledge: the amount of time for which knowledge is useful shortening while the amount of available knowledge is exploding
- The shortening or elimination of supply chains, enabling at-home fabrication of weapons and biological materials
- The increased automation and augmentation of law enforcement functions, manufacturing, and personal lives
- The increasing effectiveness of management of mental health
- The increased persistence of biometric, biologic, geographic, transactional, and environmental data
- The accelerating development of technology.

Workshop Activities and Results

During the workshop, the participants developed scenarios using a 2x2 scenario logic in which one axis represented the effectiveness (or ineffectiveness) of law enforcement use of technology to perform future missions, and the other axis represented the extent to which law enforcement was supported (or opposed) by society in the future. Three workshop breakout groups (see Appendix A for the workshop agenda) generated scenarios by creating alternative visions of the future in the period 2024–2034 and then considering possible pathways to futures that they regarded as either desirable or undesirable. (Descriptions of the methods used can be found in Chapter Two and descriptions of the scenarios in Chapter Three.) The breakout groups also identified technology needs to enable pathways to futures they regarded as desirable or to prevent pathways to futures they regarded as undesirable or to mitigate the impacts of these futures if they occurred. The technology needs from the breakout groups were consolidated to

eliminate overlap and duplication, and the full group of participants discussed, debated, and revised the consolidated needs and produced a final list of 30 technology needs. A Delphi consensus generation method was then used with the full group of participants to prioritize these needs. (Descriptions of the 30 technology needs and the prioritization process can be found in Chapter Four.)

Summary of Scenarios Generated by Workshop Participants

Workshop participants generated scenarios that covered the entire range of the 2x2 (technology and society) scenario logic. An important caveat accompanying these scenarios is that they are at a generic level, whereas law enforcement agencies differ greatly in size, location, capabilities, resources, and political realities. These scenarios are, by necessity, drawn at a high level that averages over all of these factors. Individual agencies might well be in different positions on the scenario axes. The issues addressed by the scenarios are, however, quite generally applicable to all agencies. The scenarios are briefly summarized below and fully described in Chapter Three of this report.

Workshop breakout groups began their scenario generation by debating the current (2014) situation with respect to technology and society. They agreed that law enforcement is not currently effective in using technology to perform its mission, because of the wide availability of technology to criminals with little restriction on its use and the current restrictions on law enforcement agencies with respect to both budget and use of technology. They also felt that the public generally supports law enforcement, but this support is being eroded by, for example, poor implementation or too forceful use of technology, public concern with immediate response to incidents, and lack of coordination between law enforcement agencies.

Workshop participants generally agreed that scenarios in which law enforcement effectively uses technology to perform future missions were desirable futures, and those in which law enforcement is ineffective in using technology to perform future missions were undesirable futures, with the case in which society also supports law enforcement being the most desirable. Workshop participants developed specific trajectories of how law enforcement might move from the current (2014) position over time. Participants also developed specific examples—detailed visions of what the future might look like if law enforcement were to traverse some of those trajectories.

Scenarios leading to the most desirable futures included a "transparent society" in which more and more personal data are readily available for collection and analysis, including a great deal of law enforcement data (permitting public auditing of law enforcement operations), not just private data. In this future, society in general comes to terms with a great deal of what had formerly been private information being readily available and develops norms for using it in ways generally seen as desirable. An alternative most desirable scenario envisioned the wide applicability of network-centric policing. In this future, law enforcement moves toward cultures and systems that emphasize network structures, information sharing, and collaboration. It also features the development of intelligent agents and displays to help filter and prioritize information.

Scenarios leading to futures still regarded as desirable, but less so than those described in the previous paragraph, included a "police militarization" future based on the trend of blended warfighting and policing in response to both high-profile mass shootings (and other attacks) and the ready availability of surplus military gear. In this future vision, the "warfighter/crime fighter" distinction has become blurred and there is the risk that criminals become paramili-

tary insurgents, potentially overwhelming law enforcement, in which case the scenario morphs into an undesirable future.

Scenarios leading to undesirable futures included a "shortage-crisis policing" future in which law enforcement becomes consumed with needs to guard scarce resources and/or address natural disasters. In the event that the public supported very heavy law enforcement tactics, the scenario would morph into one in which policing was broadly supported but overwhelmed. Another scenario leading to an undesirable future was a "status quo future," representing the stagnation of law enforcement technology. In this future vision, law enforcement is less agile in responding to societal changes, and societal approval declines. Another scenario considered was one that initially goes toward a desirable future, but law enforcement is unable to keep up with criminal use of technology. The latter could come about for several different reasons, e.g., technology advances too rapidly and law enforcement does not have the resources and capacity to keep up, or law enforcement agencies fail in recruitment, training, implementation, process, or policy.

Workshop participants also considered scenarios leading to a desirable future that oscillated between societal support and opposition. One such scenario begins with movement toward more effective use of technology by law enforcement, accompanied either by increased support from the public or decreased support from the public. Because of the difficulty of continually increasing public support as technology is used more pervasively, with the increasing likelihood of social or legal obstacles, public support is lost. As a result of law enforcement's response to eroding public support by using technology in a less intrusive and more competent manner, public support is regained. This type of back-and-forth movement continues, with the possibility of reduced amplitude as law enforcement learns how to use technology effectively in a way that gains public support. Workshop participants hypothesized that this can be accomplished through (1) proactive use of social media and other means to establish effective communication among law enforcement and with the public, (2) effective education and training of law enforcement personnel, and (3) partnerships with public- and private-sector organizations.

Technology Needs Identified and Prioritized by Workshop Participants

The 30 technology needs identified by the workshop participants fall into three topic areas: law enforcement knowledge and practice (14 needs); law enforcement information sharing and use (5 needs); and research and development of (other than information) technologies for law enforcement (11 needs). As described in Chapter Four and Appendix D, we ranked these needs using a Delphi process based on the questions and scales shown in Appendix C. Using the Delphi results, we placed the needs into three priority tiers, with Tier 1 being the highest and Tier 3 being the lowest.

Detailed descriptions of all 30 needs, as well as their groupings into topic areas and categorization according to a law enforcement technology taxonomy, are presented in Chapter Four. Table S.1 shows this information for the Tier 1 (highest-priority) needs. Note that some needs apply to more than one subcategory within their taxonomy category.

Table S.1
Tier 1 Technology Needs

Description of Need	Technology Topic Area	Technology Taxonomy Category
Need to develop educational material on social media to better engage the public and improve internal communications, including (1) informing the public, (2) getting incident reports from the public, and (3) getting assistance in solving crimes. Training material needs to include good examples. Can also include coverage of hiring and working with media experts. Material needs to be updated regularly to reflect new media and communications technologies.	Law Enforcement Knowledge and Practice	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
Need research and development (R&D) on technologies to use information more effectively, including smart search, sensor analytics, general predictive analytics, tools to filter and prioritize information (both push and pull), and tools to support real-time control and sharing of data from investigations and other law enforcement operations	Law Enforcement Information Sharing and Use	Information and Communications Technology Information Analysis Information Management
Need research on the use of tagging and tracking technologies (small radio frequency identification [RFID], nano, dyna dots, implants) for tracking inventory, equipment, and people for administrative and investigative purposes	Research and Development of (Other Than Information) Technologies	Information and Communications Technology Information Collection
Need research on methods to disseminate innovative, promising practices across the large number of law enforcement agencies. Should include "change management" practices and practices for gathering and using lessons learned.	Law Enforcement Knowledge and Practice	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
Need to improve training suitable for new technologies. Includes identifying/updating training needs, skill sets, and roles; tailoring training for people with different roles, levels, and backgrounds; and taking advantage of new educational technologies.	Law Enforcement Knowledge and Practice	Management/Knowledge Development and Training (applies to all sub-categories)
Need to develop technologies and processes to support data sharing, including communications infrastructure, equipment standards, integrated data systems, and adaptable/upgradable systems	Law Enforcement Information Sharing and Use	Information and Communications Technology Information Management
Need research on recognizing and dealing with legal and policy constraints for information sharing	Law Enforcement Information Sharing and Use	Information and Communications Technology Information Management
Need improved translation technologies to include dialect, indigenous languages, and cultural factors translation	Research and Development of (Other Than Information) Technologies	Information and Communications Technology Information Analysis
Need more R&D on ethics development in general	Law Enforcement Knowledge and Practice	Management/Knowledge Development and Training Societal/Legal Knowledge Development and Training
Need to update law enforcement agency recruiting practices, including recruiting people with needed skills, updating screening and hiring mechanisms, and updating training academy processes for future network-enabled training environments	Law Enforcement Knowledge and Practice	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training Specialist/ Technologist Knowledge Development and Training

Table S.1—Continued

Description of Need	Technology Topic Area	Technology Taxonomy Category
Need methods to permit LE personnel to create and use artificial identities for valid LE purposes	Research and Development of (Other Than Information) Technologies	Information and Communications Technology Information Collection
Need technology to identify in the field when someone is under the influence or impaired from future legal and custom-made drugs and other biological agents (could reflect behavioral screening, chemical screening, or combinations of the two)	Research and Development of (Other Than Information) Technologies	Information and Communications Technology Information Collection

Conclusions of the Law Enforcement Futuring Workshop

Workshop participants noted that in many cases criminals currently make more effective use of technology than law enforcement. Because of this, and the rapid rate of advancement of technology, they concluded that doing nothing to improve the effectiveness of law enforcement use of technology would inevitably lead to an undesirable future in which criminals have the upper hand and public support for law enforcement agencies is eroded.

One clear outcome of the scenario analysis was that there are many possible paths to undesirable futures. Some of the potential drivers of such paths are lack of resources, insufficient understanding of or training in the use of technologies, too intrusive use of technology (for example, with military-style equipment), lack of effective communication with the public, and poor leadership or ineffective or counterproductive policies. Paths to desirable futures, in which law enforcement uses technology effectively, and especially to those most desirable futures in which public support is also achieved and retained, require concerted action.

We note that the topic areas in Table S.1, as well as the specific high-priority needs, are quite consistent with the major themes emerging from RAND's earlier assessment and prioritization of *current* law enforcement technology needs, focusing on information technology. (See Hollywood et al., 2015.) The earlier assessment also found general themes focusing on improving the sharing and use of information, improving law enforcement's knowledge of technology and how to use it through various education and training means, and developing and fielding various affordable new technologies.

Implicit in this consistency across studies—and directly from the discussion and generated needs at the workshop—*is that workshop participants felt the best way to address the challenges of the future was to focus on improving today's law enforcement's capabilities, with an eye toward the challenges of a technologically complex future.*

We draw the following conclusions from the Law Enforcement Futuring Workshop:

1. Positive steps to address identified needs in technology, policy, and practice must be taken to avoid paths to futures that workshop participants identified as undesirable. The literal "do nothing" path was seen as leading to highly undesirable futures, and even the "do just enough to stay afloat" path was seen as leading to poor outcomes.
2. Because technology and society will continue to evolve, moving to and staying on paths to futures that the participants identified as desirable will require continuing action to

establish and retain public support and for law enforcement practitioners to effectively meet technology-based challenges.

3. Enabling paths to desirable futures in the period 2024–2034 will require addressing identified needs in practice, education, and training; information sharing; and development and/or adaptation of technology now.

Acknowledgments

The authors first wish to thank the workshop participants, who took time from busy schedules to spend almost a full week discussing and debating the future of law enforcement and the role that technology may play in the pathways to both desirable and undesirable futures. The scenarios that they produced and their insights into the interplay between technology, society, and law enforcement over the next ten to 20 years, as well as their prioritized list of technology needs, will provide data to inform important technology decisions in government and the private sector. We also thank Steven Schuetz and Michael O'Shea for their essential advice and guidance in the planning and performance of the workshop, Amanda Hagerman-Thompson for her expert support of the travel and logistical arrangements and for serving as note-taker in breakout group sessions, and Michael Watson for serving as note-taker in breakout group sessions. Finally, we thank our peer reviewers, Bart Custers and Dolores Gallego, for their detailed and insightful reviews, which led to substantial improvements in the quality of the manuscript.

CHAPTER ONE

Introduction

The Law Enforcement Futuring Workshop, which was held at the RAND Corporation's Arlington, Virginia, offices from July 22 to 25, 2014, was a key part of a research effort funded by the U.S. Department of Justice's National Institute of Justice (NIJ) to assess and prioritize technology needs across the criminal justice community. Complementing previous research that focused on problems that are *currently* faced by law enforcement agencies (Hollywood et al., 2015), this workshop was a visioning exercise to explore the range of possible *future* law enforcement methods and operations that may be enabled by, or may be required to respond to, technology developments and applications over the next two decades. The objective of the workshop was to explore a range of futures—which could be desirable or undesirable from the perspective of the balance between law enforcement and criminal offenders—and identify technology needs that would enable desirable futures or either avoid or mitigate the effects of undesirable ones. The specific research questions to be investigated were threefold:

1. How might technology and society evolve in the future?
2. How might the evolution of technology and society affect the use of technology by law enforcement?
3. What are the priority needs of law enforcement related to technology, including research and development, training, policy, and practice?

Visioning the Future Environment

In the future, law enforcement will have to function in an environment in which advances in *technology* and the evolution of *society* may significantly affect both *the nature of laws and of their enforcement*. To achieve their missions, law enforcement organizations will need to utilize advanced technologies. The balance between law enforcement and those planning or committing crimes or endangering public safety and security will also be shaped by new technology, with the advantage in some cases going to law enforcement and in some cases to the perpetrators. The interaction between police and criminal offenders will play out within a *context set by society*—a context that may by its nature give the advantage to either party. For example, concerns about privacy or individual rights may limit extensive application of some technologies by police, whereas criminals will be able to operate without such limits. Laws and the nature of their enforcement may provide new opportunities that empower law enforcement. The workshop provided an opportunity for its participants to grapple with such issues and collaborate to identify and evaluate potential paths for the future of law enforcement. They produced several

visions of the future in the period 2024–2034, as well as scenario pathways from the present to alternative futures, as responses to the first and second research questions above.

Trends That Will Affect the Future of Law Enforcement

Prior to the workshop, RAND staff reviewed the literature on law enforcement futures and the more general futures and trends literature, and considered the broad societal and technology trends that may affect the future environment. The objective here was to provide the workshop participants with "food for thought" about the evolution of technology and society in advance of the workshop so that they would have a frame of reference for considering the first two of the three research questions listed above. While it is impossible to make a comprehensive list of trends, we attempted to include all those that have been shown to, or been proposed to, affect law enforcement. In compiling this list of trends, we built on the previous work of the National Law Enforcement and Corrections Technology Center (NLECTC) Information and Geospatial Technologies Center (Hollywood et al., 2015) and the existing literature on police futures (e.g., Inayatullah, 2013; Jackson and Levin, 2010; Jackson, Myers, and Cowper, 2010).

A pre-workshop read ahead was sent to the participants, including a description of the methodology for this futuring exercise, a discussion of several important societal and technology trends, and some key questions to be addressed at the workshop. At the start of the workshop, 12 trends that were compiled as noted above were presented to the participants. Since this was not, and could not be, a comprehensive list, participants were invited to add trends that they felt could be important. During the workshop the participants did identify additional trends that they deemed important to the future of society and law enforcement, such as the trend toward the militarization of police, which were incorporated into the scenarios they developed.

The 12 trends presented at the workshop follow, along with questions for thought about them that were provided to the participants.

Societal Trends

The National Political Environment: Conflict, Uncertainty, and a Collapse in Trust That May Lead to Political Upheaval

Recent years have seen increasing political polarization and legislative gridlock on Capitol Hill. As just one example, the chief executive officer of *Politico* has noted that the political dysfunction is even more severe than it appears in the national media, and is likely to get worse over the next few years. Continued gridlock seems likely, quite possibly punctuated with intermittent government shutdowns and other political crises; as a result, the passage of new major legislation to address a number of critical issues seems unlikely. Federal funding for agencies and programs will be highly volatile (VandeHei, 2014). Trends noted as driving continued polarization and dysfunction by VandeHei and others include the increasing clustering and concentration of people with similar political views, leading to electing representatives who have similar views (see also Bishop, 2009); demand for polarized views on cable and Internet channels (see also Baum and Groeling, 2008); and the rise of interest groups that have explicit "no compromise" policies and will work against politicians who violate them (see also Gutmann and Thompson, 2012, and Fukuyama, 2014, who also comments on the increasing rigidity of how checks and balances are used in the U.S. political system).

Polling has shown that national political polarization and gridlock have resulted in the collapse of public confidence in the U.S. government. As just a couple examples, Gallup's August 2014 polling on satisfaction or dissatisfaction with the state of affairs in the United States reported that just 22 percent were "satisfied" (Jones, 2014b), and only 13 percent approved of Congress (Jones, 2014a).

While the continuation of polarization and gridlock is not inevitable, this trend raises the risk of an unknown future political shock resulting in major change in the operation of government. Just a couple of the possibilities include the rise of popular movements larger than Occupy Wall Street; successful calls for a Constitutional Convention, with three states proposing conventions to date (Celock, 2013; Sabato, 2008, is an example call for specific constitutional changes); and third-party splits (see, for example, *The Economist*, 2013).

Questions for Thought

- What challenges might "spillover" effects of the collapse in trust of the U.S. government create for state and local criminal justice agencies?
- Could these trends lead to major social unrest?
- How can agencies plan under a high degree of uncertainty in (at least federal) funding streams?

The U.S. Population Is Aging

In 2009, there were 39.6 million Americans aged 65 years or older, or 12.9 percent of the population. By 2030, there will be about 72.1 million Americans aged 65 or older, or 19 percent of the population (U.S. Department of Health and Human Services, 2014).

Question for Thought

- Will the increasing number of older individuals lead to more and different requirements for guaranteeing public safety?

Formerly Illegal Drugs Are Being Legalized and Decriminalized

As noted by the U.S. Office of National Drug Control Policy (2013), "Since 1996, 20 states and Washington, DC have passed laws allowing smoking of marijuana to be used for a variety of medical conditions. It is important to recognize that these state marijuana laws do not change the fact that using marijuana continues to be an offense under Federal law." Washington State and Colorado have both legalized the recreational use of marijuana.

Questions for Thought

- How will these laws be expanded to cover other drugs?
- In practice, will federal law continue to compromise with state laws?
- Will these laws increase crime?
- Will these laws lower police recruiting standards for drug testing?
- Will these laws result in challenges to police actions, such as looking out for driving while high?
- Should police chiefs speak out more to influence legislatures?

The Modern Expectation and Capability to Live "Anonymously" Is Changing

In addition to passive and often unwitting collection of personal data, Americans are increasingly choosing to make their personal data available and to collect data on others. There is an ongoing increase in the availability of photo and video recording devices, and this will only become more persistent and omnipresent, going from dedicated camcorders to camcorders on cell phones to camcorders on small body-worn cameras and eyeglasses (e.g., Google Glass). People will increasingly be able to collect and broadcast additional metadata and data about themselves and others. For example, Google has temporarily banned facial recognition apps for Google Glass, but there are apps under development that will perform facial recognition of photos against social media and other sources for both commercial (business) and protective (identify violent criminals and sex offenders) purposes (Robertson, 2014).

Questions for Thought

- Will the nature of crime change as people become less anonymous?
- Will persistent and omnipresent data collection devices change the nature of anonymity?
- Will strangers identify each other in heads-up displays or other bio-integrated electronics?
- Will the location and movements of law enforcement be ubiquitously tracked and reported publicly?
- Will the increased "trackability" of individuals lead to reduced "in-person" crime?
- Will public or bystanders unknowingly collect valuable physical or digital evidence?

Technology Trends

Development of New Means of Exchange for Products and Services: New Criminal Risks, New Law Enforcement Opportunities

Recent years have seen the growth of Internet sites that enable strangers to connect and exchange goods and services. Prime examples include Craigslist, eBay, and Airbnb. Such sites have helped facilitate illicit transactions that were previously more difficult; a major example is the "Silk Road" clandestine network, which was commonly used for illicit drug trafficking and other criminal transactions, including murder-for-hire (Zetter, 2013).

In addition to conducting illegal transactions, criminals can use exchange sites like Craigslist to identify strangers who may be vulnerable to robbery and other crimes. As an example of a law enforcement response, the East Chicago police have made their headquarters parking lot and lobby available for conducting cash transactions to complete Internet purchases (Perez, 2014).

Detecting, monitoring, and preventing illicit transactions is a central activity for law enforcement. The advent of digital currencies such as Bitcoin, Peercoin, and Mastercoin may make such transactions more difficult to monitor. These currencies are not managed by national clearinghouses or banks. However, the rise of digital currencies may offer law enforcement opportunities, as well: Although the physical identities of Bitcoin owners are difficult to discover, the record of transactions is public (Lee, 2011). Such transparency may actually facilitate law enforcement investigations.

Questions for Thought

- Will the proliferation of cryptocurrencies facilitate and/or obfuscate illicit transactions?

- Will virtual markets for custom malware, virtual hit-men, identity thieves, etc., have a significant effect on the daily activities of law enforcement?
- How will law enforcement monitor digital transactions that are not conducted via a central service?
- Should law enforcement routinely provide physical safe havens for individuals who meet to exchange goods?

Information and Knowledge That Was Historically Difficult to Obtain and Interpret Is Becoming Much More Freely Accessible

The World Wide Web, digitization of libraries and other major sources of content, and the increasing availability of scientific research results through open-access journals and systems are all making knowledge that was historically very difficult to obtain and interpret much more accessible. However, this trend may have a dark side—making it much easier to get knowledge on how to carry out acts of violence and terror.

Questions for Thought

- Will the wide dissemination of highly technical knowledge collections facilitate otherwise ordinary individuals producing items with the potential for extraordinary impact?
  - For example, will it be easier for a deranged teenager to make a weapon of mass destruction in his family's garage?

Knowledge Itself Is Becoming Much More Dynamic

Specifically, Long and Newman (2010) note that "while the half-life of knowledge [the amount of time for which knowledge is useful] is shortening, the amount of available knowledge is exploding." The former calls for continuous learning and training to address the frequent change, while the latter calls for increasing specialization to address the increasing range of knowledge.

Questions for Thought

- How will law enforcement agencies provide opportunities and tools for continuous learning?
- Do many more police jobs need to be specialized?

Supply Chains Are Being Shortened or Eliminated

Technology is increasingly shortening—and in some cases virtually eliminating—end-to-end supply chains to supply material goods, from design to supply to production to distribution. The best-known technologies for this are 3-D printing systems. Currently, these are known for printing plastic objects and parts, but technology is increasingly allowing for the fabrication of objects with different materials (for example, McLeod, 2014, discusses printing with multiple metals). 3-D printing will increasingly allow for printing larger objects, up to and including very specific types of buildings (Hock, 2014). Fabrication technologies also include inexpensive electronics and computerization kits, allowing for building smart devices fairly easily (for example, Heck's 2012 tutorial on Arduino microcontrollers). There is a social element to at-home fabrication, as well, commonly referred to as the Maker movement (Anderson, 2012, provides a detailed review).

However, there are risks in that these at-home fabrication technologies do not inherently distinguish between benign objects and weapons. Lately there has been significant concern about using fabrication machines to make guns, with designs to do so improving rapidly (Greenberg, 2014). Longer-term concerns go beyond fabrication of guns to dangerous biology, such as fabrication of DNA evidence and biological weapons.

Questions for Thought

- Will the advent of cloning allow sophisticated individuals to fabricate and distribute false cloned DNA evidence?
- Will 3-D printing facilitate the creation of difficult-to-detect weapons (e.g., guns, knives)?
- Will theft increasingly involve the theft and unauthorized use of 3-D designs?

There Is Increased Automation and Augmentation of Law Enforcement Functions, Manufacturing, and Personal Lives

Key examples of this trend include digital augmentation of traffic control, energy distribution, building management, and public transportation. In just one area, driverless cars have been projected to appear as soon as the 2020 model year (Ohnsman, 2013). Personal examples include wearable computing and perhaps even bionics (mechanical devices integrated to some extent with bodies).

Increased automation poses potential social and cultural risk due to jobs being replaced by automation. One widely reported Oxford Martin School study claims that up to 47 percent of U.S. jobs could be replaced by 2033 (Frey and Osborne, 2013). For example, the expected rise of driverless cars opens the possibility of replacing truck drivers with self-driving trucks (Berman, 2013).

On the positive side, automation and augmentation could offer police departments abilities to analyze data and monitor areas on scales that would otherwise be completely impractical. As just one example, the prototype "Knightscope" policing robot is intended by its developers to autonomously patrol areas and detect suspicious activity and persons and vehicles of interest, alerting human officers if it finds something "interesting" (Statt, 2013).

Questions for Thought

- How will police use automation to their benefit?
- Could robots take over some police functions?
- Could police send automated and armored "protective custody" vehicles to individuals under assault?
- Will automated transportation affect the amount of time law enforcement dedicates to managing and responding to vehicle violations and traffic accidents?
- What about the possibility of smuggling?
- What about the possibility of automated murder?

Effectiveness in the Management of Mental Health Is Increasing

There are a number of novel drugs in development or testing for diseases of the mind, as well as automated methods for administering and monitoring the drugs and their effectiveness. For example, the Pharmaceutical Research and Manufacturers Association has recently advertised

treatments in development for social anxiety, schizophrenia, cocaine addiction, depression, and certain eating disorders (Pharmaceutical Research and Manufacturers Association, 2014).

Questions for Thought

- Will designer drugs and automated monitoring and administration devices reduce the burden placed on police by those with mental health issues?
- Will police need less—or different—training in handling medical or mental impairment situations?

There Is Increased Collection of Biometric, Biologic, Geographic, Transactional, and Environmental Data[1]

Ever more systems and devices are generating data about persons and uploading them to various networks for various uses, often without the knowledge of the persons. Mobile and wearable devices are recording and retaining more biometric, biologic, geographic, and transactional data. Service providers are recording and retaining more biometric, biologic, geographic, and transactional data as well. Finally, intelligent infrastructure systems inherently function as a massive sensor net.

All of this data collection, especially when collected or used for governmental purposes, has led to increasing political and legal opposition to "mass surveillance." This trend has been exacerbated by the "Snowden revelations." There have been legislative and legal challenges to the use of digital evidence, automated license plate readers, unmanned aerial systems, and facial recognition. As just a few examples:

- In the U.S. Supreme Court case *Riley v California* (134 S.Ct. 999, 2014), the Court unanimously ruled that law enforcement needs warrants to search cell phones.
- In June 2014, the House of Representatives passed a provision to ban federal agencies' acquisition of license plate readers, and to ban agencies giving out grants to state and local agencies for acquiring license plate readers (Gerstein, 2014).
- As of September 2013, nine states had passed laws limiting the use of unmanned aerial systems (National Conference of State Legislatures, 2013).

Questions for Thought

- Will the proliferation of data sources require that investigators become data analysts?
- Will the nature of crime change as people become less anonymous?
- Will strangers passing each other on the street have "virtual" knowledge about each other's commercial interests using heads-up displays?
- What will be the impact of the counter-challenges to all of this data collection, specifically on security-related collection?

Accelerating Technology Development Is Changing Society, Criminals, and Law Enforcement

The wide availability of advanced technologies will provide new threats and opportunities for law enforcement. For example,

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[1] A previously discussed trend relates to people deliberately collecting data from others or making personal data about themselves readily available. This trend relates to data passively collected from people, frequently without their knowledge.

- Social media provides new options for crime and law enforcement.
- Augmented reality provides increased situational awareness.
- Digital forensics provide unique prosecutorial opportunities.
- Unmanned vehicles and GPS could provide ubiquitous tracking and monitoring capabilities.

In fact, law enforcement relies heavily on commercial technologies such as the smartphone, which alone contains technology described by 250,000 patents (O'Connor, 2012). The technology needs described in Chapter Four of this report recognize this strong dependence on commercial technology and the anticipated rapid development of emerging technologies such as those listed above.

Questions for Thought

- How will we inform and incentivize private industry to apply its developed technologies to meet law enforcement needs?
- How will we take advantage of both legacy and new technologies to meet law enforcement needs in the future operational environment resulting from societal and technology trends?
- How will law enforcement defeat threats and take advantage of opportunities in the future operational environment?

It's Not Just About Technology

While technology can be a major driver of change, it is not the only potential driver. As a result, the workshop focused not only on technology, but also on the *context in which it may be used* by law enforcement, criminals, and members of society. Technology is also not the only way to respond to change. To be successful in the future environment, law enforcement may indeed need new technology tools, but may also need changes in training, policies and procedures, or other factors that shape the relationship between law enforcement agencies, other organizations, and the public they protect. In addition to looking at technologies, the workshop participants also considered emerging problems and opportunities and combinations of technology, training, and policy that can address them. Thus, the prioritized list of technology needs developed by the workshop participants includes areas such as leadership, training, and information dissemination.

Structure of This Report

This report is structured as follows. Chapter Two describes the methodologies used during the workshop to develop the scenarios and the prioritized list of technology needs. Chapter Three describes the scenarios developed by the three workshop breakout groups. Chapter Four presents and describes the prioritized list of technology needs, categorizing them by topic areas and according to a law enforcement technology taxonomy. Chapter Five discusses common threads in the scenarios and themes in the high-priority technology needs, and presents the conclusions

of the workshop. Appendix A provides the workshop agenda, and Appendix B provides a list of workshop participants. Appendix C presents the question descriptions and ranking scales used for the Delphi exercise. Appendix D presents the statistical analysis of the Delphi responses that was used to determine the ranking of technology needs.

CHAPTER TWO

Methodology

Three different types of methods were used during this workshop: (1) scenario development and analysis as a structured way to describe possible futures (Schwartz, 1991); (2) the "Three Horizons" visioning method (Curry and Hodgson, 2008), which was used to generate scenarios and associated technology needs; and (3) a Delphi consensus generation method (Gordon, 2009), which was used to prioritize the technology needs. The workshop agenda (Appendix A) was organized so that all participants met initially to frame the discussion of law enforcement futures, three separate breakout groups then developed scenarios and lists of technology needs, and all participants heard reports from the breakout groups, discussed the scenarios, and reviewed and prioritized a consolidated list of technology needs. Below, we briefly describe each of the methods used.

Discussion of Choice and Application of Methods

When designing this workshop in the context of the three research questions stated in Chapter One, we viewed this work as an exercise in technology foresight, for which a wide variety of methods, ranging from the qualitative (e.g., brainstorming) to semi-quantitative (e.g., cross-impact/structural analysis) and quantitative (e.g., benchmarking), as well as from highly creative (e.g., wild cards) to evidence-based (e.g., modeling) and from individual expertise–based (e.g., expert panel) to highly interactive (e.g., conferences/workshops).[1] As is typical of foresight exercises, we used a combination of methods. Because the objective of this work was to identify and prioritize law enforcement technology needs, we chose to rely on the expertise of law enforcement practitioners. However, we brought these practitioners together in a workshop format to enable a highly interactive approach to developing future visions. In structuring the workshop, we relied on the following principles:

- the use of small focus groups oriented by a detailed in-brief describing the objective and trend information stated in Chapter One, then assigned to develop future visions through creative discussion and debate[2]
- a structured agenda (shown in Appendix A) that led the focus groups through the "Three Horizons" visioning process described later in this chapter

[1] See, for example, Popper, 2008.

[2] This was modeled after the Helsinki Design Lab's "design studio" approach described in Boyer, Cook, and Steinberg, undated.

- reporting of the individual focus group results to all workshop participants and group discussion to build a consensus[3] that incorporated insights from all three focus groups.

For the development of scenarios, we combined a conventional 2x2 scenario framework,[4] based on the notion of evolution of society and technology described earlier, with the "Three Horizons" method of visioning, in which the focus groups first characterized the present time, then envisioned what 2024–2034 might look like, and finally considered the possible pathways from the present to different visions of 2024–2034. Our application of these methods is described in the following two sections. We combined them in this way to gain a synergistic advantage—a palette for the focus group visions of the co-evolution of society, technology, and law enforcement.

With respect to the Delphi method, our use is somewhat less conventional. We chose not to use a Delphi survey to generate future timelines or scenarios because we wanted interaction between the practitioners in a small group setting to develop the scenarios. However, the third research question listed in Chapter One required prioritization of the 30 technology needs. We accomplished this prioritization using estimates of the expected value of each technology need, and a Delphi method to elicit expected value estimates from each participant. The expected value method is itself based on several previous RAND studies (Silberglitt et al., 2004; Chow, Silberglitt, and Hiromoto, 2009; Landree et al., 2009) and is described later in this chapter. The Delphi method was implemented during the workshop in two rounds using an electronic spreadsheet. The same ranking scales (shown in Appendix C) were used by all participants during this Delphi exercise. A detailed statistical analysis of the Delphi data is given in Appendix D.

Selection of the Workshop Participants

This workshop provided a unique opportunity to explore the future evolution of society, technology, and law enforcement through the eyes of an interacting group of law enforcement practitioners. The selection of this group of practitioners was thus a critical element of the method. We selected workshop participants from two basic inputs. The first was a list of potential participants compiled by NIJ staff. This list was composed of individuals whom the NIJ staff recommended because of their combination of expertise, experience, and collaborative abilities, some of whom had previously participated in working groups sponsored by NIJ. The second input was a list compiled by RAND staff based on a literature review and experience organizing and attending technical working groups for the NLECTC Information and Geosciences Center. This list was composed of individuals whom the RAND staff recommended because of the breadth, depth, and quality of their publications or because of their expertise and experience and demonstrated ability to make outstanding contributions to technical working groups. In the selection process, we sought to balance representation of different experiences and perspectives, e.g., geographical location, academic versus government, federal versus

[3] Consensus for scenarios was on starting point and possible pathways and positions in 2024–2034 based on the framework shown under "Developing Scenarios for Law Enforcement" later in this chapter. For technology needs, RAND staff produced a consolidated list that integrated the needs from the focus groups. The full group of participants reviewed, discussed, and revised this consolidated list before reaching consensus on the 30 technology needs presented in Chapter Four.

[4] There are many examples in the literature. One that uses axes somewhat analogous to those of the present study is described in Fernández-Güell, 2010.

state and local agencies, size of agency, rank of individual, type of job responsibility. The list of participants who accepted invitations and attended the workshop is given in Appendix B. Of the 19 participants, there were three academics, one international, one law enforcement journalist, four federal employees, three state police, five large city police, and two small city police. Many different job responsibilities and rank were represented: professor, chief technology officer, chief criminologist, director of planning and research, chief of police, captain, lieutenant, and sergeant.

While we believe we assembled a well-experienced and talented group of participants who interacted in a highly collegial manner and produced a thought-provoking and well-founded set of scenarios and priority technology needs, we recognize that these results reflect their subjective assessments. As with any exercise of this type, a different group may well have produced a different set of results. And, of course, in any visioning exercise, especially one that seeks to prioritize technology needs, unforeseen future events in society or technology may challenge or invalidate the results. Nonetheless, some of our findings are consistent with other studies (e.g., Tyler, 2004; Custers, 2012; Hollywood et al., 2015), and we believe they will provide a useful guide to researchers, research sponsors, technology providers, and law enforcement agencies when thinking about the future and law enforcement technology needs.

Developing Scenarios for Law Enforcement

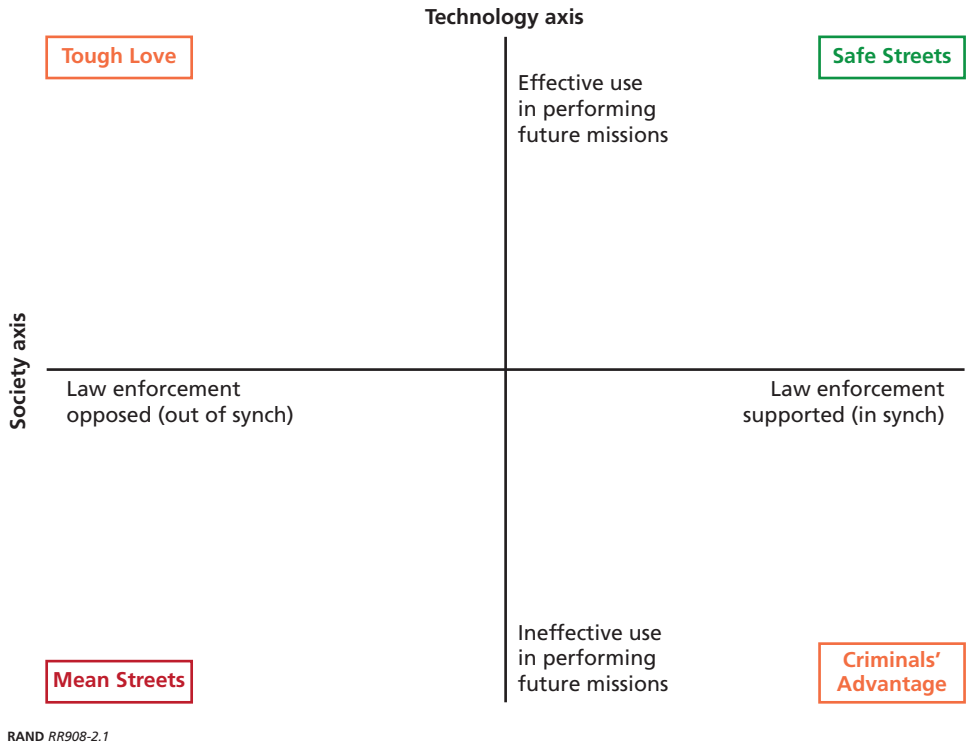
As noted above, the scenario framework was a critical aspect of the methodology of this study, because it provided the palette on which the workshop participants drew their future visions. We constructed this framework based on the observation that the most important factors driving the future of law enforcement fall into two categories: technology and society. On the one hand, the pathways of future scenarios will be driven by how advances in technology are adopted and used by police, perpetrators, and the public. On the other hand, they will also be driven by how laws and law enforcement evolve and are viewed by the public, which will determine available resources and have a strong influence on the effectiveness with which police can employ technology.

Bearing in mind that the objective was to identify and characterize law enforcement technology needs, we made one principal axis the effectiveness of law enforcement in using technology to accomplish its missions. We used the other axis to represent the effects of the evolution of society on law enforcement. Here we reasoned that the most important aspect of societal evolution affecting law enforcement futures would be the extent to which society supported or opposed law enforcement.

Accordingly, workshop scenarios were drawn on the graph shown in Figure 2.1. Points on the (vertical) technology axis represent the effectiveness of law enforcement in using technology to accomplish its missions, increasing from bottom to top. Points on the (horizontal) society axis represent the extent to which society and law enforcement evolve in concert (in synch)[5] or in conflict (out of synch), with the level of compatibility and support increasing from left to right. The four corners of the graph represent four very different possible futures.

[5] Here *in synch* and *out of synch* do not imply dependency between the independent axes of Figure 2.1, but rather describe whether society is generally supportive of law enforcement actions or opposed to them.

Figure 2.1
Scenario Format for Law Enforcement Futuring Workshop



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Safe Streets

The upper right corner of the graph represents a future in which law enforcement has the upper hand in the use of technology to counter criminals and protect the public. In this future, law enforcement also enjoys strong public support, resulting in ample available resources and broad authority to use technology and to take action.

Mean Streets

The lower left corner of the graph represents a diametrically opposed future, in which criminals have the upper hand in use of technology and strong public opposition greatly restricts the resources available to law enforcement and the authority granted.

Tough Love

The upper left corner of the graph represents a hybrid between the previous two futures, in which law enforcement has the upper hand in the use of technology, but is hampered by strong public opposition that limits its resources and its authority.

Criminals' Advantage

The lower right corner of the graph represents another hybrid future in which criminals have the upper hand in the use of technology, but law enforcement receives strong support from the public.

These four possible futures are extremes. It is highly unlikely that any of them will occur. They were intended to provoke thought and discussion about where on this graph we are in

2014, where current trends may be moving us, the relative desirability of different positions in the future, and how actions we take now might affect the paths to different possible futures. This framework was sent to the workshop participants as a read ahead prior to the workshop. It was also included in the in-brief at the workshop and was accepted by the participants as a valid framework for the work of the breakout groups. The workshop breakout groups then used this graph to develop alternative scenarios and identify high-priority technology needs that may enable those scenarios they saw as desirable and prevent or mitigate the impacts of those scenarios they saw as undesirable. Identification of desirable and undesirable scenarios was one of the assignments to the breakout groups (step 6 in the following section).

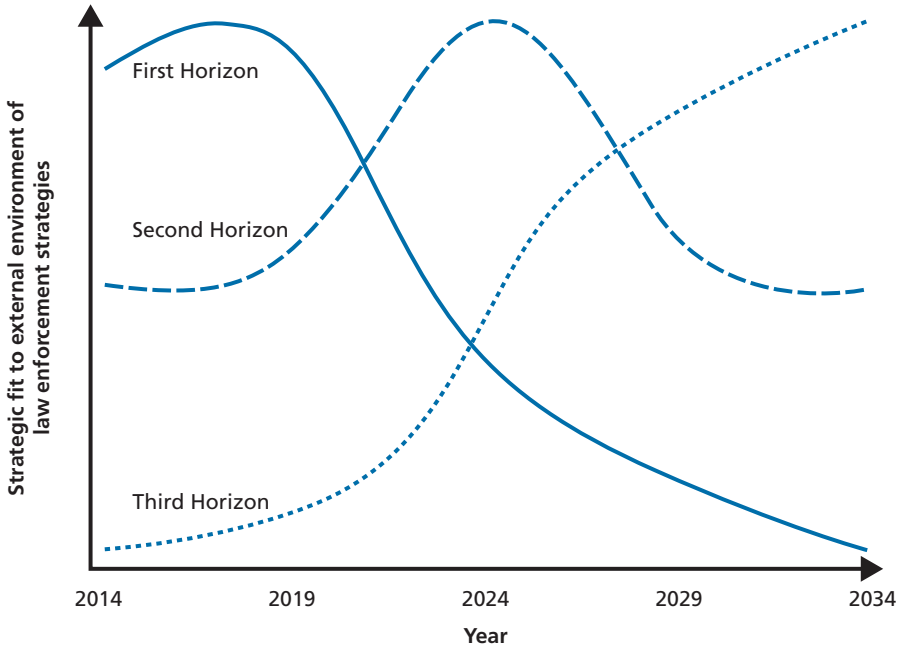
The Three Horizons Visioning Method

The Three Horizons visioning method is a method for considering alternative future visions, comparing them, and analyzing how they might occur by devising scenarios and pathways or trajectories from the present to the future. The method consists of defining the characteristics of the present and the future visions, then considering and evaluating pathways from the present to the future and establishing the details of alternative scenarios. When using this method, one divides the present and future into three time horizons. The First Horizon is the present time. The Third Horizon is the envisioned future, which in the case of the Law Enforcement Futuring Workshop was ten to 20 years ahead, or the period from 2024 to 2034. The Second Horizon is the intermediate time period, which for this workshop was 2014–2024. Figure 2.2 shows a representation of these three time horizons adapted from Curry and Hodgson (2008). The y-axis represents the extent to which strategies, for law enforcement in this application of the method, fit the external environment. The x-axis is time, increasing to the right. The figure indicates that the fit of the First Horizon strategies decreases as the environment in which law enforcement must operate changes with advances in technology and the evolution of society. This eventually yields to a Third Horizon, which will require a new set of strategies, indicated in the figure as evolving from the present to the 2024–2034 time period. The Second Horizon is shown as a bridge between the First and Third Horizons, whose strategic fit rises and falls in the intermediate time period. *Following Curry and Hodgson, we regard the Second Horizon as a time of conflict resolution between the many possible pathways to very different Third Horizons—"pockets" of the future embedded in the present.*

Workshop participants in three different breakout groups applied this visioning method within the scenario framework shown in Figure 2.1, using the following nine steps:

1. Explore and discuss the current (First Horizon) position on the scenario chart (Figure 2.1) and the role of technology in this position.
2. Identify the drivers for and barriers to the use of technology by law enforcement in the current position and characterize current technologies and capabilities of law enforcement to use these technologies.
3. Envision possible locations on the scenario chart in 2024–2034 (Third Horizon) and the similarities and differences of these locations from the current location.
4. Identify problems that these future positions on the scenario chart would pose for law enforcement and opportunities that they would create.

Figure 2.2
Schematic Representation of the Three Horizons Visioning Method



SOURCE: Adapted from Curry and Hodgson, 2008.
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5. Explore the role that technology would play in law enforcement missions in these future positions.
6. Debate what would be desirable and undesirable future locations on the scenario chart and why.
7. Envision possible paths (Second Horizon) from the current location to desirable future locations, the possible enablers (drivers) of these paths, and what would prevent these paths (barriers).
8. Consider how technology could enable or prevent these paths, and which technologies could enable paths to desirable locations and/or prevent paths to undesirable locations or mitigate their effects.
9. Finally, identify technology needs (including training and changes in policies or processes) to enable paths to desirable locations and/or prevent paths to undesirable locations or mitigate their effects.

The Delphi Consensus Generation Method

The Delphi method, which was developed at RAND decades ago (e.g., see Dalkey, 1969) is a means of generating consensus among a group of participants in which the participants all answer the same questions and the results are shared anonymously. The participants are then given the choice to change any of their answers based on the anonymous group results that

they have seen. This process can be repeated over several rounds, and participant responses can include comments that are also shared anonymously. The Delphi method and its many variants have been used widely in policy analysis. An excellent review and summary is given in Gordon (2009). In this case, we used an electronic spreadsheet that each participant filled out anonymously, and in the second round we provided a spreadsheet that anonymously reported the responses and comments of all participants and allowed each participant to anonymously change any answer.

The application of a Delphi method can be defined by several characteristics. A recent study (Gallego and Bueno, 2014) elaborated such characteristics for 24 different Delphi technological forecasting studies of information systems and technology. In terms of those characteristics, our application of the Delphi method can be characterized as follows: questions developed by the RAND study team; a two-round mini-Delphi; a homogeneous panel of 19 experts; and use of a 9-point Likert scale, without weights, according to the experience of the experts. The RAND team developed the questions to achieve the objective of prioritizing technology needs that were to be identified by the workshop participants. The panel was homogeneous in that they were all law enforcement practitioners or academics studying the practice of law enforcement. However, as noted previously, the expertise, experience, job responsibilities, and perspectives were balanced among the participants. The number of experts was a tradeoff between keeping the focus groups in the range of 6–8 to optimize creative discussion and having a large enough total group to get an acceptable statistical distribution of responses. The study referenced above suggested 15–30 as an acceptable range of participants, and our results supported this—out of the answers to 120 questions in Round 2, only one had a standard deviation greater than 2.5 on the 9-point scale, and 15 percent had a standard deviation greater than 2.0. The questions and scales are described in Appendix C and the statistical analysis in Appendix D.

The objective of the Delphi method used here was to prioritize a set of technology needs generated by the participants. This was done by determining expected values of each technology need, using a method developed at RAND (Silberglitt and Sherry, 2002) and previously applied to evaluate portfolios of U.S. Army (Chow, Silberglitt, and Hiromoto, 2009) and Navy (Silberglitt et al., 2004) research and development projects, and information dissemination activities of the U.S. National Security Agency (Landree et al., 2009), and to prioritize law enforcement technology needs (Hollywood et al., 2015).[6] These expected values were determined as described below using the results of the Delphi method answers to the following four questions:

1. How important will this need be in enabling or preventing/mitigating scenarios?
2. How pervasive will this need be in enabling or preventing/mitigating scenarios?
3. How hard would it be to overcome technical barriers?
4. How hard would it be to overcome operational and deployment barriers?

[6] In this method, the value of a project or activity to meet defined requirements or a technology need to meet mission requirements is defined as a random variable. The expected value is determined by the probability distribution of the possible states of this variable. Applications of the method have used expected value estimates made by analysts or by Delphi panels. In both cases, the expected values were determined as products of (1) estimates of benefit if the project or activity is successful or the technology need is met, and (2) the probability of success, taking into account both technical and operational or implementation barriers. Application of the method requires clear definition of the objectives and ranking scales and subject-matter expertise to make the estimates of benefit and probability of success.

To ensure that each participant had a common understanding of the questions and a consistent basis for their answers, we provided a description of each question and definitions of scores on a scale from 1 to 9 for each answer. These descriptions and definitions are presented in Appendix C. Each workshop participant rated each technology need using the same 1 to 9 scale. We then determined an expected value (EV) from these scores using the following equation:[7]

$$EV = Importance \times Pervasiveness \times Technical\ Probability \times Implementation\ Probability,$$

where *Importance* was the answer to question 1 above, *Pervasiveness* the answer to question 2, *Technical Probability* the answer to question 3, and *Implementation Probability* the answer to question 4. This equation treats the answers to questions 2–4 as factors that scale the estimate of importance. The answer to question 2 is an estimate of the fraction of all scenarios in which the technology need will be important. The answer to question 3 is an estimate of the probability of technical success in addressing the need. The answer to question 4 is an estimate of the probability of success in implementing this technical solution if it is available. The first two factors determine the potential value of meeting the technology need. This value depends on both the importance of the need and how many of the desirable scenarios in which it is important. The second two factors determine the probability of success in achieving this value. Probability of success depends on both solving technical problems and being able to implement the technical solution.

Using the above equation and the technology need scores provided an expected value for each technology need from each of the workshop participants. To obtain a combined expected value, one can fit the statistical distribution of the individual participant expected values to a functional form, such as the normal or lognormal distribution, or use a non-parametric approach. We chose the latter and used the average and the median of the individual participant expected values. This has the advantage that it does not require any assumption about the distribution of these expected values. Moreover, there is a statistical test (Wild and Seber, 1999) that allows the comparison of the (e.g., 19) individual participant expected values for one need with those for another need to determine the probability that the need with a lower average or median should actually be ranked higher than the one with a higher average or median. After ranking the technology needs by average and median of the individual participant expected values, we applied this test to validate the rankings, and then to help separate them into higher- and lower-ranked tiers. The rankings are described in Chapter Four, and the details of the statistical analysis are presented in Appendix D.

The Delphi method was applied in this workshop using two rounds. In the first round, the participants were provided with the descriptions of the four questions listed above and the definitions of the rating scales and answered the questions for each technology need. They were then presented with a summary of the first-round results that showed the arithmetic mean (i.e., average) and standard deviation of participant answers to each of the four questions for each of 30 technology needs. They then discussed the ratings and reasons for them for the three cases in which the standard deviation was greater than 2.5 out of 9 (corresponding, for a normal

[7] This equation implicitly assumes that a particular numeric value for a particular parameter carries the same meaning/weight/relevance as that value does for each of the other three parameters, and that it carries the same meaning/weight/relevance for one person as it does for another.

distribution, to about 13 answers out of 19 distributed over a distance of 2.5 from either side of the average). After this discussion, the participants were then given a chance to change any of their scores in a second round. It was these second round results that were used to determine the expected values and the technology need rankings presented in Chapter Four.

The Process Followed During the Workshop

As shown in the agenda (Appendix A), we held both full participant sessions and breakout group sessions. The workshop began with full participant sessions that served to frame the problem of law enforcement futures and the scenario approach. Three different breakout groups then applied the scenario and Three Horizons methods described in previous sections of this chapter to develop scenarios and lists of technology needs. A full group session then discussed the scenarios and technology needs from the breakout groups and came to consensus on the list of technology needs to be prioritized. Finally, the full group prioritized the technology needs using the Delphi method described in the previous section.

CHAPTER THREE

Future Law Enforcement Scenarios

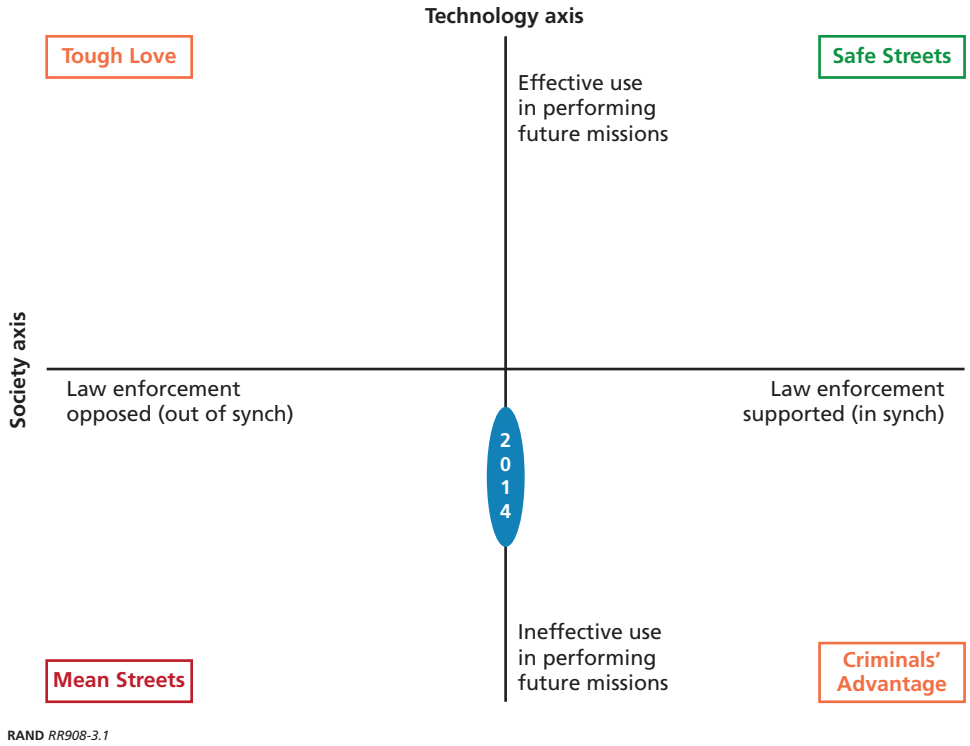
This chapter describes the future law enforcement scenarios developed at the workshop. While the three breakout groups independently developed sets of scenarios, these shared many common aspects. In the following, we have integrated the work of the three groups into a single set of workshop scenarios. An important caveat accompanying these scenarios is that they are at a generic level, whereas law enforcement agencies differ greatly in size, location, capabilities, resources, and political realities. The scenarios we present below are by necessity drawn at a high level that averages over all of these factors. Individual agencies might well be in different positions on the scenario axes. The issues addressed by the scenarios are, however, quite generally applicable to all agencies.

Current Position on the Scenario Chart

Workshop participants debated the current position on the scenario chart of Figure 2.1, and the weight of opinion was that we are currently somewhere below the *y*-axis, reflecting the wide availability of technology to criminals with little restriction on its use, and the current restrictions on law enforcement agencies with respect to both budget and use of technology. There was also uncertainty about whether we are currently to the left or right of the *y*-axis. This is indicated in Figure 3.1, where the oblong area in blue represents the fact that, while the participants felt that the public generally supports law enforcement (the right side of the area), current problems such as the following contribute to erosion of this support (the left side of the area):

- Recruitment, hiring, and training is often out of synch with community expectations and technological realities.
- The public is often concerned with immediate response to incidents.
- Technology is often poorly implemented, and sometimes used too forcefully or too intrusively.
- There is a lack of explanation when and why technology is used.
- There is too little sharing of information and response times can be slow.
- There is a lack of coordination between law enforcement agencies.
- As crime morphs from real to virtual, criminals are early adopters of technology, whereas law enforcement is hampered by lack of funding and training.
- The growing distrust of government is spreading to law enforcement.
- Law enforcement is reactive in nature.

Figure 3.1
First Horizon (2014) Position on Scenario Chart



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Current Roles of Technology

Workshop participants discussed the many roles of technology in law enforcement today. The discussion focused on the following issues:

- Expectations of the public are often different from reality with respect to the capabilities of law enforcement in personnel qualification, management, and culture to effectively use technology.
- Public acceptance is often shaped by extreme events.
- An increasing and sometimes overwhelming amount of data are available, and standards for its capture, storage, and use are lacking.
- Law enforcement use of technology faces legal issues, e.g., data storage and sharing, individual privacy, evidence chains.
- Public and private data sources and advanced analytic tools create challenges and opportunities for law enforcement.
- Keeping up with public, private, and other agencies' use of technology sometimes becomes an end rather than a means.
- Ubiquitous information exposes law enforcement personnel to incidents that can affect their psychological and social well-being.
- Technology can be used to increase efficiency and provide force multiplication, but measuring effectiveness is difficult.

- Technology advances both assist with and increase requirements for training and education of law enforcement personnel.

Emerging Uses of Technology

As a prelude to the discussion of future scenarios, the workshop participants discussed the emerging uses of technology by criminals and law enforcement, as well as the drivers for and barriers to law enforcement use.

Emerging Uses of Technology by Criminals

The wide availability over the Internet of information, designs, equipment, and materials has created open-access technology for weapons and drugs. For example, additive manufacturing methods such as 3-D printing have already been demonstrated as a means to produce guns that would evade metal detectors or important gun components that would provide a means to assemble automatic weapons from parts that are freely available commercially (Greenberg, 2014). Classes of new designer psychedelic drugs, some not illegal, are available on Internet forums (Grigoriadis, 2013). Such open-access weapons and drugs are already available to criminals. As emerging technologies develop further, one can envision, for example, cyber attacks on medical devices such as pacemakers or the use of the "Internet of things" to identify targets or create situations that require police response. There is also the possibility of criminals embedding technology in public or private systems for later use.

Emerging Uses of Technology by Law Enforcement

Social media use is one of the most important emerging uses of technology by law enforcement. Several of the workshop participants noted that social media can be an important tool for law enforcement agencies to communicate with the public. They stressed, however, that it is important to engage in a dialog and hear and respond to public concerns in the most effective way possible. Used in this way, social media can provide a means to connect with the local community, provide a conduit for pushing out correct information, and prevent rumors and incorrect information from gaining steam. When considering paths to desirable futures, participants identified effective use of social media as a key driver toward futures with public acceptance of law enforcement use of technology, i.e., the right-hand side of the scenario chart.

Participants identified several other emerging uses of technology by law enforcement, including the expansion of surveillance capacity as the number and location of cameras (including wearable ones) increases; the use of cloud computing to reduce the need for physical infrastructure in agencies; the use of advanced data collection, analytics, and information dissemination to increase situational awareness for officers in the field; the use of Global Positioning System (GPS) technology to monitor officer location; and the increased use of military-style equipment, reflecting a trend toward militarization of police that can lead to difficulties in developing and retaining public support.

Drivers for Law Enforcement Use of Technology

Participants identified both public expectations and the continuing advance of technology as key drivers for law enforcement use. With the ubiquitous use of technology by the public and by criminals, law enforcement agencies must become familiar with current and emerging uses.

In this sense, the development of technology is itself driving innovation in its use by all parties. As noted above, technology can improve efficiency and act as a force multiplier, which in the current fiscal environment is an additional driver.

Barriers to Law Enforcement Use of Technology

Participants identified several different barriers to law enforcement use of technology. Declining budgets and the lack of public and political support were often mentioned. Another identified barrier to using technology in ways that would change current practice was anxiety and inertia among the command staff and workforce. Issues associated with the cost of maintenance and with necessary training were also raised, as was as the incomplete citizen understanding of technology and how it would be used by the police.

Current Trends in Law Enforcement Use of Technology

Participants agreed that, as the ability to collect multiple types of data (e.g., video, location, biometric), as well as "big data" analytical capability, continues to increase, outsourcing will become the dominant paradigm for most law enforcement agencies that cannot afford to develop and maintain internal capabilities on a par with those available for hire. They also envisioned the emergence of automated or robotic policing, but with limited daily use, with physical patrolling giving way to cyber patrols rather than robotics.

In the discussion of current trends, many participants noted that while technologies and technical tools that could make law enforcement more effective are widely available, there has been very slow response to technology development and poor implementation of technologies by law enforcement. Participants argued that there is limited and isolated awareness of what is in development and that haphazard implementation contributes to eroding public support. It was argued, for example, that law enforcement is particularly poorly positioned to enact or even facilitate crime prevention in cyberspace. One identified problem is the failure to define objectives, strategies, and assessments for the use of technology to accomplish law enforcement missions.

Future Scenarios

Starting from the current position on the scenario chart shown in Figure 3.1, workshop participants developed future scenarios leading to Third Horizon (2024–2034) positions in all four quadrants.[1] The consensus was that those scenarios leading to the two quadrants above the x-axis (toward "Tough Love" and "Safe Streets" in Figure 2.1) were desirable futures, because they represent futures in which law enforcement can effectively use technology to accomplish its missions. However, the consensus also was that "Safe Streets" was more desirable than "Tough Love," because the latter, in which law enforcement actions meet resistance from society, has greater potential for conflict that could cause movement toward undesirable futures. Scenarios leading to the two quadrants below the x-axis (toward "Mean Streets" and "Crimi-

[1] In the discussion of scenarios in this chapter, "scenario" refers to an entire trajectory from the 2014 First Horizon position to a specific end point—the Third Horizon (2024–2034) position. These scenarios represent alternative futures with different trajectories or pathways.

nals' Advantage" in Figure 2.1) were undesirable futures because they represent futures in which law enforcement cannot effectively use technology to accomplish its missions.

Workshop participants developed specific trajectories of how law enforcement might move from the current "2014" position over time. Participants also developed specific examples—detailed visions of what the future might look like if law enforcement were to traverse some of those trajectories.

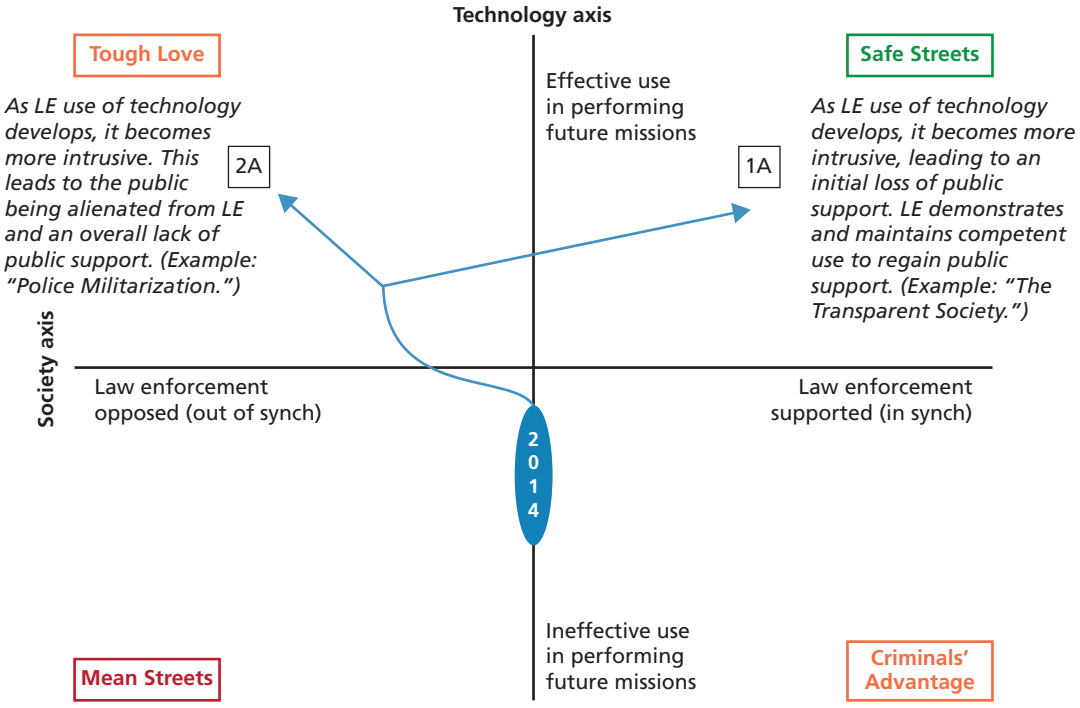
Scenarios Leading to Desirable Futures

There are four scenarios leading to desirable futures—two that initially move into the "Tough Love" quadrant, and two that initially move into the "Safe Streets" quadrant. We begin with the former, which we call scenarios 1A and 2A, as shown in Figure 3.2. In both of these scenarios, the initial use of technology by law enforcement is intrusive, which erodes public support. The difference between the scenarios is that in 1A, law enforcement demonstrates and maintains competent use and regains public support, while in 2A community alienation continues and the lack of support for law enforcement grows. The effective use of communications, especially social media, to establish a constructive dialog with the community could enable the pathway toward scenario 1A.

Example of Path 1A: The Transparent Society

This example future is loosely based on the ideas in the book *The Transparent Society* (Brin, 1998). This future extends the trend that more and more personal data are readily available for

Figure 3.2
Desirable Scenarios That Initially Move into the "Tough Love" Quadrant



NOTE: LE = law enforcement.

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collection and analysis. In comparison with more undesirable futures, however, the available data include a great deal of law enforcement data (permitting public auditing of law enforcement operations), not just private data. Further, society in general comes to terms with a great deal of what had formerly been private information being readily available, and develops norms for using it in ways generally seen as desirable.

Problems in this future, especially early on (hence the "1A" trajectory), focus on members of the public having far less privacy and personal space than they once did. For example, previously private "youthful indiscretions" can now haunt just about anyone. Greater public scrutiny applies to law enforcement operations, as well, and there is an increased risk of backlash even for rare cases of misbehavior. There are also concerns about the stigmatization of anyone who is "different" (cyber-bullying on a larger scale). Other problems include corporate dominance over personal information (although to a much lesser extent than a future that will be discussed below), and increased risks of cybercrime, given so much personal data that can be exploited for ill uses.

That said, there were a number of benefits in this future. The greater availability of data drives more effective data exploitation methods for good uses. Persistent electronic accountability increasingly drives good behavior, including hacking protections that actually lead to a decreased risk of cybercrime. Police at all levels enjoy greater efficiency and effectiveness as they have a great deal more information—in the extreme case, seeing many perpetrators caught red-handed on video.

Roles for technology and technology management in this vision include the following:

- Data gathering—surveillance technologies
- Data analytics—network analysis, database systems, "Total Information Awareness–type" capabilities (with the latter used in conjunction with strong norms, as described below)
- Data reporting—ability to retrieve what is needed when it is needed, such as being able to convert sensor/video data to easily searchable information
- Leadership and ethics, including clear boundaries and understandings for using these technologies
- Auditing and reporting tools tracking how technologies are being used and holding users accountable
- Transparency tools—releasing information in ways that protect individuals' privacy
- Technologies to protect the privacy of victims of crime (e.g., preventing access to sexual exploitation images).

Example of Path 2A: Police Militarization

This future is an extension of the trend of blending warfighting and policing, including both equipment and tactics, in response to both high-profile mass shootings (and other attacks) and the ready availability of surplus military gear, up to and including 15-ton-plus Mine Resistant Ambush Protected (MRAP) vehicles. In this vision, the "warfighter/crime fighter" distinction has become blurred. On the positive side, this future offers the potential of becoming highly effective and efficient in reducing crime; lives are also saved from the use of more protective gear and weaponry. There is more collaboration ("joint operations") in conducting law enforcement activities, and more technology development and fielding (as well as equipment sales).

The negatives place this future likely in the "Tough Love" quadrant. There is a strong public backlash and alienation from the public, as police legitimacy suffers due to a perception that the public is being suppressed by force rather than voluntary compliance. Civil liberties may similarly suffer in reality in addition to public perception. Finally, there is a risk that there may be more deaths overall, as criminals and "resisters" engage in an arms race with police.

In the worst case in this scenario, criminals become paramilitary insurgents and potentially overwhelm law enforcement, in which case the scenario shifts from the "Tough Love" quadrant and moves to the "Mean Streets" quadrant. (We discuss this trajectory as Path 4B below.)

Roles for technology and technology management in this vision include the following:

- Social media and messaging to explain what is actually being done and why
- Weapon development
- Biometrics development
- Development of protective technology (armor, hardening, etc.)
- Sensors development, e.g., creation of "smart dust" (very small "particles" to monitor an area)
- Increased bandwidth for networking
- Analytics development (to monitor the sensors), including "Total Information Awareness–type" applications
- Development of unmanned aerial systems (UASs)
- "Reluctant warrior"—creation of a mindset, leadership, and ethics to focus on communications/analysis/restraint to resolve problems when possible
- "Smart, tactical, mobile, semi-autonomous" camera systems to document interactions—needs include consideration of when they should be used, cultural shifts, and training on best uses
- Augmented reality technologies
- Exoskeletons—wearable devices that increase physical abilities.

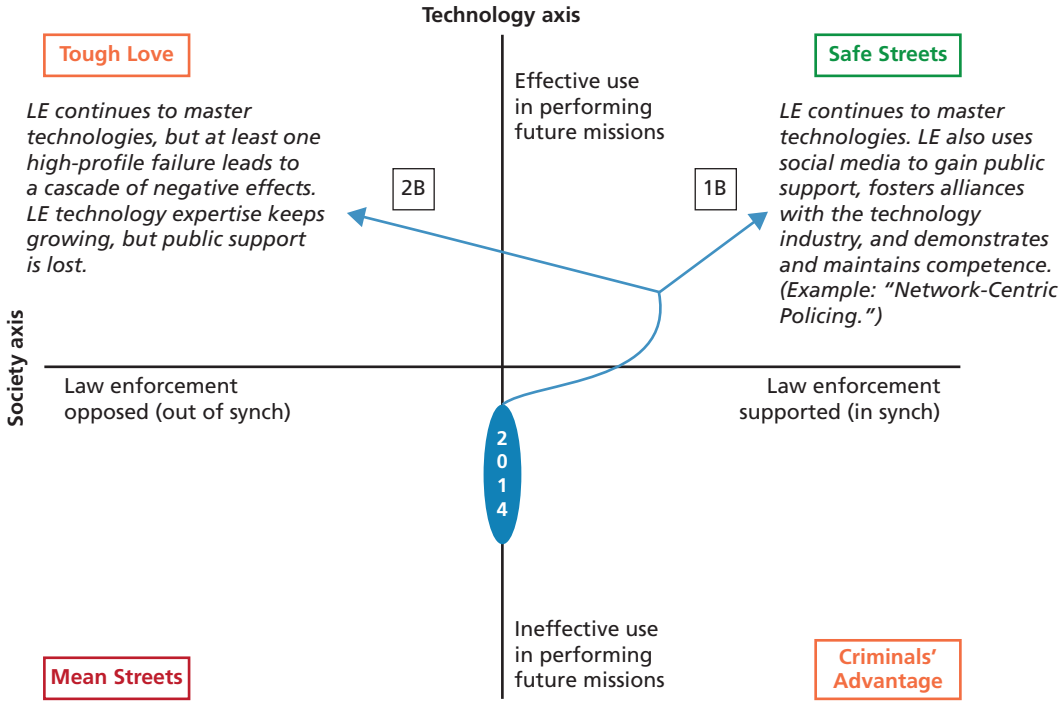
The two desirable scenarios that initially move into the "Safe Streets" quadrant, which we call scenarios 1B and 2B, are shown in Figure 3.3. In both cases law enforcement continues to master and use technology effectively. In scenario 1B, law enforcement effectively uses social media to gain public support, fosters alliances with the technology industry to remain current, and is able to demonstrate and maintain competence in the effective use of technology. In scenario 2B, at least one high-profile failure or improper use of technology causes a cascade of negative effects, and public support is lost even though technical expertise continues to grow and the effective use of technology continues to increase.

We note here that, while all four of the above scenarios lead to desirable futures in which law enforcement has the upper hand in the use of technology versus criminals and can use it effectively to perform its mission, the participants viewed scenarios 1A and 1B as more desirable than scenarios 2A and 2B, because they represent futures in which public support for law enforcement is also present and growing.

Example of Path 1B: Network-Centric Policing

In this future, law enforcement moves toward cultures and systems that emphasize network structures, information sharing, and collaboration to address objectives. It also features the

Figure 3.3
Desirable Scenarios That Initially Move into the "Safe Streets" Quadrant



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development of intelligent agents and displays to help filter and prioritize information, helping all levels to focus on "what's most important now." (Note that this scenario does not necessarily mean the "Transparent Society," as it does not inherently include harvesting the public's personal information.)

This vision is associated with greater law enforcement efficacy and efficiency, as there would be more organizational and self-synchronization, with fewer "bodies" and structures needed to achieve similar effects. Workshop participants suggested that the cyber aspects of policing in this vision would be more appealing to younger personnel, which would aid law enforcement recruiting and retention.

Risks in this vision include information and communications overload, as well as greater exposure to cyber attackers and the potential for extreme technical failures (e.g., "blue screens of death" on key police equipment). Workshop participants were also concerned there may not be adequate funding to procure the new information technology (IT), much less maintain it and train people to use it properly. Another concern was that there may not be adequate business process knowledge and technical leadership to use the IT effectively. There were also concerns that this vision could cause an even greater divide between agencies, with agencies without advanced technical assets becoming increasingly unable to collaborate with those that had them.

While this vision was generally seen as positive, major privacy and civil rights violations—especially if the information being shared is observations of the general public—could lead to a path 2B–like future, with a loss of police legitimacy. Further, failures to adopt the new

technology effectively over the long term could lead to an initial surge in effectiveness, followed by an increasing inability to keep pace with criminals. (This is Path 3B, below.)

This future calls for a broad range of new technologies and methods for employing them. The range of needs is actually significantly broader than some of the other "techno-centric" visions, as there is a need to do much more than focus on capturing and processing large amounts of surveillance data. Roles for technology and technology management in this vision include the following:

- Intelligent agents
- Collaboration applications, tools, systems
- Strategy, doctrine, and procedures for using network-centric technologies
- Leadership and ethics for the network-centric era
- Skillset/culture shift/incentives toward productive collaboration to take advantage of information-sharing capabilities
- Change in academy and other training toward new network-centric environment
- Approaches to identify and recruit best candidates for new network-centric environment
- Change in law enforcement personnel mix toward those with technology expertise (along with strategies to help bring about the personnel mix changes)
- Social media and messaging to explain what is actually being done and why
- Biometrics development
- Sensors development
- Analytics development (to monitor the sensors), including "Total Information Awareness"–type applications
- Increased bandwidth for networking
- UAS development
- "Reluctant warrior"—mindset, leadership, ethics to focus on communications/analysis/restraint to resolve problems when possible
- "Smart, tactical, mobile, semi-autonomous" camera systems to document interactions—needs include consideration of when they should be used, cultural shifts and training, identification of best uses
- Augmented reality technologies.

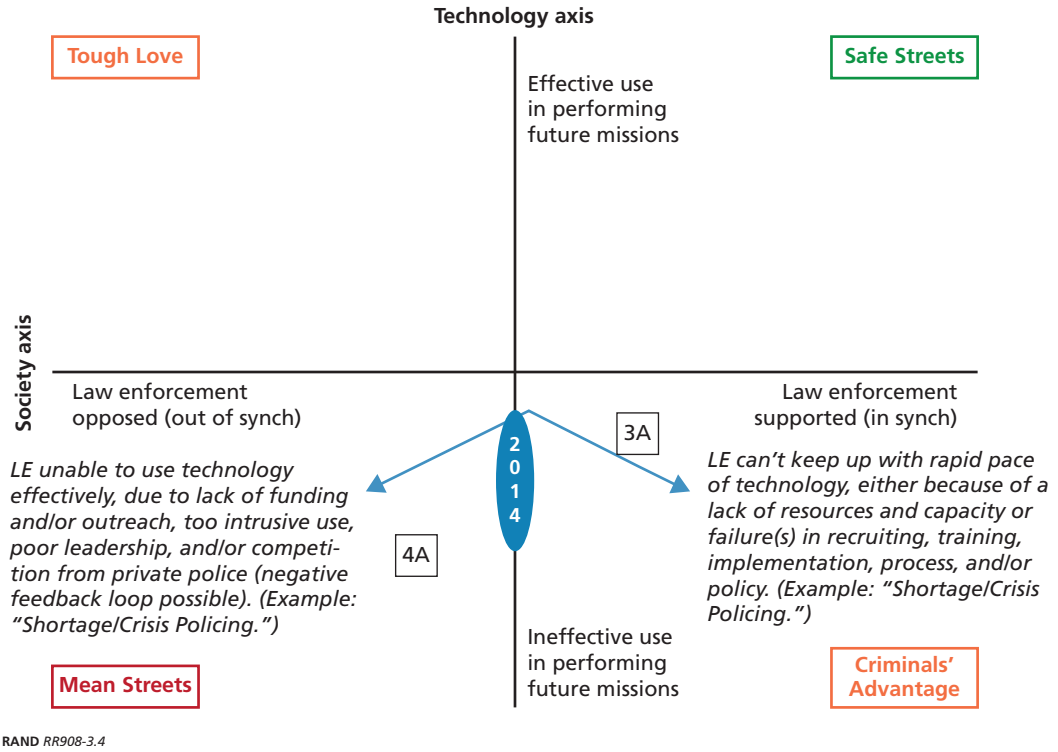
Scenarios Leading to Undesirable Futures

There are five scenarios that lead to undesirable futures. Figure 3.4 shows two futures in which movement is continuous into an undesirable quadrant. In scenario 3A, law enforcement is unable to effectively use technology, either because technology advances too rapidly and law enforcement does not have the resources or capacity to keep up, or because of failure in recruitment, training, implementation, process, or policy. Scenario 4A could come about for a variety of reasons—loss of funding for law enforcement, too intrusive use of technology, lack of community outreach, poor leadership, a negative feedback loop resulting from outperformance by private police, or any combination of these. Another possibility is response to crises such as scarcity of resources or natural disaster(s), as in the example given below.

Example of Path 4A: Shortage/Crisis Policing

In this vision, law enforcement in the future becomes consumed with needs to guard scarce resources and/or address natural disasters. Police have to focus on guard and riot control duty,

Figure 3.4
Scenarios Showing Continuous Movement into an Undesirable Quadrant



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leaving little time and money for general crime control. This future also would tend to have hostile police/community relations, as police must act as a wedge between the public and the scarce resources. The risks of corruption, from selling access to scarce resources, were also seen as quite high. We note that an extreme case of this future was partly inspired by the movie *Soylent Green*.

In the event that the public did feel that very heavy law enforcement tactics were needed, a future more consistent with Path 3A is possible, with policing broadly supported but overwhelmed.

To the extent this scenario has a positive side, police could provide invaluable assistance at time of crisis in creating some order out of disorder. It could also result in development of collaboration tools, including both social and technical elements (interoperability, credentialing, etc.).

Roles for technology and technology management in this vision are heavily focused on protection and crowd control, and include the following:

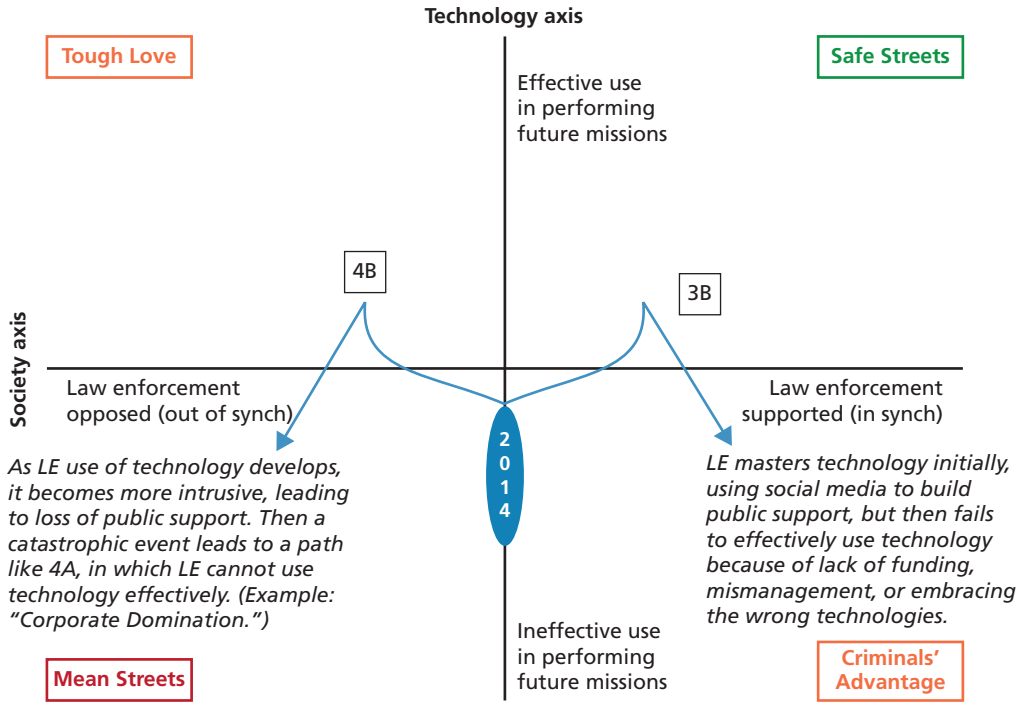
- Monitoring of social media to track general level of discontent and specific attacks
- Social media and messaging to mitigate discontent and civil unrest
- Social media and messaging to inform people of threats to avoid
- Leadership and ethics initiatives
- Trust-building mechanisms
- Partnerships with private entities to help avoid getting to crisis points (e.g., smart meters and fines for overuse of scarce resources).

Figure 3.5 shows two futures in which initial movement is into a desirable quadrant, but law enforcement is not able to sustain this movement, and the scenario leads to an undesirable quadrant. In scenario 3B, law enforcement initially continues to master technology and effectively use social media to establish public support, as in scenario 1B, but at some point, for any of the reasons described above for scenario 3A, perhaps because of loss of funding, mismanagement, or improper use of technology, law enforcement loses the capability to effectively use technology. Scenario 4B starts out like scenario 2A, in which law enforcement develops technological capability that is applied intrusively, leading to alienation of the community and a lack of support. However, in this scenario a catastrophic event occurs, leading to one or more of the problems described in scenario 4A and a negative feedback loop occurs. One manifestation of this type of future is given in the example below.

Example of Path 4B: Corporate Domination

In this future, loosely inspired by the movie *Blade Runner*, corporations increasingly dominate what have traditionally been law enforcement functions. Specifically, persons must submit to corporate-created rules and corporate surveillance in more and more spaces. The idea would be to dramatically expand codes of conduct, surveillance, and security personnel currently in commercial spaces such as shopping malls to become the norm in commercial districts and residential communities. This future also features a general lack of criminal accountability for corporations, resulting in a high risk of corruption or even outright criminality. In the short term, corporations might initially be more "efficient," but in the long term, the risks of corruption, as well as inherent differences in corporate and public interests on the focus of security

Figure 3.5
Undesirable Scenarios in Which Initial Movement Is into a Desirable Quadrant



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efforts (protecting corporate property versus the public), would tend to drive down effectiveness in fighting crime.

Other than some low-level tactical technologies, there is a limited role for law enforcement technology in this future vision, since private corporations would do most policing.

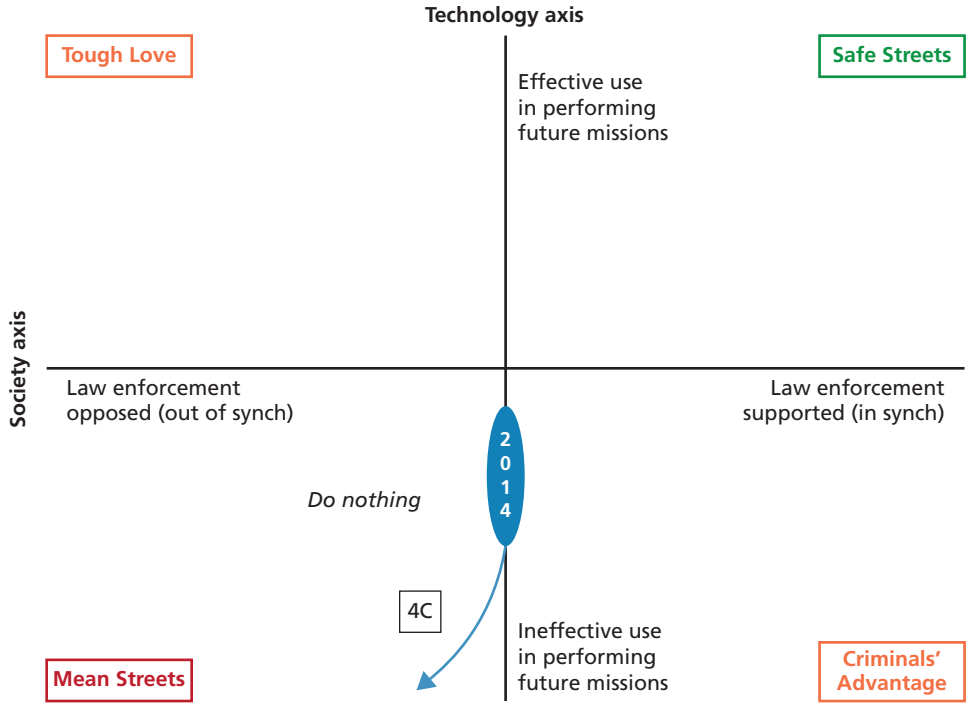
Figure 3.6 shows another scenario developed by workshop participants, the "do-nothing" scenario, which we call Path 4C. In this case, because of technology advances and the active use of technology by criminals, law enforcement loses both technology capability and public support.

Example of Path 4C: Status Quo Future

This future represents the technological stagnation of policing. Law enforcement is less agile to respond to societal changes, and societal approval declines. Among other issues, there will be a growing gap between public expectations of law enforcement capabilities (e.g., driven by television and movies) and reality. That said, workshop participants did not see that much of an increased backlash against police, since law enforcement would adopt new technologies and methods slowly. However, they also did not expect a truly major decline in crime-fighting effectiveness, since they reasoned that agencies would "do just enough" to roughly keep pace with criminals.

The role of technology in this scenario consists largely of slow adoption of technologies from the public and commercial worlds, including those tools and systems identified above for other scenarios (e.g., social media, surveillance tools). Vendors to law enforcement agencies would likely drive the development and adaptation of technologies in this scenario.

Figure 3.6
The "Do-Nothing" Scenario



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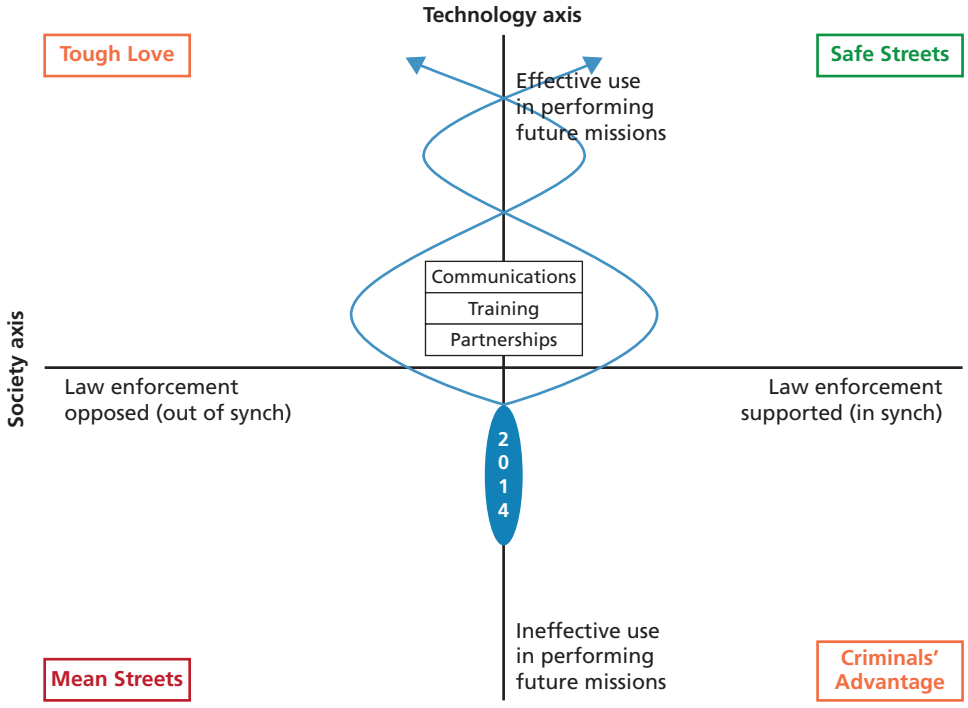
The Uncertain Path: Mass Movements/Unrest

Beyond the scenarios described above, workshop participants identified one additional specific vision: policing in the face of a mass movement and/or mass unrest that leads to major changes in the political status quo of the United States. There is no trajectory diagram for this vision because the impact of mass movement–induced political change on law enforcement is highly uncertain—the "arrow" could end up pointing virtually anywhere on the scenario chart.

Possible Pathways to Desirable Futures

The scenarios represented in Figures 3.2–3.6 show pathways with at most one branch point, corresponding to a single catastrophic event or the cumulative effect of changes in the external environment or actions by law enforcement. The future, however, is likely to have many such possible branch points. Figure 3.7 illustrates one set of possibilities with several branch points that could lead to a desirable future. It begins with movement toward more effective use of technology by law enforcement, accompanied either by increased support from the public (toward "Safe Streets") or decreased support from the public (toward "Tough Love"). Because of the difficulty of continually increasing public support as technology is used more pervasively, with the increasing likelihood of social or legal obstacles, the "Safe Streets" path turns toward "Tough Love." As a result of law enforcement's response to eroding public support by using technology in a less intrusive and more competent manner, the "Tough Love" path turns toward "Safe Streets." This type of back and forth movement between the upper two quadrants continues, with the possibility of reduced amplitude as law enforcement learns how to use technology effectively in a way that gains public support. Workshop participants hypothesized

Figure 3.7
Branching Scenarios Leading to Desirable Futures



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that this can be accomplished through (1) proactive use of information sharing mechanisms, including social media and other means to establish effective communication both among law enforcement and with the public; (2) effective training of law enforcement personnel; and (3) partnerships with public- and private-sector organizations.

CHAPTER FOUR

Technology Needs

After developing the scenarios described in the previous chapter, workshop breakout groups considered the pathways described there and how technology, or law enforcement practice, training, education, or policy related to technology, might enable or hinder those paths. They then identified technology needs based on the roles of technology described in Chapter Three that, if addressed, could enable movement toward the desirable scenarios described there, and/or prevent movement toward the undesirable ones or mitigate their effects. For example, the branching scenario shown in Figure 3.7 would be enabled by (1) effective communication among law enforcement and between law enforcement and the public; (2) education and training for law enforcement practitioners that results in effective and appropriate use of technology that respects the rights of citizens; and (3) development of partnerships with other agencies, citizen groups, and industry to leverage scarce resources, facilitate effective communication, and effectively adapt technology to accomplish law enforcement missions. These enablers led to technology needs, e.g., development of educational material on social media to better engage the public and improve internal communications, improvement of training suitable for new technologies, and research on methods to disseminate innovative, promising practices across the large number of law enforcement agencies. Roles of technology in the other scenarios led to additional technology needs.

As shown in the workshop agenda in Appendix A, each breakout group devoted most of the morning of the third day of the workshop to this exercise, generating its own set of technology needs. These needs fell into three categories: (1) those that were unique, (2) those that strongly overlapped needs generated by another breakout group, and (3) those that were related in some way to needs generated by another breakout group. During the lunch break on the third day of the workshop, the RAND team produced a draft list of consolidated needs by combining the overlapping ones and defining new needs that brought together related ones. In the following session, this draft list of consolidated needs was presented, debated, and revised by the full group of participants, resulting in a consensus list of 30 technology needs. These needs were then ranked and prioritized into three tiers.

Ranking of Technology Needs

As described in Chapter Two, we ranked the consolidated list of 30 technology needs using a Delphi process in which all 19 workshop participants answered the questions on importance,

pervasiveness, technical probability, and implementation probability shown in Appendix C.[1] Participants used the scoring scales, also shown in Appendix C, via which importance was rated from 1 to 9, pervasiveness was rated from 0.1 to 0.9, and technical and implementation probability were rated from 10 percent to 90 percent. We then calculated an expected value for each participant for each of the 30 needs as the product of that participant's four numerical scores of that need.

A key objective of the workshop was to use these estimates to rank the 30 needs from high to low, with 1 being the highest and 30 being the lowest. There are many possible approaches to accomplish this objective. Such sets of discrete estimates can be fitted to a continuous distribution, for example, using a normal or lognormal distribution (Aitchison and Brown, 1957). Then the mean or median of the distribution can be used as a ranking metric, and the variance of the distribution as a measure of uncertainty. Alternatively, one can use the data directly to find an average and median of the individual participant estimates and use either the average or the median as a ranking metric. We chose the latter path because, most importantly, it does not require any assumptions about the shape of the distribution. Further, there is a statistical test that provides a direct measure of the probability that any lower-ranked need should actually be ranked higher than a given higher-ranked need.[2]

Table 4.1 shows the rankings of the needs based on the median and the average of the expected values from the (e.g., 19) individual participants for each need.[3] In Table 4.1, the needs are ordered from highest (first) to lowest (last) according to the median expected value. The first seven of the 30 needs are identical whether the median or average expected value is used, although their rank order is different. In Appendix D, we present a statistical analysis of the rank order of the needs by median and by average expected value. This analysis follows the procedure described in Wild and Seber (1999) to determine the probability that any given need ranked according to median or average expected value should actually be ranked higher than another specific need ranked above it, based on comparing the actual (e.g., 19) participant expected values of one need versus those of another. Analysis of the tables in Appendix D shows that rankings based on both medians and averages of the participant expected values provide good confidence levels for the need rankings. These tables also quantify how the inherent uncertainties resulting from the differences in scores assigned by the individual participants affect the confidence in correctly ranking one need higher than another. A key finding of this analysis is that the larger the separation in ranking between two needs, the more confidence that one need is correctly ranked higher than the other.

We placed the needs into three priority tiers, with Tier 1 being the highest and Tier 3 being the lowest, based on the rankings by median and average expected value and the analysis presented in Appendix D. Tier 1 contains the 12 needs that were ranked in the top ten by either median or average expected value.[4] Tier 2 contains the ten needs that were ranked

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1 One participant did not answer the questions for Need 24, so for that need, there were 18 respondents.

2 This test is the Wilcoxon rank-sum test, which is described, for example, in Wild and Seber, 1999. It is based solely on the order in which each of the individual estimates, scores, or observations for a need fall, when these observations and those of the other need considered in a pairwise comparison are ordered together according to their scores.

3 In cases where the expected values were the same, we averaged the rankings. Rankings from one to ten (out of 30 needs) based on either median or average are shaded in the last two columns of Table 4.1.

4 The first seven were in fact ranked as the top seven by both methods. The tables in Appendix D show that there is a very low probability that any of the other five needs in Tier 1 should be ranked above any of these seven.

Table 4.1
Ranking of Needs, by Median and Average Expected Value

Tier #	Description of Need	Median Expected Value	Average Expected Value	Ranking by Median	Ranking by Average
1	Need to develop educational material on social media to better engage the public and improve internal communications, including (1) informing the public, (2) getting incident reports from the public, and (3) getting assistance in solving crimes. Training material needs to include good examples. Can also include coverage of hiring and working with media experts. Material needs to be updated regularly to reflect new media and communications technologies.	3.9	3. 6	1	1
1	Need research and development (R&D) on technologies to use information more effectively, including smart search, sensor analytics, general predictive analytics, tools to filter and prioritize information (both push and pull), and tools to support real-time control and sharing of data from investigations and other law enforcement operations	3.6	2.9	2	7
1	Need research on the use of tagging and tracking technologies (small radio frequency identification [RFID], nano, dyna dots, implants) for tracking inventory, equipment, and people for administrative and investigative purposes	3.5	3.2	3.5	4
1	Need research on methods to disseminate innovative, promising practices across the large number of law enforcement agencies. Should include "change management" practices and practices for gathering and using lessons learned.	3.5	3.1	3.5	5
1	Need to improve training suitable for new technologies. Includes identifying/updating training needs, skill sets, and roles; tailoring training for people with different roles, levels, and backgrounds; and taking advantage of new educational technologies.	3.1	3.3	5.5	2.5
1	Need to develop technologies and processes to support data sharing, including communications infrastructure, equipment standards, integrated data systems, and adaptable/upgradable systems	3.1	3.3	5.5	2.5
1	Need research on recognizing and dealing with legal and policy constraints for information sharing	2.7	3.0	7	6
1	Need improved translation technologies, including dialect, indigenous languages, and cultural factors translation	2.3	2.5	9.5	9
1	Need more R&D on ethics development in general	2.3	2.2	9.5	14.5
1	Need to update LE agency recruiting practices, including recruiting people with needed skills, updating screening and hiring mechanisms, and updating training academy processes for future network-enabled training environments	2.3	2.4	9.5	11
1	Need methods to permit LE personnel to create and use artificial identities for valid LE purposes	2.3	2.4	9.5	11
1	Need technology to identify in the field when someone is under the influence or impaired from future legal and custom-made drugs and other biological agents (could reflect behavioral screening, chemical screening, or combinations of the two)	2.1	2.8	12	8
2	Need to develop means for measuring public and criminal uses of technology and countermeasures to LE uses of technology	2.0	1.9	13.5	21.5

Table 4.1—Continued

Tier #	Description of Need	Median Expected Value	Average Expected Value	Ranking by Median	Ranking by Average
2	Need to identify and adapt business models, including public/private partnership models, that will facilitate LE agencies' recognizing new needs and updating and using technologies effectively	2.0	2.3	13.5	13
2	Need improved technologies—including both tactics and physical systems—for safely defusing or disabling people, groups, and vehicles (specifically includes alternatives to kinetic impact weapons)	1.8	2.2	15.5	14.5
2	Need research on technologies that can "see" or sense threats at a distance (on people, behind walls, in vehicles)	1.8	1.8	15.5	24
2	Need to identify LE resource needs and roles emerging from new technologies and uses by criminals and the public (including both virtual and biological crimes)	1.7	2.1	19	17.5
2	Need research on rules and procedures for going undercover in virtual worlds	1.7	2.4	19	11
2	Need research on social aspects of improving information sharing and collaboration (needs to consider incentives, organizational cultures, and training needs—can consider models coming out of online gaming and online communities)	1.7	2.1	19	17.5
2	Need to develop collaborations with the Centers for Disease Control and Prevention (CDC) and other public health agencies, to provide for as much preparation time and guidance as possible to prepare for public health crises	1.7	2.1	19	17.5
2	Need to develop "super HR" systems that can track details about LE personnel's training, certification, record, etc., over the course of their careers and share this information as appropriate (would also include "scores" and "badges" reflecting experiences, training, reputation, and accomplishments)	1.7	2.0	19	20
2	Need research on leadership and leadership development suited for the network-enabled era (includes research on what constitutes "good" and "bad" leadership and research on what leadership courses and methods "work" [and what "work" means], for whom, and in what contexts, specifically including emerging network-enabled organizations)	1.6	2.1	22	17.5
3	Need capabilities to exploit a wide range of robotics/autonomy technologies, ranging from ground robots to larger UAS to small swarming UAS to self-driving vehicles to "smart infrastructure" that can be "deputized" for LE purposes	1.5	1.8	23.5	24
3	Need practices to best exploit emerging technologies and practices from the military (e.g., exoskeletons, smart uniforms), while also mitigating or eliminating negative consequences of using military technologies (collateral damage minimization, deconfliction technologies)	1.5	1.3	23.5	26.5
3	Need research on approaches for providing "honest brokers" to assess performance of technological systems and disseminate the results (could include validation testing of emerging technologies and/or variants of "reputation/peer review" forums with comments for purchasers of tools [Yelp, Tripadvisor, etc.])	1.4	1.8	25	24
3	Need research on virtual/holographic remote presence technologies (an example includes supporting remote consultations between mental health personnel and persons exhibiting mental health problems)	1.3	1.3	26.5	26.5

Table 4.1—Continued

Tier #	Description of Need	Median Expected Value	Average Expected Value	Ranking by Median	Ranking by Average
3	Need technology to assist in the assessment of potential problems for LE personnel from exposure to violent situations and images	1.3	1.9	26.5	21.5
3	Need an improved understanding of how LE can use emerging cognitive technologies (such as possibly emerging lie detection, prior presence on scene, and intent prediction technologies)	0.8	0.9	28	29
3	Need to develop "opt-in and opt-out" sensors for public areas that allow people to have more control over the data that are collected on them (e.g., automated face blurring on camera feeds), along with security provisions (policy-driven overrides) to ensure protection of the public	0.7	1.1	29	28
3	Need to understand state of research and LE implications and needs for "brain bots"—early bionic brain implants that will support memory, decisionmaking, and hands-free interfaces	0.4	0.6	30	30

between eleventh and twentieth by either median or average expected value. Tier 3 contains the eight needs that were ranked lower than twentieth by both median and average expected value.

Topic Areas of Ranked Technology Needs

The technology needs fall into two general areas. Fourteen of the 30 involve improving law enforcement knowledge or practice associated with technology, while the remaining 16 are directly associated with technology or technological capabilities. This roughly 50-50 split between calls for new technologies and calls for new technology-related knowledge and practices also appeared in Hollywood et al. (2015), which analyzed current needs for law enforcement information technology.

Of the technology needs, five are specifically associated with improving the sharing and use of information, while the remaining 11 deal principally with research and development of a broad range of different technologies. We thus group the 30 technology needs into three topic areas: law enforcement knowledge and practice, law enforcement information sharing and use, and research and development of (other than information) technologies for law enforcement. These findings are completely consistent with those for the top current information technology–related needs for law enforcement (Hollywood et al., 2015); those needs fell into the same three broad topic areas, as well.

There are five knowledge and practice needs in Tier 1:

- Educational material on social media to better engage the public and improve internal communications (the top-ranked need by either the median or average metric)
- Methods to disseminate innovative, promising practices across the large number of law enforcement agencies
- Training suitable for new technologies tailored for individuals with differing backgrounds and assignments, taking advantage of new educational technologies

- More research on ethics development in general
- Updating of law enforcement agency recruiting practices to acquire needed skills and improve screening and hiring mechanisms, and updating of training academy processes for network-enabled training environments.

There are three law enforcement information sharing and use needs in Tier 1:

- Research and development on technologies to use information more effectively and tools to filter and prioritize information and to support real-time control and sharing of data from investigations and other operations
- Development of technologies and processes to support data sharing, including infrastructure, equipment standards, and integrated, adaptable systems
- Research on recognizing and dealing with legal and policy constraints on information sharing.

There are four (other than information) technology needs in Tier 1:

- Research on the use of tagging and tracking technologies for inventory, equipment, and people for both administrative and investigative purposes
- Improved translation technologies, including dialect, indigenous languages, and cultural factors translation
- Methods to permit law enforcement personnel to create and use artificial identities for valid law enforcement purposes
- Technology to identify in the field when someone is under the influence or impaired from future legal and custom-made drugs and other biological agents.

Tier 2 consists of seven knowledge and practice needs, one law enforcement information sharing and use need, and two (other than information) technology needs. Knowledge and practice needs in Tier 2 involve measuring public and criminal uses of technology and countermeasures to law enforcement use of technology; identifying and adapting business practice models to facilitate effective law enforcement use of technology; identifying law enforcement resource needs and roles emerging from new technologies; research on rules and procedures for going undercover in virtual worlds; collaborations with public health agencies for better preparation for public health crises; developing human resource systems that can track and share details of law enforcement personnel training, certification, and record over the course of their careers; and research on leadership and leadership development suited for the network-enabled era. The Tier 2 information sharing need is for research on social aspects of improving information sharing and collaboration, e.g., based on models coming out of online gaming and online communities. Tier 2 (other than information) technology needs are for improved technologies for safely defusing or disabling people, groups, and vehicles, and for research on technologies that can see or sense threats at a distance.

Tier 3 consists of two knowledge and practice needs, one information sharing need, and five (other than information) technology needs. The knowledge and practice needs in Tier 3 are (1) means to best exploit emerging technologies and practices from the military while also mitigating or eliminating negative consequences and (2) improving understanding of how law enforcement can use emerging cognitive technologies. The information sharing need is for

research on providing honest brokers to assess technological system performance and disseminate the results. The (other than information) technology needs involve exploiting robotics/autonomy, supporting interactions with virtual/holographic remote presence, assessment of potential problems from exposure of personnel to violent situations and images, "opt-in" and "opt-out" sensors for public areas to allow more control of data that are collected on people, and understanding of the state of research and law enforcement implications of early bionic brain implants.

Technology Categorization of Ranked Technology Needs

For the purposes of categorizing the 30 technology needs identified by the workshop participants, we use the following truncated version of a law enforcement technology taxonomy:[5]

- Information and Communications Technology
  - Information Collection (Including Surveillance)
  - Information Analysis
  - Information Management (Including Sharing)
  - Information Delivery
- Management/Knowledge Development and Training
  - Management/Leadership Knowledge Development and Training
  - Officers/Practitioners Knowledge Development and Training
  - Specialists/Technologists Knowledge Development and Training
  - Societal/Legal Knowledge Development, and Training
- Person-Worn Equipment and Weapons/Force
  - Personal Clothing, Protection, or Augmentation
  - Weapons and Force
  - Vehicles.

Examining the needs in Table 4.1, we observe that 14 of them fall under the category of Information and Communications Technology, an additional 12 fall under Management/Knowledge Development and Training, and the remaining four fall under Person-Worn Equipment and Weapons/Force. Table 4.2 shows the technology taxonomy category for each of the 30 needs. Three of the needs fit into two taxonomy subcategories, and one need applies to all subcategories in its category, as indicated in the table.

Table 4.3 shows the breakdown of needs by tier across taxonomy categories. Within top levels of the taxonomy, needs were fairly evenly scattered throughout categories and tiers, except for an emphasis on Management/Leadership Knowledge Development and Training, with nine needs. The totals in Table 4.3 add up to 36 rather than 30 because some needs in Table 4.2 fit into more than one subcategory of their categories, as noted previously.

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[5] Law enforcement technology needs from several different sources are categorized according to a more complete and detailed version of this taxonomy in Hollywood et al., 2015.

Table 4.2
Taxonomy Categorization of Technology Needs

Tier #	Description of Need	Technology Taxonomy Category
1	Need to develop educational material on social media to better engage the public and improve internal communications, including (1) informing the public, (2) getting incident reports from the public, and (3) getting assistance in solving crimes. Training material needs to include good examples. Can also include coverage of hiring and working with media experts. Material needs to be updated regularly to reflect new media and communications technologies.	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
1	Need R&D on technologies to use information more effectively, including smart search, sensor analytics, general predictive analytics, tools to filter and prioritize information (both push and pull), and tools to support real-time control and sharing of data from investigations and other law enforcement operations	Information and Communications Technology Information Analysis Information Management
1	Need research on the use of tagging and tracking technologies (small RFID, nano, dyna dots, implants) for tracking inventory, equipment, and people for administrative and investigative purposes	Information and Communications Technology Information Collection
1	Need research on methods to disseminate innovative, promising practices across the large number of law enforcement agencies. Should include "change management" practices and practices for gathering and using lessons learned.	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
1	Need to improve training suitable for new technologies. Includes identifying/updating training needs, skill sets, and roles; tailoring training for people with different roles, levels, and backgrounds; and taking advantage of new educational technologies.	Management/Knowledge Development and Training (applies to all subcategories)
1	Need to develop technologies and processes to support data sharing, including communications infrastructure, equipment standards, integrated data systems, and adaptable/upgradable systems	Information and Communications Technology Information Management
1	Need research on recognizing and dealing with legal and policy constraints for information sharing	Information and Communications Technology Information Management
1	Need improved translation technologies, including dialect, indigenous languages, and cultural factors translation	Information and Communications Technology Information Analysis
1	Need more R&D on ethics development in general	Management/Knowledge Development and Training Societal/Legal Knowledge Development and Training
1	Need to update LE agency recruiting practices, including recruiting people with needed skills, updating screening and hiring mechanisms, and updating training academy processes for future network-enabled training environments	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training Specialist/Technologist Knowledge Development and Training
1	Need methods to permit LE personnel to create and use artificial identities for valid LE purposes	Information and Communications Technology Information Collection
1	Need technology to identify in the field when someone is under the influence or impaired from future legal and custom-made drugs and other biological agents (could reflect behavioral screening, chemical screening, or combinations of the two)	Information and Communications Technology Information Collection

Table 4.2—Continued

Tier #	Description of Need	Technology Taxonomy Category
2	Need to develop means for measuring public and criminal uses of technology and countermeasures to LE uses of technology	Information and Communications Technology Information Analysis
2	Need to identify and adapt business models, including public/private partnership models, that will facilitate LE agencies' recognizing new needs and updating and using technologies effectively	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
2	Need improved technologies—including both tactics and physical systems—for safely defusing or disabling people, groups, and vehicles (specifically includes alternatives to kinetic impact weapons)	Person-Worn Equipment and Weapons/Force Weapons and Force
2	Need research on technologies that can "see" or sense threats at a distance (on people, behind walls, in vehicles)	Information and Communications Technology Information Collection
2	Need to identify LE resource needs and roles emerging from new technologies and uses by criminals and the public (including both virtual and biological crimes)	Management/Knowledge Development and Training Specialist/Technologist Knowledge Development and Training
2	Need research on rules and procedures for going undercover in virtual worlds	Management/Knowledge Development and Training Officer/Practitioner Knowledge Development and Training
2	Need research on social aspects of improving information sharing and collaboration (needs to consider incentives, organizational cultures, and training needs—can consider models coming out of online gaming and online communities)	Information and Communications Technology Information Management
2	Need to develop collaborations with CDC and other public health agencies, to provide for as much preparation time and guidance as possible to prepare for public health crises	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
2	Need to develop "super HR" systems that can track details about LE personnel's training, certification, record, etc., over the course of their careers and share this information as appropriate (would also include "scores" and "badges" reflecting experiences, training, reputation, and accomplishments)	Information and Communications Technology Information Management
2	Need research on leadership and leadership development suited for the network-enabled era (includes research on what constitutes "good" and "bad" leadership and research on what leadership courses and methods "work" [and what "work" means], for whom, and in what contexts, specifically including emerging network-enabled organizations)	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
3	Need capabilities to exploit a wide range of robotics/autonomy technologies, ranging from ground robots to larger UAS to small swarming UAS to self-driving vehicles to "smart infrastructure" that can be "deputized" for LE purposes	Person-Worn Equipment and Weapons/Force Personal Clothing, Protection, or Augmentation (for small devices) Vehicles (for large systems)
3	Need practices to best exploit emerging technologies and practices from the military (e.g., exoskeletons, smart uniforms), while also mitigating or eliminating negative consequences of using military technologies (collateral damage minimization, deconfliction technologies)	Person-Worn Equipment, and Weapons/Force Personal Clothing, Protection, or Augmentation

Table 4.2—Continued

Tier #	Description of Need	Technology Taxonomy Category
3	Need research on approaches for providing "honest brokers" to assess performance of technological systems and disseminate the results (could include validation testing of emerging technologies and/or variants of "reputation/peer review" forums with comments for purchasers of tools [Yelp, Tripadvisor, etc.])	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
3	Need research on virtual/holographic remote presence technologies (an example includes supporting remote consultations between mental health personnel and persons exhibiting mental health problems)	Information and Communications Technology Information Delivery
3	Need technology to assist in the assessment of potential problems for LE personnel from exposure to violent situations and images	Management/Knowledge Development and Training Management/Leadership Knowledge Development and Training
3	Need an improved understanding of how LE can use emerging cognitive technologies (such as possibly emerging lie detection, prior presence on scene, and intent prediction technologies)	Information and Communications Technology Information Analysis
3	Need to develop "opt-in and opt-out" sensors for public areas that allow people to have more control over the data that are collected on them (e.g., automated face blurring on camera feeds), along with security provisions (policy-driven overrides) to ensure protection of the public	Information and Communications Technology Information Collection
3	Need to understand state of research and LE implications and needs for "brain bots"—early bionic brain implants that will support memory, decisionmaking, and hands-free interfaces	Person-Worn Equipment, and Weapons/Force Personal Clothing, Protection, or Augmentation

Table 4.3
Categories of Needs, by Tier

		Tier			
Need Division	**Need Category**	**1**	**2**	**3**	**All**
Information and Communications Technologies	Information Analysis	2	1	1	4
	Information Collection	3	1	1	5
	Information Delivery			1	1
	Information Management	3	2		5
Management Knowledge/ Development and Training	Management/Leadership Knowledge Development and Training	4	3	2	9
	Officer/Practitioner Knowledge Development and Training	1	1		2
	Specialist/Legal Knowledge Development and Training	2			2
	Specialist/Technologist Knowledge Development and Training	2	1		3
Person-Worn Equipment and Weapons/Force	Personal Clothing, Protection, or Augmentation			3	3
	Weapons and Force		1		1
	Vehicles			1	1

CHAPTER FIVE

Conclusions

During this workshop, after considering a broad range of societal and technology trends (as discussed in Chapter One), the participants conceived, discussed, and debated the characteristics and desirability of many different possible futures for law enforcement. Again, the first two research questions that participants considered were

1. How might technology and society evolve in the future?
2. How might the evolution of technology and society affect the use of technology by law enforcement?

For these questions, participants envisioned continued technology development and societal adoption and adaptation, and agreed that law enforcement agencies need substantial improvement in their ability to use technology effectively. They noted that, in many cases, criminals currently make more effective use of technology than law enforcement. Because of this, and the rapid rate of advancement of technology, they concluded that doing nothing to improve the effectiveness of law enforcement use of technology would inevitably lead to an undesirable future in which criminals have the upper hand and public support for law enforcement agencies is eroded.

The third research question was

3. What are the priority needs of law enforcement related to technology, including research and development, training, policy, and practice?

The workshop's answer to this question was based on the analysis of desirable and undesirable futures. One clear outcome of the scenario analysis was that there are many possible paths to undesirable futures. Some of the potential drivers of such paths are lack of resources, insufficient understanding of or training in the use of technologies, too intrusive use of technology (for example, with military-style equipment), lack of effective communication with the public, and poor leadership or ineffective or counterproductive policies. Paths to desirable futures, in which law enforcement uses technology effectively, and especially to those most desirable futures in which public support is also achieved and retained, require concerted action. Workshop participants identified and prioritized technology needs based on analysis of multiple scenarios and pathways to both desirable and undesirable futures.

As described in Chapter Three, paths to desirable futures can be built on a triad of information sharing, education and training, and partnerships:

- Effective information sharing both within law enforcement and with the public that provides rapid information dissemination and a vehicle to support clear understanding—both law enforcement's understanding of community needs and desires and public understanding of law enforcement needs and operational realities. (Here, workshop participants highlighted the need for effective use of social media.)
- Education and development of law enforcement personnel at all levels, both on the latest technologies and in their effective and least intrusive use by law enforcement, as well as general development of personnel, so they can adapt to whatever scenarios the future holds.
- Development of partnerships with the public, the private sector, and other government agencies and nonprofit organizations, with the objectives of developing a range of operationally effective systems and cost-effective adoption and implemention of technology by law enforcement agencies, as well as enhancing communication channels.

Workshop participants identified and prioritized technology needs to enable movement toward desirable futures and/or to prevent or mitigate the effects of movement toward undesirable futures. These needs are in broad alignment with the triad above. This triad, along with the specific needs from the workshop, is quite consistent with the major themes emerging from RAND's earlier assessment and prioritization of *current* law enforcement technology needs, focusing on information technology (Hollywood et al., 2015). The earlier assessment also found general themes focusing on improving the sharing and use of information, improving law enforcement's knowledge of technology and how to use it through various education and training means, and development and fielding of various affordable new technologies.

Implicit in this consistency across studies—and directly from the discussion and generated needs at the workshop—is that *workshop participants felt the best way to address the challenges of the future was to focus on improving today's law enforcement's capabilities, with an eye toward the challenges of a technologically complex future*. This is in contrast to focusing on comparatively futuristic research and development needs, which is what one might typically expect from a futuring workshop. Indeed, only a handful of needs from the workshop (on swarming unmanned vehicles, exoskeletons, holographic presence, and brain implants) can be thought of as "futuristic," and these were all ranked in Tier 3.

Below, we discuss each of the themes in the triad in more detail, along with the specific Tier 1 needs that support them.

Information Sharing as a Driver Toward Desirable Futures

Supporting Tier 1 needs:

- *Research and development on technologies to use information more effectively and tools to filter and prioritize information and to support real-time control and sharing of data from investigations and other operations*
- *Development of technologies and processes to support data sharing, including infrastructure, equipment standards, and integrated, adaptable systems*
- *Research on recognizing and dealing with legal and policy constraints on information sharing.*

Information sharing broadly defined was seen as a major unifying driver across the more positive scenarios and specific needs. The need for agencies to improve how they share and use information, internally, with other law enforcement partners, and with the public, was a very common theme throughout the workshop. Indeed, the specific vision for the most desirable future path to the future was labeled in Chapter Three as "Network-Centric Policing," with the ability to share information effectively one of its defining characteristics.

Considering specific needs, the highest-priority need identified in this workshop (discussed below) was the development of educational materials on social media that can be regularly updated to include the latest media and communications technologies. This directly supports critical internal and external communication needs, including informing the public, getting incident reports from the public, and getting assistance in solving crimes. Other top needs focused not just on the technology infrastructure for information sharing, but also on processes and policy. Policy and legal constraints routinely prevent or limit information sharing; in fact, there have been claims that policy and process barriers are actually significantly larger barriers to information sharing than technical interoperability issues.

Education and Development as a Driver Toward Desirable Futures

Supporting Tier 1 needs:

- *Educational material on social media to better engage the public and improve internal communications (the top-ranked need by either the median or average metric)*
- *Methods to disseminate innovative, promising practices across the large number of law enforcement agencies*
- *Training suitable for new technologies tailored for individuals with differing backgrounds and assignments, taking advantage of new educational technologies*
- *More research on ethics development in general*
- *Updating of law enforcement agency recruiting practices to acquire needed skills and improve screening and hiring mechanisms, and updating of training academy processes for network-enabled training environments.*

This theme broadly reflects an overarching need to improve the capabilities of law enforcement personnel to use technology effectively. It includes improving dissemination and education about new technologies and how to use them (i.e., promising processes and policies). It also includes research and development of new methods and tools to improve the education and training of law enforcement personnel in general (along with recruiting and retention).

This overarching need is critical if new technologies are to have a real-world impact in improving agencies' adaptations to future scenarios. Importantly, this need includes not just using technology efficiently but using it in ways that provide for legitimacy with the public. The most desirable specific future, "Network-Centric Policing," included a number of elements focused on major improvements in the capabilities of law enforcement personnel, both in a general sense and in reference to using specific technologies.

Considering specific needs, one highly ranked need was the improvement of training that is suitable for new technologies. This includes identifying/updating training needs, skill sets, and roles; tailoring training for people with different roles, levels, and backgrounds; and taking

advantage of new educational technologies. Current practices in law enforcement agencies can, either directly or indirectly, hinder their effective use of technology. Moreover, innovative and promising practices are often not disseminated, either within or between agencies. Improper or intrusive use of technology can result from a lack of understanding or implementation of ethical practice or procedures. Beyond training, law enforcement recruiting practices need to be updated to attract and retain staff with strong technology know-how in today's job market.

Beyond the specific needs listed above, workshop participants discussed at length the need to improve the development and selection of leaders at all levels of law enforcement agencies. They noted that leadership development, recruitment, and selection have been major problem areas since the dawn of policing, although they were unable to identify any specific science and technology needs that they felt were likely to lead to breakthroughs. However, the fact that they did not identify any top needs did not mean they did not think leadership was critical—in fact, some participants said they thought leadership was perhaps the most important requirement for law enforcement agencies to be able to adapt to and thrive in whatever scenarios occur in the future.

Technology Research and Development as a Driver Toward Desirable Futures

Supporting Tier 1 Needs:

- *Research on the use of tagging and tracking technologies for inventory, equipment, and people for both administrative and investigative purposes*
- *Improved translation technologies, including dialect, indigenous languages, and cultural factors translation*
- *Methods to permit law enforcement personnel to create and use artificial identities for valid law enforcement purposes*
- *Technology to identify in the field when someone is under the influence or impaired from future legal and custom-made drugs and other biological agents.*

Beyond information sharing, which was broad and strong enough to be called out as its own leg of the triad, technology research and development in a number of areas was seen as necessary for agencies to move toward desirable paths. Notably, the "Network-Centric Policing" future actually calls for law enforcement mastery of a range of emerging technology areas, not just networking. In fact, this future called for a much larger number of technologies than any of the other (and much less desirable) futures.

The top needs in this theme cover a wide range of technologies. Law enforcement needs to adapt the latest small and unobtrusive tagging and tracking technologies for people, equipment, and inventory in both investigations and administration. Current translation technology limitations in recognizing dialects, indigenous languages, and cultural effects, which create manifold problems for officers in the field, need to be overcome. Because of the growth of cybercrime, it is important to establish practices and procedures that will allow law enforcement personnel to create and use artificial identities. With the proliferation of local capabilities to produce drugs and other biological agents, it will become increasingly important to have technology in the field to determine when someone is under the influence of or impaired by future legal or custom-designed drugs or other biological agents.

Conclusions from the Law Enforcement Futuring Workshop

The above examples of high-priority technology needs are by no means a comprehensive set. They do, however, represent the participants' highest-ranked tier of needs, consisting of 12 of the 30 identified needs. The balance of the needs and the other two tiers in which they were ranked were described in Chapter Four.

Beyond any individual theme or specific need, the key message of this workshop is that by addressing law enforcement's need to improve its technologically related capabilities today we can greatly enhance our chances of moving on a path toward desirable futures.

We draw the following conclusions from the Law Enforcement Futuring Workshop:

1. Positive steps to address identified needs in technology, policy, and practice must be taken to avoid paths to futures workshop participants identified as undesirable. The literal "do nothing" path was seen as leading to highly undesirable futures, and even the "do just enough to stay afloat path" was seen as leading to poor outcomes.
2. Because technology and society will continue to evolve, moving to and staying on paths to futures that workshop participants identified as desirable will require continuing action to establish and retain public support and for law enforcement practitioners to effectively meet technology-based challenges.
3. Enabling paths to desirable futures in the period 2024–2034 will require addressing identified needs in practice, education, and training; information sharing; and development and/or adaptation of technology now.

APPENDIX A

Workshop Agenda

National Institute of Justice
NLECTC Priority Technology Needs Initiative
Law Enforcement Futuring Workshop
Workshop Agenda

Day 1: July 22, 2014

8:00–8:30	Registration
8:30–8:45	Welcome (NIJ)
8:45–9:30	In-brief (RAND)
9:30–10:30	Full group discussion of (10–20 year) future issues for law enforcement
10:30–10:45	Break
10:45–12:00	Continue full group discussion of future issues
12:00–13:30	Lunch on your own

Breakout Groups Begin

13:30–15:30 Discussion of Current Problems/Issues (First Horizon)

- Current location on scenario axes
- The role of technology
- Drivers/barriers to use of technology
- Current technology characterization

15:30–15:45 Break

15:45–17:00 Finish discussion of First Horizon

- Consensus on current location on scenario axes and technology characterization

Day 2: July 23, 2014

Breakout Groups Continue

8:30–10:30 Possible Futures (Third Horizon)

- Possible locations on scenario axes
- Characteristics (similarities and differences from First Horizon)
- Problems and opportunities
- The role of technology

10:30–10:45 Break

10:45–12:00 Continue discussion of Third Horizon

12:00–13:30 Lunch on your own

13:30–15:30 Continue discussion of Third Horizon

15:30–15:45 Break

15:45–17:00 Finish discussion of Third Horizon
- Consensus on possible future locations on scenario axes, problems and opportunities, and the role of technology

Day 3: July 24, 2014

Breakout Groups Continue

8:30–10:30 Possible Pathways (Second Horizon)
- Desirable and undesirable locations on scenario axes
- Pathways to desirable futures
- Drivers/barriers
- The role of technology
- Technology needs

10:30–10:45 Break

10:45–12:00 Finish discussion of Second Horizon
- Consensus on desirable and undesirable locations on scenario axes, pathways to desirable futures, and technology needs

End of Breakout Groups

12:00–13:30 Lunch on your own

13:30–15:30 Re-convene all participants for reports from breakout groups
- Desired futures
- Possible pathways
- The role of technology
- Technology needs

15:30–15:45 Break

15:45–17:00 All-participant discussion of breakout group results
- Consensus on scenarios and technology needs

Day 4: July 25, 2014

8:30–10:30 All-participant Delphi session Round 1 for needs prioritization

10:30–10:45 Break

10:45–11:30	All-participant Delphi session Round 1 (continued)
11:30–12:30	Lunch on your own
12:30–13:30	Report on Delphi Round 1
13:30–15:00	Discussion of non-consensus issues in Delphi Round 1 • Opportunity to revise answers (Delphi Round 2)
15:00–15:30	Final session: thank you and participant survey

APPENDIX B

Workshop Participants

David Azuelo, Captain, Tucson Police Department, Tucson, Arizona

Michael Buerger, Associate Professor, Bowling Green State University, Bowling Green, Ohio

Brian Cain, Sergeant, Holly Springs Police Department, Holly Springs, Georgia

Elliott Cohen, First Sergeant, Maryland Department of State Police

Thomas Cowper, Director of Planning and Research, New York State Police

John Daley, Commander and Chief Technology Officer, Boston Police Department, Boston, Massachusetts

Brad Deardorff, Assistant Special Agent-in-charge, Federal Bureau of Investigation, Seattle, Washington

Tim Dees, Journalist (former police officer, Reno, Nevada)

John Evans, Project Manager for Western and Northern Canada, Defence Research Development Canada

John Jackson, Sergeant, Houston Police Department, Houston, Texas

John Jarvis, Chief Criminologist, Behavior Sciences Unit, Federal Bureau of Investigation

Monica Mapel, Assistant Special Agent-in-charge, Immigrations and Customs Enforcement, Department of Homeland Security, San Antonio, Texas

Daniel McFarland, Lieutenant, New York City Police Department, New York, New York

Thomas Monahan, Lieutenant, Las Vegas Metro Police Department (retired)

Ben Reed, Jr., Chief, Elko Police Department, Elko, Nevada

Timothy Roufa, Captain, Florida Highway Patrol

Joseph Schafer, Professor and Chair of the Department of Criminology & Criminal Justice, Southern Illinois University, Carbondale, Illinois

Deborah Spence, COPS Office, Department of Justice, Washington, D.C.

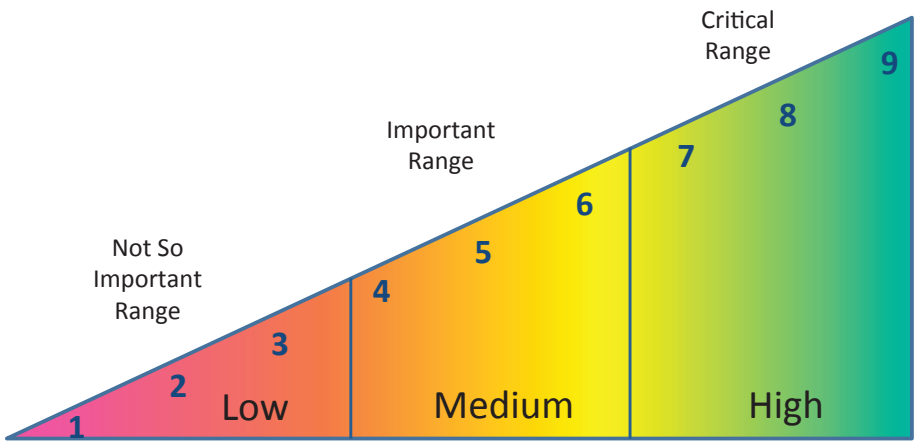
Gene Stephens, Distinguished Professor Emeritus, University of South Carolina College of Criminal Justice

Delphi Questions and Ranking Scales

Question 1 – How Important Will This Need Be in Enabling or Preventing/Mitigating Scenarios?

- For this answer, consider the scenario in which this need would be most important
- First rank the need as high, medium, or low
  - Is this need critical for this scenario (high)?
  - Is this need important for this scenario (medium)?
  - Is this need not so important for this scenario (low)?
- Then decide where you think this need falls within these high, medium and low ranges →

Scales to Use for Ranking



Question 2 – How Pervasive Will This Need Be in Enabling or Preventing/Mitigating Scenarios?

- For this answer, consider all the scenarios in which this need would be important
- First rank the need as high, medium, or low
  - Is this need important for many/most scenarios (high)?
  - Is this need important for several scenarios (medium)?
  - Is this need important for few scenarios (low)?
- Then decide where you think this need falls within these high, medium and low ranges

Question 3 – How Hard Would It Be to Overcome the Technical Barriers?

1. Rate the likelihood that this need could be successfully met from a *technical* perspective
   - *High*: path to overcoming technical barriers is clear and seems achievable (70-90% chance)
   - *Medium*: technical barriers are difficult and success is uncertain (40 – 60% chance)
   - *Low*: technical barriers are formidable and success requires a breakthrough (10-30% chance)
2. Where is likelihood of overcoming technical barriers within the High, Medium, or Low Category?
   - Towards the upper end – more likely to succeed
   - In the middle of the category
   - Towards the lower end – less likely to succeed

Question 4 – How Hard Would It Be to Overcome the Operational and Deployment Barriers?

1. Rate the likelihood that this need could be successfully met from an *operational* perspective
   - *High*: path to overcoming operational/deployment barriers is clear and seems achievable (70-90% chance)
   - *Medium*: operational and deployment barriers are difficult and success is uncertain (40 – 60% chance)
   - *Low*: operational and deployment barriers are formidable and success requires change (10-30% chance)
2. Where is likelihood of overcoming operational and deployment barriers within the High, Medium, or Low Category?
   - Towards the upper end – more likely to succeed
   - In the middle of the category
   - Towards the lower end – less likely to succeed

APPENDIX D

Statistical Analysis of Delphi Responses

The 30 technology needs identified by the participants in the Law Enforcement Futuring Workshop are listed in Table D.1. The Need numbers have no special significance, merely reflecting the order in which the needs were identified by the workshop participants. However, they will be useful in the discussion below as identifiers of specific needs.

During the workshop, participants scored these needs by answering the questions described in Appendix C using the scales also shown there. This gave a value for importance ranging from 1 to 9, a value for pervasiveness ranging from 0.1 to 0.9, and values for technical and implementation probability each ranging from 10 percent to 90 percent. As described in Chapter Four, we calculated an expected value estimate for each participant for each need as the product of the scores for the answers to the four questions. This gave us 19 discrete expected value estimates for 29 of the needs and 18 discrete expected value estimates for one of the needs.

A key objective of the workshop was to use these estimates to rank the 30 needs from high to low, with ranking 1 being the highest and ranking 30 being the lowest. There are many possible approaches to accomplish this objective. Such sets of discrete estimates can be fitted to a continuous distribution, for example using a normal or lognormal distribution (Aitchison and Brown, 1957). Then the mean or median of the distribution can be used as a ranking metric, and the variance of the distribution as a measure of uncertainty. Alternatively, one can use the data directly to find an average and median of the individual participant estimates and use either the average or the median as a ranking metric. We chose the latter path because, most importantly, it does not require any assumptions about the shape of the distribution. Further, there is a statistical test that provides a direct measure of the probability that any lower-ranked need should actually be ranked higher than a given higher-ranked need.[1] We describe the below rankings using average and median, as well as the statistical analysis of each set of rankings.

We illustrate the ranking method using the median as the ranking metric. Table D.2 shows the median of the discrete expected value estimates of the participants for each need, and the ranking of the need, where a lower number represents a higher ranking, i.e., ranking number 1 designates the highest ranked need and ranking number 30 designates the lowest ranked need. When the median expected value of two needs was the same, we averaged the ranking.

[1] This test is the Wilcoxon rank-sum test, which is described, for example, in Wild and Seber, 1999. It is based solely on the order in which each of the individual estimates, scores, or observations for a need fall, when these observations and those of the other need considered in a pairwise comparison are ordered together according to their scores.

Table D.1
Number and Description of Technology Needs

Need #	Technology Need
1	Need to develop educational material on social media to better engage the public and improve internal communications. Includes (1) informing the public, (2) getting incident reports from the public, and (3) getting assistance in solving crimes. Training material needs to include good examples. Can also include coverage of hiring and working with media experts. Material needs to be updated regularly to reflect new media and communications technologies.
2	Need research on approaches for providing "honest brokers" to assess performance of technological systems and disseminate the results. Could include validation testing of emerging technologies. Could include variants of "reputation/peer review" forums with comments for purchasers of tools (Yelp, Tripadvisor, etc.).
3	Need improved technologies—including both tactics and physical systems—for safely defusing or disabling people, groups, and vehicles. Specifically includes alternatives to kinetic impact weapons.
4	Need practices to best exploit emerging technologies and practices from the military (up to exoskeletons, smart uniforms), while also mitigating/eliminating negative consequences of using military technologies (collateral damage minimization, deconfliction technologies)
5	Need R&D on technologies to use information more effectively, including smart search, sensor analytics, general predictive analytics, tools to filter and prioritize information (both push and pull), and tools to support real-time control and sharing of data from investigations and other law enforcement operations
6	Need to improve training suitable for new technologies. Includes identifying/updating training needs, skill sets, and roles; tailoring training for people with different roles, levels, and backgrounds; and taking advantage of new educational technologies
7	Need to develop means for measuring public and criminal uses of technology and countermeasures to LE uses of technology
8	Need to update LE agency recruiting practices, including recruiting people with needed skills, updating screening and hiring mechanisms, and updating training academy processes for future network-enabled training environments
9	Need capabilities to exploit a wide range of robotics/autonomy technologies, ranging from ground robots to larger UAS to small swarming UAS to self-driving vehicles to "smart infrastructure" that can be "deputized" for law enforcement purposes
10	Need an improved understanding of how LE can use emerging cognitive technologies (such as possibly emerging lie detection, prior presence on scene, and intent prediction technologies)
11	Need technology to identify in the field when someone is under the influence or impaired from future legal and custom-made drugs and other biological agents. Could reflect behavioral screening, chemical screening, or combinations of the two.
12	Need research on leadership and leadership development suited for the network-enabled era (includes research on what constitutes "good" and "bad" leadership and research on what leadership courses and methods "work" [and what "work" means], for whom, and in what contexts, specifically including emerging network-enabled organizations)
13	Need to identify LE resource needs and roles emerging from new technologies and uses by criminals and the public (including both virtual and biological crimes)
14	Need to identify and adapt business models, including public/private partnership models, that will facilitate LE agencies' recognizing new needs and updating and using technologies effectively
15	Need technology to assist in the assessment of potential problems for LE personnel from exposure to violent situations and images
16	Need research on virtual/holographic remote presence technologies. An example includes supporting remote consultations between mental health personnel and persons exhibiting mental health problems.
17	Need improved translation technologies, including dialect, indigenous languages, and cultural factors translation

Table D.1—Continued

Need #	Technology Need
18	Need research on methods to disseminate innovative, promising practices across the large number of law enforcement agencies. Should include "change management" practices and practices for gathering and using lessons learned.
19	Need more R&D on ethics development in general
20	Need research on social aspects of improving information sharing and collaboration. Research needs to consider incentives, organizational cultures, and training needs. Can consider models coming out of online gaming/online communities.
21	Need research on recognizing and dealing with legal and policy constraints for information sharing
22	Need to develop collaborations with CDC and other public health agencies to provide for as much preparation time and guidance as possible to prepare for public health crises
23	Need to develop "opt-in and opt-out" sensors for public areas that allow people to have more control over the data that are collected on them (automated face blurring on camera feeds, for example), along with security provisions (policy-driven overrides) to ensure protection of the public
24	Need methods to permit LE personnel to create and use artificial identities for valid LE purposes
25	Need to understand state of research and LE implications and needs for "brain bots"—early bionic brain implants that will support memory, decisionmaking, and hands-free interfaces
26	Need research on the use of tagging and tracking technologies (small RFID, nano, dyna dots, implants) for tracking inventory, equipment, and people for administrative and investigative purposes
27	Need research on technologies that can "see" or sense threats at a distance (on people, behind walls, in vehicles)
28	Need research on rules and procedures for going undercover in virtual worlds
29	Need to develop "super HR" systems that can track details about LE personnel's training, certification, record, etc., over the course of their careers and share this information as appropriate (would also include "scores" and "badges" reflecting experiences, training, reputation, and accomplishments)
30	Need to develop technologies and processes to support data sharing, including communications infrastructure, equipment standards, integrated data systems, and adaptable/upgradable systems

To assess the validity of these rankings, we performed the Wilcoxon rank-sum test, which compares two needs solely based on the order in which each of their individual expected value estimates falls.[2] To perform a Wilcoxon rank-sum test, one places all of these estimates for the two needs to be compared on the same number line, and ranks them from low to high, regardless of which need they represent. One then calculates the *sum* of the *rankings* of one of the two needs and compares it with the sum of the rankings that one would expect if the two needs were identical.

We now work out a simple example to illustrate the method. Suppose there were two expected value estimates for Need A, which we represent by A's, and another two expected value estimates for Need B, which we represent by B's. We place these four expected value estimates on the same number line, and order them according to their expected values. If the two needs were identical, then these expected values would have come from the same distribution, and there would be six equally probable orderings: AABB, ABAB, ABBA, BAAB, BABA, and BBAA. The sum of the rankings, or rank-sum, for Need A in the case of AABB is 3, since

[2] There are many articles that describe how a Wilcoxon rank-sum test is performed. A good description is provided in Wild and Seber, 1999.

Table D.2
Ranking of Needs Using Median as a Ranking Metric

Need #	Short Description of Need	Median	Rank
1	Develop educational material on social media to better engage the public and improve internal communications	3.9	1
5	R&D on technologies to use information more effectively	3.6	2
26	Research on the use of tagging and tracking technologies	3.5	3.5
18	Research on methods to disseminate innovative, promising practices across LE agencies	3.5	3.5
6	Improve training suitable for new technologies	3.1	5.5
30	Develop technologies and processes to support data sharing	3.1	5.5
21	Research on recognizing and dealing with legal and policy constraints for information sharing	2.7	7
17	Improved translation technologies	2.3	9.5
19	More R&D on ethics development	2.3	9.5
8	Update LE agency recruiting practices	2.3	9.5
24	Methods to permit LE personnel to create and use artificial identities	2.3	9.5
11	Technology to identify in the field when someone is under the influence from legal and custom-made drugs	2.1	12
7	Develop means for measuring public and criminal uses of technology and countermeasures to LE uses of technology	2.0	13.5
14	Identify and adapt business models that will facilitate LE agencies' recognizing new needs and updating and using technologies effectively	2.0	13.5
3	Improve technologies for safely defusing or disabling people, groups, and vehicles	1.8	15.5
27	Research on technologies that can "see" or sense threats at a distance	1.8	15.5
13	Identify LE resource needs and roles emerging from new technologies and uses by criminals and the public	1.7	19
28	Research on rules and procedures for going undercover in virtual worlds	1.7	19
20	Research on social aspects of improving information sharing and collaboration	1.7	19
22	Develop collaborations with CDC and other public health agencies to prepare for public health crises	1.7	19
29	Develop "super HR" systems that can track details about law enforcement personnel's training, certification, record, etc.	1.7	19
12	Research on leadership and leadership development suited for the network-enabled era	1.6	22
9	Need capabilities to exploit a wide range of robotics/autonomy technologies	1.5	23.5
4	Best practices to exploit emerging technologies and practices from the military, while also mitigate negative consequences of using military technologies	1.5	23.5
2	Research on providing "honest brokers" to assess performance of technological systems and disseminate the results	1.4	25
16	Research on virtual/holographic remote presence technologies	1.3	26.5
15	Technology to assist in the assessment of potential problems for LE personnel from exposure to violent situations and images	1.3	26.5
10	Improve understanding of how LE can use emerging cognitive technologies	0.8	28
23	"Opt-in and opt-out" sensors for public areas that allow people to have more control over the data collected on them, along with security provisions to ensure protection of the public	0.7	29
25	Understand state of research and LE implications and needs for "brain bots"	0.4	30

NOTE: For full descriptions of needs, see Table D.1.

the two As appear in ranks 1 and 2. For ABAB, since the two As appear in ranks 1 and 3, the rank-sum for Need A is 4. Similarly, the rank-sums for Need A in the other 4 cases are 5, 5, 6, and 7. Since each of these orderings is equally probable under the assumption that the needs are identical, the expected rank-sum for Need A is 5 (i.e., the average of 3, 4, 5, 5, 6, and 7). In the actual Delphi exercise of this example, if both of the two participants estimated higher expected values for Need A than Need B, the ordering would be BBAA. This gives a rank-sum of 7 for Need A. Since 7 is greater than the expected rank-sum of 5, it is more likely that Need A should be ranked higher than Need B. Were the needs identical, a Need A rank-sum of 7 would occur only one out of six times, so the test estimates the probability that Need B should be ranked the same or higher than Need A as one-sixth, or 17 percent. The test can statistically calculate for any pair of needs and for any number of estimates, the probability that one need should be ranked above or below the other. In the following, we use this test to provide pairwise probabilities of the relative rankings of the needs.

We now illustrate the use of the Wilcoxon rank-sum test using actual data from our Delphi exercise by comparing the highest-ranked need, Need 1, defined as A, with the seventh-ranked need, Need 21, defined as B. Let N_a be the number of observations for A, which is 19, since 19 participants provided individual expected value estimates for Need 1. N_b, the number of observations for B, is also 19.[3]

We perform the test in the following steps, with the results shown in Table D.3.

- Step 1: Order the observations, or individual participant expected value estimates, for A (Need 1) and B (Need 21) from small to large, as shown in the column labeled "Score or Observation" in Table D.3.
- Step 2: Rank the individual participant expected value estimates in increasing order, *regardless of which need they come from*, as shown in the column labeled "Rank" in Table D.3. When multiple needs have the same score, the rank would be the average.
- Step 3: Calculate the Wilcoxon rank-sum (w_a) by adding the ranks belonging to Need 1, as shown in the column labeled Rank for Need 1. The result is 404.[4]
- Step 4: Find the average and standard deviation of the distribution of the Wilcoxon rank-sum of Need 1 from all possible random draws of 19 expected values for Need 1 and 19 expected values for Need 21. As shown in Wild and Seber" (1999), these are the mean $Mu_a = N_a (N_a + N_b + 1)/2 = 370.5$ and standard deviation $Sigma_a = (N_a N_b (N_a + N_b + 1)/12)^{1/2} = 34.25$ of a normal distribution, because of the large number of possible combinations of 38 different numbers.[5] Using the values of w_a, Mu_a, and $Sigma_a$, one can then use normal probability tables to find the probability that a rank-sum value of 404 for Need 1 would occur from random draws if the two needs were identical. This value is 16.4 percent, as

[3] N_a and N_b need not be the same in order to perform a Wilcoxon rank-sum test. In fact, in the cases involving Need 24, we used 18 for this need and 19 for the other need, since only 18 participants rated Need 24.

[4] Since we are calculating the Wilcoxon rank-sum for Need 1, ranks belonging to Need 21 are not counted. If we were calculating the Wilcoxon rank-sum for Need 21, we would not count needs belonging to Need 1.

[5] This does not require A or B to have a normal distribution. The test remains non-parametric, in spite of this simplifying assumption. This approximation is good when the number of observations for both needs is greater than 12 (Wild and Seber, 1999).

Table D.3
Wilcoxon Rank-Sum Test for Comparing the Rankings of Need 1 and Need 21

Need #	Score or Observation	Rank	Rank for Need 1
1	0.0	1.5	1.5
21	0.0	1.5	
21	0.4	3	
21	0.5	4	
1	0.9	5.5	5.5
21	0.9	5.5	
1	1.1	7	7
1	1.5	8	8
21	1.6	9	
21	1.8	10	
21	2.0	11	
21	2.1	12.5	
21	2.1	12.5	
1	2.3	14	14
1	2.7	15.5	15.5
21	2.7	15.5	
21	3.0	17	
1	3.1	18.5	18.5
21	3.1	18.5	
1	3.4	20	20
1	3.6	21.5	21.5
21	3.6	21.5	
1	3.9	23	23
1	4.0	24.5	24.5
1	4.0	24.5	24.5
1	4.1	26.5	26.5
1	4.1	26.5	26.5
1	4.5	28	28
21	4.6	29.5	
21	4.6	29.5	
1	5.1	31.5	31.5
21	5.1	31.5	
21	5.2	33	
1	6.6	36	36
1	6.6	36	36
1	6.6	36	36

Table D.3—Continued

Need #	Score or Observation	Rank	Rank for Need 1
21	6.6	36	
21	6.6	36	
		w_a	404
		N_{ax}	19
		N_b	19
		M_{ua}	370.5
		$Sigma_a$	34.25
		P-$value_a$	0.164

shown in Table D.3.[6] Thus, there is only a 16.4 percent chance that the lower-ranked Need 21 should be ranked the same or higher than the currently higher-ranked Need 1, signifying high confidence that Need 1 should be ranked higher than Need 21.

In the following, we apply the Wilcoxon rank-sum test to evaluate the probability that any need should be ranked at least as high as any need that is ranked above it. We illustrate this approach with Need 7, which is the 13.5th ranked need in Table D.2. We developed Table D.4 by applying the Wilcoxon rank-sum test (as shown above for Need 1 and Need 21) to Need 7 and each of the 12 needs that were ranked higher than it using the median expected value as a ranking metric. The entries in the third row of Table D.4 are the probability (P-value) that Need 7 should be ranked the same or higher than the need in the second row of the table. We see that these probabilities are very low for the first- to seventh-ranked needs, and that the highest are 28 percent for the 9.5th-ranked Need 24 and 29 percent for the 9.5th-ranked Need 19.

Table D.5 shows the full triangular matrix of probabilities that needs should be ranked at least as high as higher-ranked needs, with the probabilities for Need 7 in its twelfth row. The colors of the boxes are graded from green to dark red. Generally, if the box is green, the probability is very small (typically less than 5 percent), yellow slightly larger (up to 15 percent), orange larger yet (up to 40 percent). At the extreme, a dark red box, for example that for Need 11 versus Need 19, shows a probability of 77 percent. Whenever it is higher than 50 percent,

Table D.4
Probabilities That Need 7 Should Be Ranked at Least as High as Higher-Ranked Needs Using Median as a Ranking Metric

Rank #	1	2	3.5	3.5	5.5	5.5	7	9.5	9.5	9.5	9.5	12
Need #	1	5	26	18	6	30	21	17	19	8	24	11
7	0	0.03	0.02	0.04	0.02	0.01	0.07	0.16	0.29	0.21	0.28	0.13

[6] The P-value in Table D.3 is defined as: P-value = probability ($W_a \geq w_a$), where W_a is the rank-sum for 19 randomly drawn observations for A versus another 19 randomly drawn observations for B, both from the same distribution. The low P-value shows that it is highly unlikely that Need 1 and Need 21 should be ranked the same, and the higher rank-sum for Need 1 shows that it is properly ranked higher than Need 21.

Table D.5
Probabilities That Needs Should Be Ranked at Least as High as Higher-Ranked Needs Using Median as a Ranking Metric

Rank #	1	2	3.5	3.5	5.5	5.5	7	9.5	9.5	9.5	9.5	12	13.5	13.5	15.5	15.5	19	19	19	19	19	22	23.5	23.5	25	26.5	26.5	28	29
Need #	1	5	26	18	6	30	21	17	19	8	24	11	7	14	3	27	13	28	20	22	29	12	9	4	2	16	15	10	23
5	0.187																												
26	0.295	0.637																											
18	0.211	0.448	0.369																										
6	0.29	0.592	0.523	0.535																									
30	0.336	0.735	0.558	0.598	0.512																								
21	0.164	0.535	0.315	0.413	0.295	0.285																							
17	0.024	0.16	0.099	0.164	0.102	0.063	0.233																						
19	0.007	0.064	0.039	0.074	0.03	0.024	0.157	0.347																					
8	0.021	0.175	0.099	0.131	0.061	0.051	0.224	0.43	0.512																				
24	0.002	0.035	0.083	0.024	0.047	0.007	0.061	0.392	0.452	0.452																			
11	0.078	0.305	0.203	0.363	0.22	0.16	0.413	0.604	0.772	0.68	0.703																		
7	0.002	0.028	0.015	0.039	0.017	0.009	0.072	0.164	0.295	0.207	0.282	0.134																	
14	0.025	0.113	0.061	0.143	0.074	0.051	0.168	0.425	0.517	0.477	0.56	0.256	0.715																
3	0.009	0.048	0.039	0.063	0.048	0.031	0.134	0.27	0.43	0.396	0.41	0.168	0.598	0.374															
27	0.002	0.033	0.009	0.028	0.007	0.002	0.03	0.099	0.15	0.116	0.173	0.068	0.32	0.233	0.246														
13	0.003	0.022	0.021	0.061	0.041	0.015	0.097	0.22	0.448	0.305	0.392	0.191	0.637	0.315	0.558	0.725													
28	0.027	0.147	0.087	0.16	0.059	0.036	0.157	0.358	0.592	0.402	0.512	0.251	0.715	0.626	0.581	0.785	0.653												
20	0.008	0.048	0.039	0.072	0.044	0.015	0.083	0.228	0.436	0.3	0.416	0.16	0.575	0.38	0.471	0.653	0.506	0.369											
22	0.009	0.047	0.029	0.078	0.048	0.024	0.116	0.224	0.402	0.285	0.392	0.137	0.541	0.336	0.465	0.642	0.436	0.341	0.477										
29	0.005	0.05	0.02	0.061	0.02	0.008	0.057	0.134	0.207	0.14	0.202	0.099	0.408	0.275	0.325	0.483	0.396	0.246	0.385	0.391									
12	0.006	0.033	0.021	0.057	0.02	0.012	0.085	0.15	0.32	0.211	0.341	0.107	0.459	0.38	0.385	0.581	0.369	0.28	0.369	0.408	0.581								
9	0.002	0.029	0.008	0.03	0.007	0.003	0.024	0.081	0.113	0.066	0.083	0.072	0.251	0.203	0.207	0.408	0.28	0.127	0.265	0.29	0.358	0.265							
4	1E-04	0.002	6E-04	0.002	6E-04	2E-04	0.003	0.009	0.008	0.011	0.021	0.005	0.036	0.022	0.037	0.105	0.032	0.028	0.059	0.044	0.134	0.066	0.22						
2	0.002	0.017	0.011	0.028	0.008	0.003	0.02	0.068	0.124	0.083	0.144	0.054	0.27	0.237	0.199	0.31	0.275	0.121	0.211	0.27	0.347	0.325	0.483	0.763					
16	2E-04	0.002	9E-04	0.004	9E-04	3E-04	0.002	0.009	0.018	0.011	0.015	0.006	0.044	0.045	0.04	0.087	0.05	0.019	0.054	0.064	0.076	0.057	0.14	0.336	0.15				
15	0.005	0.03	0.014	0.036	0.011	0.006	0.037	0.066	0.107	0.085	0.134	0.042	0.211	0.207	0.153	0.29	0.187	0.124	0.199	0.256	0.325	0.246	0.442	0.74	0.442	0.785			
10	2E-05	8E-05	5E-05	4E-04	4E-05	2E-05	4E-04	5E-04	0.001	1E-03	0.003	4E-04	0.004	0.004	0.002	0.006	0.003	7E-04	0.003	0.007	0.009	0.003	0.017	0.092	0.006	0.078	0.026		
23	4E-05	4E-04	2E-04	7E-04	2E-04	1E-04	0.001	0.002	0.002	0.003	0.005	0.001	0.01	0.004	0.01	0.023	0.006	0.004	0.01	0.013	0.024	0.008	0.056	0.168	0.026	0.242	0.066	0.581	
25	6E-06	2E-05	1E-05	5E-05	7E-06	7E-06	7E-05	6E-05	9E-05	8E-05	3E-04	5E-05	4E-04	4E-04	2E-04	8E-04	2E-04	1E-04	3E-04	9E-04	0.001	5E-04	0.004	0.014	9E-04	0.012	0.003	0.121	0.078

the Wilcoxon rank-sum test indicates that the rankings should be reversed. Unfortunately, the test is only capable of comparing the relative rankings of two needs at a time, and there are numerous permutations of pairwise comparisons among 30 needs. Consequently, there are simply too many moving parts to use Table D.5 to rearrange the rankings of the 30 needs to yield a "best" set of rankings. While the test has this limitation, it is still highly useful in providing a measure of uncertainty in the ratings. For example, Table D.5 shows that the ranking difference or distance between needs is a key determinant for ranking confidence. For example, the seven top-ranked needs (#1, 5, 26, 18, 6, 30, and 21) form a reasonable top-ranked group, because needs below them have typically only a small chance to match or out-rank the top seven. Thus, Table D.5 provides a statistical basis for deciding which and how many needs should be in the top-ranked group, as well as other ranked groups. Even in cases with greater uncertainty, it is useful to characterize this uncertainty rather than to ignore it.

As noted previously, we ranked the needs using both median and average as the ranking metric. We now describe the ranking using average as the ranking metric, including the Wilcoxon rank-sum test to characterize the uncertainty in these rankings. Table D.6 shows the average of the individual participant expected value estimates and the rankings based on using the average as the ranking metric.

Table D.7 shows the triangular matrix of probabilities that any need should be ranked at least as high as the needs ranked above it, for the rankings using average as the ranking metric. Similarly to, but independently of, Table D.5, it shows that the probability of any need ranked below the seven top-ranked needs (#1, 30, 6, 26, 18, 21, and 5) to be properly ranked within the top seven is very small. Interestingly, while the rank order of the top seven needs based on median and average as the ranking metric is different, each group contains the same seven needs.

We have developed two quantitative metrics to compare the two ranking schemes. The first metric is called the Average Chance Up, which is the average of all the entries in Table D.7. This metric can be interpreted as the average chance for any of the 29 needs[7] to deserve to be ranked higher. Thus, the smaller this number, the better the ranking scheme. For example, if the Average Chance Up is zero, it means the ranking scheme is perfect, because all needs have no chance to be ranked higher. For the average-based ranking, the Average Chance Up is 0.15, which is the sum of all the entries (66.7) in Table D.7 divided by the number of cells (435). For the median-based ranking, the Average Chance Up is 0.17, which is the sum of all the entries (73.5) in Table D.5 divided by the number of cells (435). For this metric, the average-based ranking is slightly better because it has a lower Average Chance Up of 0.15, as opposed to 0.17. The Average Chance Up tells us that, on average, each need has a 15 percent to 17 percent chance to have the same ranking as, or a higher ranking than, any higher-ranked needs.

The second metric is called the Average Chance+1, which is the average chance for a need to match or exceed the ranking that is immediately above it or, more simply stated, the average chance of being ranked one position higher. For example, Table D.7 shows that the chance for Need 18 to move up one ranking to match Need 26 is 0.37, or 37 percent (see the row for Need 18 and the column for Need 26). Summing the cells along the diagonal and dividing the sum by the number of cells (29) yields the Average Chance+1. Both the average- and median-based ranking schemes give the same value for this metric, 0.42 (i.e., 12.1 for average and 12.3 for

[7] Since the top-ranked need cannot go any higher, only 29 of the 30 needs has a chance to move to a higher ranking.

Table D.6
Ranking of Needs Using Average as a Ranking Metric

Need #	Short Description of Need	Average	Rank
1	Develop educational material on social media to better engage the public and improve internal communications	3.6	1
30	Develop technologies and processes to support data sharing	3.3	2.5
6	Improve training suitable for new technologies	3.3	2.5
26	Research on the use of tagging and tracking technologies	3.2	4
18	Research on methods to disseminate innovative, promising practices across LE agencies	3.1	5
21	Research on recognizing and dealing with legal and policy constraints for information sharing	3.0	6
5	R&D on technologies to use information more effectively	2.9	7
11	Technology to identify in the field when someone is under the influence from legal and custom-made drugs	2.8	8
17	Improved translation technologies	2.5	9
8	Update LE agency recruiting practices	2.4	11
24	Methods to permit LE personnel to create and use artificial identities	2.4	11
28	Research on rules and procedures for going undercover in virtual worlds	2.4	11
14	Identify and adapt business models that will facilitate LE agencies' recognizing new needs and updating and using technologies effectively	2.3	13
3	Improve technologies for safely defusing or disabling people, groups, and vehicles	2.2	14.5
19	More R&D on ethics development	2.2	14.5
20	Research on social aspects of improving information sharing and collaboration	2.1	17.5
22	Develop collaborations with CDC and other public health agencies to prepare for public health crises	2.1	17.5
12	Research on leadership and leadership development suited for the network-enabled era	2.1	17.5
13	Identify LE resource needs and roles emerging from new technologies and uses by criminals and the public	2.1	17.5
29	Develop "super HR" systems that can track details about law enforcement personnel's training, certification, record, etc.	2.0	20
15	Technology to assist in the assessment of potential problems for LE personnel from exposure to violent situations and images	1.9	21.5
7	Develop means for measuring public and criminal uses of technology and countermeasures to LE uses of technology	1.9	21.5
27	Research on technologies that can "see" or sense threats at a distance	1.8	24
2	Research on providing "honest brokers" to assess performance of technological systems and disseminate the results	1.8	24
9	Capabilities to exploit a wide range of robotics/autonomy technologies	1.8	24
16	Research on virtual/holographic remote presence technologies	1.3	26.5
4	Best practices to exploit emerging technologies and practices from the military, while also mitigate negative consequences of using military technologies	1.3	26.5
23	Develop "opt-in and opt-out" sensors for public areas that allow people to have more control over the data collected on them, along with security provisions to ensure protection of the public	1.1	28
10	Improve understanding of how LE can use emerging cognitive technologies	0.9	29
25	Understand state of research and LE implications and needs for "brain bots"	0.6	30

median, the sum of all diagonal cell entries, divided by 29 cells). This Average Chance+1 says that, on average, a need has a 42 percent chance to be ranked the same or higher than the need ranked immediately above it. Thus, the uncertainty of the ranking is relatively large, especially between closely ranked needs. We can also generalize this to Average Chance+n to see how the chance declines as n or ranking distance increases. Based on the comparison in the above two paragraphs and the uncertainties in our rankings observed in Tables D.5 and D.7, we find that the rankings using median and average as the ranking metric perform equally well.

Table D.8 shows the rankings using both metrics. As noted above, the top seven needs are the same using both metrics, and could thus form a top tier. At the other end of the rankings, Needs 25, 23, 10, 16, 2, 4, and 9 are ranked lowest using both metrics, and could thus form a bottom tier.[8] So one possible set of priority tiers would be the top seven in Tier 1, the bottom seven (perhaps plus Need 15) in Tier 3, and the remaining 15 or 16 needs in Tier 2.

An alternative set of priority tiers can be based on the observation above that the median and average metrics provide equally valid rankings, according to the Wilcoxon rank-sum test analysis. In this case, we would include in Tier 1 all the needs ranked in the top ten using either metric (shaded yellow in Table D.8), which would be the top seven, plus Needs 17, 19, 24, 8, and 11. Tier 3 would consist of all those needs ranked lower than twentieth using both median and average metrics, which would be identical to that of the previous paragraph, including Need 15. The remaining ten needs (shaded blue in Table D.8) would constitute Tier 2. The only difference between the two assignments to priority tiers is that five needs (17, 19, 8, 24, and 11) from Tier 2 in the first case would be promoted to Tier 1 in the second. Examination of Tables D.5 and D.7 supports including these five needs in Tier 1. Need 17 is ranked in the top ten by both methods; Needs 24 and 8 both have probabilities greater than 40 percent and close to 50 percent for moving up in both tables; Need 11 was ranked eighth using the average as ranking metric; and Need 19 was ranked 9.5th using the median as ranking metric.

[8] Need 15 is a borderline case. It is in the bottom group of eight according to Table D.2 based on medians, but is two rankings (or one since the two rankings are equal) higher than those in the bottom group of eight according to Table D.6. However, Table D.7 shows more than a 50 percent probability that two of the needs in the bottom group of eight, Need 2 and Need 9, should be ranked above Need 15.

Table D.7
Probabilities That Needs Should Be Ranked at Least as High as Higher-Ranked Needs Using Average as a Ranking Metric

Rank #	1	2.5	2.5	4	5	6	7	8	9	11	11	11	13	14.5	14.5	17.5	17.5	17.5	17.5	20	21.5	21.5	24	24	24	26.5	26.5	28	29
Need #	1	30	6	26	18	21	5	11	17	8	24	28	14	3	19	20	22	12	13	29	15	7	27	2	9	16	4	23	10
30	0.336																												
6	0.29	0.488																											
26	0.295	0.442	0.477																										
18	0.211	0.402	0.465	0.369																									
21	0.164	0.285	0.295	0.315	0.413																								
5	0.187	0.265	0.408	0.363	0.552	0.465																							
11	0.078	0.16	0.22	0.203	0.363	0.413	0.305																						
17	0.024	0.063	0.102	0.099	0.164	0.233	0.16	0.396																					
8	0.021	0.051	0.061	0.099	0.131	0.224	0.175	0.32	0.43																				
24	0.002	0.007	0.047	0.083	0.024	0.061	0.035	0.297	0.392	0.452																			
28	0.027	0.036	0.059	0.087	0.16	0.157	0.147	0.251	0.358	0.402	0.512																		
14	0.025	0.051	0.074	0.061	0.143	0.168	0.113	0.256	0.425	0.477	0.56	0.374																	
3	0.009	0.031	0.048	0.039	0.063	0.134	0.048	0.168	0.27	0.396	0.41	0.419	0.374																
19	0.007	0.024	0.03	0.039	0.074	0.157	0.064	0.228	0.347	0.488	0.548	0.408	0.483	0.57															
20	0.008	0.015	0.044	0.039	0.072	0.083	0.048	0.16	0.228	0.3	0.416	0.369	0.38	0.471	0.436														
22	0.009	0.024	0.048	0.029	0.078	0.116	0.047	0.137	0.224	0.285	0.392	0.341	0.336	0.465	0.402	0.477													
12	0.006	0.012	0.02	0.021	0.057	0.085	0.033	0.107	0.15	0.211	0.341	0.28	0.38	0.385	0.32	0.369	0.408												
13	0.003	0.015	0.041	0.021	0.061	0.097	0.022	0.191	0.22	0.305	0.392	0.347	0.315	0.558	0.448	0.494	0.564	0.631											
29	0.005	0.008	0.02	0.02	0.061	0.057	0.05	0.099	0.134	0.14	0.202	0.246	0.275	0.325	0.207	0.385	0.391	0.419	0.396										
15	0.005	0.006	0.011	0.014	0.036	0.037	0.03	0.042	0.066	0.085	0.134	0.124	0.207	0.153	0.107	0.199	0.256	0.246	0.187	0.325									
7	0.002	0.009	0.017	0.015	0.039	0.072	0.028	0.134	0.164	0.207	0.282	0.285	0.285	0.402	0.295	0.425	0.459	0.541	0.363	0.592	0.789								
27	0.002	0.002	0.007	0.009	0.028	0.03	0.033	0.068	0.099	0.116	0.173	0.215	0.233	0.246	0.15	0.347	0.358	0.419	0.275	0.517	0.71	0.32							
2	0.002	0.003	0.008	0.011	0.028	0.02	0.017	0.054	0.068	0.083	0.144	0.121	0.237	0.199	0.124	0.211	0.27	0.325	0.275	0.347	0.558	0.27	0.31						
9	0.002	0.003	0.007	0.008	0.03	0.024	0.029	0.072	0.081	0.066	0.083	0.127	0.203	0.207	0.113	0.265	0.29	0.265	0.28	0.358	0.558	0.251	0.408	0.517					
16	2E-04	3E-04	9E-04	9E-04	0.004	0.002	0.002	0.006	0.009	0.011	0.015	0.019	0.045	0.04	0.018	0.054	0.064	0.057	0.05	0.076	0.215	0.044	0.087	0.15	0.14				
4	1E-04	2E-04	6E-04	6E-04	0.002	0.003	0.002	0.005	0.009	0.011	0.021	0.028	0.022	0.037	0.008	0.059	0.044	0.066	0.032	0.134	0.26	0.036	0.105	0.237	0.22	0.664			
23	4E-05	1E-04	2E-04	2E-04	7E-04	0.001	4E-04	0.001	0.002	0.003	0.005	0.004	0.004	0.01	0.002	0.01	0.013	0.008	0.006	0.024	0.066	0.01	0.023	0.026	0.056	0.242	0.168		
10	2E-05	2E-05	4E-05	5E-05	4E-04	4E-04	8E-05	4E-04	5E-04	1E-03	0.003	7E-04	0.004	0.002	0.001	0.003	0.007	0.003	0.003	0.009	0.026	0.004	0.006	0.006	0.017	0.078	0.092	0.419	
25	6E-06	7E-06	7E-06	1E-05	5E-05	7E-05	2E-05	5E-05	6E-05	8E-05	3E-04	1E-04	4E-04	2E-04	9E-05	3E-04	9E-04	5E-04	2E-04	0.001	0.003	4E-04	8E-04	9E-04	0.004	0.012	0.014	0.078	0.121

Table D.8
Ranking of Needs by Median and Average Expected Value

Need #	Short Description of Need	Median	Average	Ranked by Median	Ranked by Average
1	Develop educational material on social media to better engage the public and improve internal communications	3.9	3. 6	1	1
5	R&D on technologies to use information more effectively	3.6	2.9	2	7
26	Research on the use of tagging and tracking technologies	3.5	3.2	3.5	4
18	Research on methods to disseminate innovative, promising practices across LE agencies	3.5	3.1	3.5	5
6	Improve training suitable for new technologies	3.1	3.3	5.5	2.5
30	Develop technologies and processes to support data sharing	3.1	3.3	5.5	2.5
21	Research on recognizing and dealing with legal and policy constraints for information sharing	2.7	3.0	7	6
17	Improved translation technologies	2.3	2.5	9.5	9
19	More R&D on ethics development	2.3	2.2	9.5	14.5
8	Update LE agency recruiting practices	2.3	2.4	9.5	11
24	Methods to permit LE personnel to create and use artificial identities	2.3	2.4	9.5	11
11	Technology to identify in the field when someone is under the influence from legal and custom-made drugs	2.1	2.8	12	8
7	Develop means for measuring public and criminal uses of technology and countermeasures to LE uses of technology	2.0	1.9	13.5	21.5
14	Identify and adapt business models that will facilitate LE agencies' recognizing new needs and updating and using technologies effectively	2.0	2.3	13.5	13
3	Improve technologies for safely defusing or disabling people, groups, and vehicles	1.8	2.2	15.5	14.5
27	Research on technologies that can "see" or sense threats at a distance	1.8	1.8	15.5	24
13	Identify LE resource needs and roles emerging from new technologies and uses by criminals and the public	1.7	2.1	19	17.5
28	Research on rules and procedures for going undercover in virtual worlds	1.7	2.4	19	11
20	Research on social aspects of improving information sharing and collaboration	1.7	2.1	19	17.5
22	Develop collaborations with CDC and other public health agencies to prepare for public health crises	1.7	2.1	19	17.5
29	Develop "super HR" systems that can track details about law enforcement personnel's training, certification, record, etc.	1.7	2.0	19	20
12	Research on leadership and leadership development suited for the network-enabled era	1.6	2.1	22	17.5
9	Capabilities to exploit a wide range of robotics/autonomy technologies	1.5	1.8	23.5	24

Table D.8—Continued

Need #	Short Description of Need	Median	Average	Ranked by Median	Ranked by Average
4	Best practices to exploit emerging technologies and practices from the military, while also mitigate negative consequences of using military technologies	1.5	1.3	23.5	26.5
2	Research on providing "honest brokers" to assess performance of technological systems and disseminate the results	1.4	1.8	25	24
16	Research on virtual/holographic remote presence technologies	1.3	1.3	26.5	26.5
15	Technology to assist in the assessment of potential problems for LE personnel from exposure to violent situations and images	1.3	1.9	26.5	21.5
10	Improve understanding of how LE can use emerging cognitive technologies	0.8	0.9	28	29
23	Develop "opt-in and opt-out" sensors for public areas that allow people to have more control over the data collected on them, along with security provisions to ensure protection of the public	0.7	1.1	29	28
25	Understand state of research and LE implications and needs for "brain bots"	0.4	0.6	30	30

Abbreviations

CDC	Centers for Disease Control and Prevention
EV	expected value
GPS	Global Positioning System
HR	Human Resources
IT	information technology
LE	law enforcement
MRAP	Mine Resistant Ambush Protected
NIJ	National Institute of Justice
NLECTC	National Law Enforcement and Corrections Technology Center
R&D	research and development
RFID	radio frequency identification
UAS	unmanned aerial system

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This report describes the results of the Law Enforcement Futuring Workshop, which was held at RAND's Washington Office in Arlington, Virginia, from July 22 to 25, 2014. The objective of this workshop was to identify high-priority technology needs for law enforcement based on consideration of current and future trends in society, technology, and law enforcement over a ten- to 20-year time period. During the workshop, participants developed sets of future scenarios, constructed pathways from the present to alternative futures, and considered how law enforcement use of technology might affect these pathways. They then identified technology needs (including training and changes in policies or practice) that, if addressed, could enable pathways to desirable futures or prevent or mitigate the effects of pathways to undesirable futures. On the final day of the workshop, the technology needs were prioritized using a Delphi method. The output of this workshop described in the report included ten future scenarios and 30 technology needs. The technology needs fell into three general categories—technology-related knowledge and practice, information sharing and use, and technological research and development—and were placed into three priority tiers.

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