Fostering Innovation in U.S. Law Enforcement

Identifying High-Priority Technology and Other Needs for Improving Law Enforcement Operations and Outcomes

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PRIORITY
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NEEDS INITIATIVE

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Preface

On behalf of the U.S. Department of Justice's National Institute of Justice, 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 in criminal justice.

This report is one product of that effort, completed as a joint effort of the RAND Corporation and the Police Executive Research Forum. It presents the results of the Second Law Enforcement Advisory Panel, a group convened in fiscal year 2016 as part of the NLECTC Priority Criminal Justice Needs Initiative to identify current challenges and innovation needs in the U.S. law enforcement system. This report and the results it presents should be of interest to law enforcement agencies seeking to make their own improvements, developers interested in learning about which new system capabilities might best be aligned with operational needs, and government researchers and funders interested in investment options that look promising but are too costly and risky for individual agencies to attempt today. This is the fourth in a series of separate sector-level reports on corrections, courts, and law enforcement intended to inform NIJ's program and research planning. For broader policymaker and public audiences, this report provides a window into problems identified with current law enforcement practices and systems, as well as possible solutions for improving performance going forward.

Other RAND research reports from the Priority Criminal Justice Needs Initiative that might be of interest include:

- Brian A. Jackson, Joe Russo, John S. Hollywood, Dulani Woods, Richard Silberglitt, George B. Drake, John S. Shaffer, Mikhail Zaydman, and Brian G. Chow, *Fostering Innovation in Community and Institutional Corrections: Identifying High-Priority Technology and Other Needs for the U.S. Corrections Sector*, Santa Monica, Calif.: RAND Corporation, RR-820-NIJ, 2015.
- John S. Hollywood, John E. Boon, Jr., Richard Silberglitt, Brian G. Chow, and Brian A. Jackson, *High-Priority Information Technology Needs for Law Enforcement*, Santa Monica, Calif.: RAND Corporation, RR-737-NIJ, 2015.
- Sean E. Goodison, Robert C. Davis, and Brian A. Jackson, *Digital Evidence and the U.S. Criminal Justice System: Identifying Technology and Other Needs to More Effectively Acquire and Utilize Digital Evidence*, Santa Monica, Calif.: RAND Corporation, RR-890-NIJ, 2015.
- Jackson, Brian A., Duren Banks, John S. Hollywood, Dulani Woods, Amanda Royal, Patrick W. Woodson, and Nicole J. Johnson *Fostering Innovation in the U.S. Court System:*

Identifying High-Priority Technology and Other Needs for Improving Court Operations and Outcomes, Santa Monica, Calif.: RAND Corporation, RR-1255-NIJ, 2016.

- Schwartz, Heather L., Rajeev Ramchand, Dionne Barnes-Proby, Sean Grant, Brian A. Jackson, Kristin Leuschner, Mauri Matsuda, and Jessica Saunders, *The Role of Technology in Improving K–12 School Safety*, Santa Monica, Calif.: RAND Corporation, RR-1488-NIJ, 2016.

RAND Justice Policy Program

The research reported here was conducted in the RAND Justice Policy Program, which spans both criminal and civil justice system issues with such topics as public safety, effective policing, police-community relations, drug policy and enforcement, corrections policy, use of technology in law enforcement, tort reform, catastrophe and mass-injury compensation, court resourcing, and insurance regulation. 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 Principal Investigator of the Priority Criminal Justice Needs Initiative, Brian A. Jackson, at Brian_Jackson@rand.org. For more information about RAND Justice Policy, see www.rand.org/jie/justice-policy or contact the director at justice@rand.org.

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Summary

Society depends on law enforcement to play a number of key roles. Foremost among these is protecting the public from crime; as far back as 1828, Sir Robert Peel's "Principles of Law Enforcement" noted that the "basic mission for which police exist is to prevent crime and disorder" (Durham Constabulary, 1829). Society also depends on law enforcement to hold offenders accountable, as well as to provide security and first-responder support during events, incidents, and emergencies. In carrying out these tasks, law enforcement officers are charged with maintaining safety for bystanders, offenders, and themselves. They also are charged with maintaining positive relations and trust with the communities they serve, giving life to the widely cited "Principles" statement that "the police are the public and the public are the police." Research and technology can play key roles in helping law enforcement agencies carry out these missions, both in helping agencies better understand the challenges they face and in addressing those challenges with innovative, comprehensive, and cost-effective solutions.

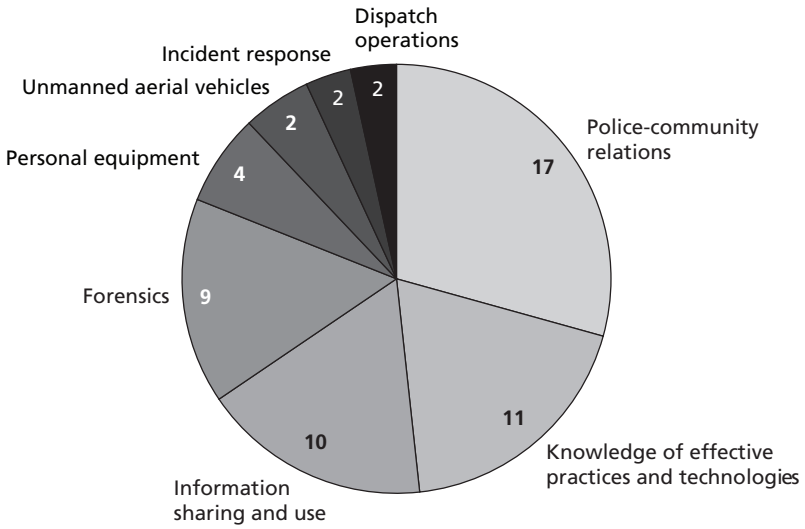
To help create the science and technology innovation agenda for law enforcement, the National Institute of Justice tasked RAND to host the Second Law Enforcement Advisory Panel (LEAP 2).[1] This panel of law enforcement experts identified and prioritized *needs* for law enforcement. In this context, a need is a requirement from the panelists for research, development, or dissemination of a *product* or *service* to help solve an operational problem facing law enforcement or take advantage of an opportunity (such as new technologies coming on line). Products and services can include materiel items, such as improved equipment or software, and nonmateriel items, such as new policies, regulations, processes, and organizational structures.

In two sessions, one focused on operational-level, "on-the-street" law enforcement issues and one focused on strategic and administrative issues, the panel collectively generated and prioritized 154 needs. These needs were roughly split among one-third relating to information technology; one-third regarding management, practices, and training (i.e., nonmateriel needs); and the remaining one-third touching on a variety of topics, including physical forensics, personal equipment, weapons, facilities, and vehicles. Of these, 51 needs fell in the highest-priority category (Tier 1 of three tiers, based on the panel rankings).

Reviewing the Tier 1 needs, we identified commonalities, or *themes*, cutting across them. Figure S.1 shows the breakdown of the high-priority needs into these themes. Over 80 percent of the Tier 1 needs fall within four themes; the remaining 20 percent fall within an additional four themes.

[1] RAND hosted the first LEAP in 2013 (Hollywood, Boon, et al., 2015), which focused heavily on information technology needs.

Figure S.1
Top Themes Emerging from LEAP 2



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Each of the themes is discussed below.

There is a demand for effective practices and technologies to improve practitioners' knowledge of technologies and how to use them. Effectively educating practitioners about new process and technology developments is necessary for almost all efforts to field innovations to succeed, so this theme helps satisfy a universal necessary condition for success. Further, almost all of the Tier 1 needs included elements related to informing and educating practitioners.

At the core of needs under this theme was a call for an information repository. This, ideally, would be a single source (or at least a pointer or search service) for capturing and sharing law enforcement information. The repository would provide results on processes and technologies, reviews of systems and products, case studies on agencies' experiences with new systems (including costs), model policies and procedures, and data on funding resources.

Also under this theme were needs calling for "research on publicity and training"—calls to improve how scientific results, technologies, and funding information are disseminated to law enforcement, and how law enforcement is trained and educated.

There is a call for effective practices and technologies to improve police-community relations. According to the panelists, the very high interest in this theme is being driven largely by the social and political tensions raised in recent years, in the wake of officer-involved shootings and civic unrest in Ferguson, Missouri, and Baltimore, Maryland. Under this theme, panelists had Tier 1 needs on improving how agencies inform the public; conducting research and evaluation on policing strategies that are community-centric; improving encounters with the public, including research and training development on deescalation and procedural justice; and creating tools and databases to collect and act on community feedback, with the caveat that agencies must genuinely act on the feedback they receive. Panelists noted a lack of adequate mental health, crisis, and social services resources for both the community and law

enforcement practitioners and called for a study to assess the extent of the shortfalls in regional and local treatment, and their implications.

There is a need to improve the sharing and use of information. For Tier 1 needs under this theme, panelists called for research on how to get crime analysis capabilities to all law enforcement agencies, including those with limited resources, through federal support and cost-sharing/part-time analyst models. Panelists noted the problem of officers being overloaded with information and called for assisting developers in identifying which pieces of information are most needed and when to support operations. Other needs to facilitate information sharing and use include supporting federated searching across government and commercial systems, developing model interoperability language for record management system (RMS) requests for proposals, and disseminating core cases that show the operational value of certain types of information sharing.

There is a need to improve forensics capabilities. Most Tier 1 needs here concerned remediating forensics backlogs and the lack of resources driving them. These included studying backlog impacts and shared-service models for forensics. They also included calls for the U.S. Department of Justice (DOJ) to broaden grants to address forensics modes besides DNA.

There is a need to improve a range of personal equipment and practices for using them. Tier 1 needs here included calls for best practices for selecting personal gear, determining when to turn body-worn cameras on and off, video management, and assessing body armor advances.

There is a need to develop policies and core use cases for unmanned aerial vehicles (UAVs). These should build off of existing model policies and use cases, such as those developed by the International Association of Chiefs of Police (IACP).

There is a need to improve dispatch center operations. Tier 1 needs include calls to assess costs and benefits of consolidating dispatch operations, as well as improve the question trees used by 911 call operators.

There is a need to improve defenses against active shooters. The first Tier 1 need here called for improving processes for handling weapon-related suspicious activity reports (notably formal reports about suspicious purchases from federally licensed firearm dealers).

There is a need to identify requirements for technologies to improve officers' physical and mental health. Panelists prioritized research and development for health purposes highly, but developed few specific needs during LEAP 2. It may be worthwhile to have an expert panel focused on physical and mental health innovations for law enforcement.

Table S.1 is a roadmap describing potential ways ahead to address the highest-priority needs emerging from LEAP 2. We have placed the needs and corresponding options for innovation in the same order as the themes above: practitioners' knowledge of effective practices and technologies, police-community relations, information sharing and use, forensics, and others.

Law enforcement today is facing a number of challenges, including problems maintaining high levels of public trust and confidence, a rise in homicides and other violent crime that includes a spike in attacks on officers, continued budget and resourcing pressures, and shortages of officers. Technology and research, combined with effective means of disseminating the results, provides an important pathway to help address these challenges. It is the hope of the panel and the authors that the needs discussed in this report will help prioritize research, development, and dissemination efforts in ways that will provide the greatest value to our law enforcement practitioners.

Table S.1
A Short-Term Roadmap for Law Enforcement Innovation

Theme	Need	Innovation Options
Knowledge of effective practices and technologies: repository	Research results repository **General comment:** All the findings resulting from studies and analyses done in response to priority needs from LEAP 2 and other expert panels will need to be added to the repository.	Rapidly develop a prototype site that links (and supports federated search) to key articles in other resources. As examples, link to CrimeSolutions.gov for practices; justnet.org for materiel information; and the Bureau of Justice Assistance, other government agencies, and associations on a wide range of policies, processes, and technical references. Note that the site may be an extension to an existing law enforcement portal, to leverage existing resources.
	Model contracts (in repository) that include sustainment costs	Work with other government agencies and associations to prepare the model language and identify examples.
Knowledge of effective practices and technologies: improving management practices	Brief explanation of evidence-based management	Develop a flyer explaining evidence-based management and listing key evidence-based program repositories (e.g., CrimeSolutions.gov; NIJ, 2016).
	Guidance on change management	Review change management references to produce a quick guide on using core techniques in law enforcement.
Knowledge of effectives practices and technologies: improving training	Training methods taxonomy	Review prior training materials to produce an initial taxonomy.
Police-community relations: strategies	Research and evaluation (R&E) on sectoral/community policing practices	Review prior references to produce a quick guide on what seems to work best.
	Measures for evaluating community relations activities	Review prior references to produce an article on suitable measures.
Police-community relations: problematic encounters	R&E on deescalation and procedural justice training	Conduct a brief study on current training materials and prepare a quick assessment for practitioners.
Police-community relations: educating the public	Articles on true prevalence of police misconduct	Review prior references to produce an article on what is known and what is not.
Information sharing and use: RMS integration	Model interoperability language for RMS	Work with global nongovernmental organizations, government agencies, and associations to develop the needed language. The language needs to list specific, testable standards with which the RMS should comply.
Forensics: backlogs	Mitigate forensics backlogs	Develop new grants and/or extend existing grants to cover non-DNA backlogs. Conduct studies on the extent of the problem and resource-sharing workarounds. Conduct a survey study on the impacts of the backlogs on the criminal justice system.
Forensics: excess evidence	Impact of excess evidence	Conduct a study on the impacts of excess evidence. Review prior legal references to identify a framework for evidence discard decisions.
Other: UAVs	Model policy and use cases	Work with the IACP to extend and publicize the IACP model policy and concept documents in this area and identify relevant information from other groups examining UAV deployment (e.g., DOJ, Federal Aviation Administration).

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We would also like to acknowledge the contributions of James Torr to improving the language and presentation of the report.

Abbreviations

BJA	Bureau of Justice Assistance
CAD	computer-aided dispatch system
DHS	U.S. Department of Homeland Security
DoD	U.S. Department of Defense
DOJ	U.S. Department of Justice
EV	expected value
IACP	International Association of Chiefs of Police
IT	information technology
LEAP	Law Enforcement Advisory Panel
NIBRS	National Incident-Based Reporting System
NIEM	National Information Exchange Model
NIJ	National Institute of Justice
PSAP	public safety access point
R&D	research and development
R&E	research and evaluation
RMS	record management system
SWAT	special weapons and tactics
UAV	unmanned aerial vehicle

CHAPTER ONE

Introduction

The National Institute of Justice (NIJ) has tasked RAND to manage the Priority Criminal Justice Needs Initiative to identify and prioritize the most pressing technology, policy, and practice needs for the criminal justice system. The initiative's principal activities are expert panels that generate and prioritize *needs for innovation* across a criminal justice community of practice (law enforcement, courts, and corrections). This report covers the needs generated by the Second Law Enforcement Advisory Panel (LEAP 2), which met in 2016.

In this context, a *need* is a requirement from our expert panelists for research, development, and/or dissemination of a *product* or *service* to help solve a pressing law enforcement problem or take an advantage of an opportunity (such as emergence of a new type of technology). Products and services can include materiel items, such as improved equipment or software, and nonmateriel items, such as new policies, regulations, processes, training, and organizational structures. All can be considered science and technology needs, across a full range of physical, social, and management sciences.

To identify and prioritize needs, the initiative recruits a combination of senior and up-and-coming mid-level expert practitioners, academics, and advocates who are at the cutting edge in a range of areas of their field of practice. Panelists also reflect a range of different types and sizes of agencies.

As of 2016, RAND has conducted advisory panels focusing on corrections, courts, and school safety (Schwartz et al., 2016) and a pilot Law Enforcement Advisory Panel (LEAP 1). Held in 2013, LEAP 1 focused largely on information technology (IT)-related needs for law enforcement (Hollywood, Boon, et al., 2015). LEAP 2, in comparison, covered a full range of law enforcement problems, opportunities, and responses, including needs related to vehicles, facilities, personal equipment, personnel development, and training, as well as IT.

LEAP 2 took place over the course of three days, broken into two 1.5-day sessions. The first session was devoted to operational policing issues; the second session was devoted to strategic-level and administrative issues. Participants had the option to stay for the entire three days if they wished to participate in both sessions. *Operational policing* focused on needs in support of officers in the field, including patrol, crisis intervention/field mental health, criminal investigations in the field, and special units, such as special weapons and tactics (SWAT), canine, narcotics, vice, and aviation. *Strategic and administrative policing* focused on command at agency and district levels, public safety access points (PSAPs, which are best known as 911 call and dispatch centers), agency IT, crime analysis, forensic labs, legal affairs, media relations, and personnel and general administration.

The core result of LEAP 2 is a list of prioritized needs for law enforcement, along with a set of higher-level themes that capture the main takeaways cutting across groups of needs.

The themes and constituent needs together are intended as a menu of potential innovations to address key problems or capitalize on emerging opportunities. They are intended for law enforcement agencies seeking to make their own improvements, developers interested in learning about which new system capabilities might best be aligned with operational needs, and government researchers and funders interested in investment options that look promising but are too costly and risky for individual agencies to attempt today.

Considering the Need for Innovation in U.S. Law Enforcement

Society depends on law enforcement to play a number of key roles in society. Foremost among these is protecting the public from crime (i.e., helping prevent crime from occurring); as far back as 1828, what are commonly referred to as "Sir Robert Peel's Principles of Law Enforcement" were provided to new members of the London Metropolitan Police and noted that the "basic mission for which police exist is to prevent crime and disorder" and that "the test of police efficiency is the absence of crime and disorder" (Durham Constabulary, 1829). Society also depends on law enforcement to respond to crime and hold offenders accountable by identifying those who committed crimes, and to respond to a range of incidents and emergencies to provide first responder and security support. In carrying out these tasks, law enforcement is charged with maintaining safety for bystanders, offenders, and themselves during enforcement activity. More broadly, they are charged with maintaining positive relations and trust with the communities they serve, giving life to the widely cited "Principles" statement that "the police are the public and the public are the police."

Today, law enforcement agencies face several major challenges as they seek to carry out these objectives. The first is overcoming shortfalls of trust and confidence with the communities they serve. Community trust and confidence, in addition to being a core principle of modern policing, are vital to protecting communities from crime, in two ways. First, people are more likely to obey the law when they believe the law and law enforcement are legitimate (Tyler, 2006; Jackson et al., 2012). Second, they are more likely to cooperate with police (Tyler and Fagan, 2008; Tyler and Jackson, 2014), which is necessary both to hold offenders accountable and keep crime levels low in general (e.g., Sampson, Raudenbush, and Earls, 1997, demonstrate how a "willingness to intervene on behalf of the common good" is a key factor for having reduced violence).

Nationally, following comparatively low levels in trust of and confidence in police in 2015 after controversial uses of force and civil unrest in several cities, ratings surged in 2016. However, trust and confidence is not uniform across the U.S. population, with ratings from whites being significantly higher than ratings from nonwhites (according to Gallup polls, e.g., McCarthy, 2016; Newport, 2016). In addition, in some areas, shortfalls in police trust and legitimacy can be significant. A 2016 survey of residents in zip codes having the highest rates of violent crime in four cities (Chicago, Milwaukee, Memphis, and Oakland) found that respondents voted for "police brutality" and "crime" as top issues for their community about equally (20 percent each); and, alarmingly, almost one-quarter of respondents said either that they would prefer to be stopped by a gang member rather than a police officer or that they were ambivalent about the question (Towery, 2016). U.S. Department of Justice (DOJ)-funded research has indicated there is some evidence for the 2015 rise in homicide rates being explained by a "Ferguson effect" (following controversial police uses of force and subsequent

unrest in Ferguson, Missouri, and other U.S. cities) involving potential reductions in proactive police activity due to reluctance on the part of officers, changes in the behavior of violent criminals, crises in police-community relations and police legitimacy in specific jurisdictions, or some combination of multiple effects (Rosenfeld, 2016).

Today's technologies are heavily affecting how police-community tensions are playing out. Just about any bystander equipped with a mobile phone can record almost any police-civilian encounter and then share that recording with the world through social media. Cameras of all types, including police body-worn and dashboard-mounted cameras, have given the public a never-before-seen view into police work and have raised the expectations of how open and transparent law enforcement will be about their activities. At the same time, mobile technology has created tremendous new opportunities—and challenges—for police agencies seeking to solve crimes through the collection and analysis of digital evidence (Jackson, 2015).

Second, police are facing a challenge in responding to increases in homicides. While still far below rates of the 1980s and 1990s, 2015 saw close to an 11 percent increase in the national homicide rate (Federal Bureau of Investigation, National Press Office, 2016). Further, an early estimate (Asher, 2017) is that 2016 saw an additional 8 percent increase in the homicide rate, primarily due to surges in a number of major U.S. cities. This is a close to 20 percent increase in the national homicide rate in just two years. As Asher notes, "a worrisome long- term trend requiring research and abatement might be developing."

Third, police face these major challenges in what continues to be a logistically challenging environment. At a past conference, the president of the International Association of Chiefs of Police (IACP) noted that the top three challenges facing departments were "budget, budget, and budget," due to ongoing consequences from the 2008 financial crisis and subsequent recession (IACP, 2011), and past RAND research has noted the major difficulties agencies face in affording new systems (Gordon et al., 2012). National media frequently reports on police agencies having substantial difficulties recruiting officers, as well (e.g., *The Economist*, 2017; Libaw, 2016). Given a strong correlation between adding officers and reducing crime (Heaton, 2010), such difficulties may pose risks to agencies' capabilities to protect the public from crime going forward.

Given these challenges, it is not surprising that there is a strong need to identify and prioritize needs for innovation in law enforcement. On just about any of the critical issues facing the profession today, there is a need for empirical research and a resulting body of knowledge to help practitioners and policymakers not only to understand the underlying issues, but also to develop effective solutions that can stand the test of rigorous evaluation.

Organization of This Report

To set the stage for the discussion of the needs, Chapter Two describes the state of U.S. law enforcement today and significant challenges driving the need for innovation. The chapter was written by the Police Executive Research Forum to capture the most pressing concerns it has heard from the law enforcement field in its many discussions with law enforcement leaders (and leaders of other organizations) over the past few years, backed with evidence captured in a range of scholarly articles.

Chapter Three describes the current state of law enforcement technology and practice, as well as previously generated needs for law enforcement. It describes how the Priority Criminal

Justice Needs Initiative categorizes criminal justice needs and technologies (products and services). It then summarizes key findings from earlier initiative research on both the current state of the art and what remains to be done to meet operational demands.

Chapter Four describes the processes for how LEAP 2 identified and prioritized needs in technology, policy, and practice. It then describes general trends in the needs identified by the LEAP 2 panelists and concludes with the highest-priority needs for innovation emerging from LEAP 2.

Finally, Chapter Five presents conclusions. It discusses the top takeaways from LEAP 2 and presents a near-term roadmap for innovation to address the highest-priority needs.

CHAPTER TWO

The State of U.S. Law Enforcement Today

Summary

Law enforcement in the United States today is facing an array of challenges:

- **Public trust and confidence in the police remains problematic**, particularly in low-income, largely minority communities (Morin and Stepler, 2016). The fact that some high-profile encounters, such as in Ferguson, Missouri, have involved white officers and black subjects may serve to fuel racial tensions (Cochran and Warren, 2012). This lack of confidence in police has contributed to large and sometimes violent protests, not just in the cities where the incidents occurred, but across the country. In a recent Pew Research Center survey, 86 percent of police surveyed said that "fatal encounters between blacks and police have made their jobs harder" ("Protests Against Police Violence Continue Across U.S," 2016).
- After years of decline, a number of jurisdictions have experienced **a rise in homicides and other violent crime**, according to a report released by the Major Cities Chiefs Association (2016). Some police officials have suggested the recent crime increases have been the result of the so-called "Ferguson effect" (Wolfe and Nix, 2016; Maciag, 2016) or a reluctance on the part of both police and community members in the current environment to work proactively and cooperatively to address crime, although recent literature has cast doubt on the generalizability of this effect nationwide (Pyrooz et al., 2016).
- There has also been a recent **increase in premeditated, ambush attacks on the police**, according to data collected by the National Law Enforcement Officers Memorial Fund (2016). Some of them, like the July 7, 2016, killings of five officers in Dallas, appear to have been motivated by anti-police hatred tied to use-of-force incidents (Fernandez, Pérez-Peña, and Bromwich, 2016). This environment may have contributed to **increasing fear among officers for their own safety**, as measured in a recent Pew poll (Morin et al., 2017).
- Across the country, **police officers perceive that they are facing greater scrutiny than ever before** (Morin et al., 2017). This scrutiny may come from individuals equipped with cell phone video cameras, activist groups, news media, or the federal government. The DOJ Civil Rights Division was more active initiating examinations of agency policies and practices from 2012 to 2017 than ever before (U.S. Department of Justice, Civil Rights Division, 2017, pp. 44–47), although the Attorney General has signaled a change in direction on this front (U.S. Department of Justice, Office of the Attorney General, 2017).

- Police agencies face **continued budget pressures and shortages of officers** (Police Executive Research Forum, 2017), driven in part by ongoing challenges in recruiting, hiring, and retaining not just a sufficient number of officers, but also the diverse and high-caliber professionals best suited for policing in the 21st century (Wilson et al., 2010). Eighty-six percent of officers in the aforementioned Pew poll (Morin et al., 2017) reported that their agency had too few members to adequately police their community.
- Law enforcement is facing an **overload of data and insufficient staffing** and resources to manage it. This pressure is especially acute in such emerging areas as digital evidence collection and analysis, which is becoming increasingly important to solving many crimes (Goodison et al., 2015).
- Agencies nationwide continue to **search for effective strategies that reduce crime *and* build community trust**. Yet, the policing profession lacks a robust capacity to conduct and broadly disseminate research that will help guide agencies in figuring out what works and what does not.[1]

Another feature of modern policing is the impact of technology. Addressing these issues requires leveraging innovative technology to understand the scope of challenges and to develop effective, comprehensive, and cost-effective solutions. Technology is being increasingly brought to bear in policing, and the profession has entered a new era of data-driven, evidence-based approaches to tackling problems (Sherman, 2013). From data analytics and digital evidence to body-worn cameras and social media, police agencies are increasingly relying on, and being challenged by, new technology. Such technology is being used to assist with potential solutions to contemporary challenges. Given the myriad of difficult issues facing law enforcement today, the reliance on technology may become even more critical, and more challenging, in the future.

The purpose of this chapter is to provide a contemporary narrative review of modern American policing. This modern history and associated challenges have been directly influenced by police use of, and reaction to, technology. Without a way to efficiently address and prioritize technology and operational needs, police will be at a disadvantage in developing effective solutions to the critical issues of the day.

Changes to the Policing Landscape from Officer-Involved Deaths and Subsequent Protests

When Police Officer Darren Wilson shot and killed Michael Brown, an unarmed African-American teenager, during a confrontation in Ferguson, Missouri, on August 9, 2014, few could have predicted how swiftly and dramatically that one incident would shape the national discussion around policing in the United States. By the next day, and for more than a week, large, often violent protests were a nightly occurrence in Ferguson and, eventually, in many

[1] A practitioner-researcher association intended to address the lack of research and dissemination on strategies that are both effective and equitable has recently been established: the American Society of Evidence-Based Policing. As one major example, Gill et al. (2014) note a general lack of clarity and consensus about what constitutes "community-oriented policing" in their meta-analysis of community-oriented policing evaluations. An earlier National Academies study similarly noted a lack of clarity and consensus on what constituted both community-oriented policing and problem-oriented policing (National Research Council, 2004).

other communities as well. Ferguson-area businesses were vandalized, and some were set on fire. Though the subsequent DOJ investigation into the shooting largely supported the officer's account and declined to bring criminal charges, the national conversation was already well under way (U.S. Department of Justice, 2015).

Of course, Ferguson was not the only recent high-profile police encounter involving the death of an African-American citizen. Three weeks earlier, Eric Garner was selling loose cigarettes on a sidewalk in Staten Island when he was approached by members of the New York City Police Department. When officers attempted to arrest Garner, a confrontation ensued, with one officer grabbing Garner around the neck area and taking him to the ground; he lost consciousness and died, and the medical examiner ruled the death a homicide. In the months that followed the deaths of Eric Garner and Michael Brown, a series of fatal encounters between mostly white police officers and African-American citizens—Tamir Rice in Cleveland, Freddie Gray in Baltimore, Laquan McDonald in Chicago, and many others—sparked a wave of protests against police actions in cities across the country.

In the process, the term "Ferguson" would become shorthand not just for the Michael Brown shooting and its immediate aftermath. It would come to represent the beginning of an intensive public examination of police use-of-force policies, training and tactics, and how police interact with the community, especially communities of color.

Gaps in the Data on Lethal Uses of Force

The sudden focus on officer-involved shootings prompted policymakers, the news media, and the public to ask what seemed to be a straightforward question: How many people die in encounters with police officers every year? The answer, as most criminologists and police chiefs already knew, was "We don't know." One of the most important issues confronting law enforcement today is a lack of comprehensive and reliable information. Right now, the FBI reports annually the number of justifiable homicides by law enforcement officers, but those data are extremely limited. First, the counts include only those cases in which the subject was killed while committing a felony. The counts are also subject to underreporting, because the FBI relies on voluntary reporting by individual police agencies. From 2011 to 2015, the FBI reported just fewer than 2,200 justifiable homicides by law enforcement officers, or about 439 per year.[2]

To plug this gap in the data, FBI director James Comey announced in 2015 that the bureau was developing a new system to collect and publish more complete and accurate statistics on police use of force (Comey, 2014). The FBI established a working group to research and make recommendations on how the additional use-of-force data will be collected, analyzed, and released (Federal Bureau of Investigation, no date). Pilot-testing is scheduled to begin in 2017 (Horwitz and Berman, 2016). While agencies may collect more detailed, reliable use-of-force data internally (Skogan and Frydl, 2004, pp. 259–262), reporting that information for

[2] Federal Bureau of Investigation, *Crime in the United States*, 2015, Expanded Homicide Data Table 14, "Justifiable Homicide." Note also that justifiable homicide data are based on the FBI's Supplementary Homicide Reports (see U.S. Department of Justice, Office of Juvenile Justice and Delinquency Prevention, 2015), which has different reporting requirements from standard Uniform Crime Reporting data. As a result, some states either do not report these data or report a limited count based on definitional issues of what is considered "justifiable."

a standardized national collection in a timely fashion may create new challenges (Stephenson, 2011, p. 1430). The research literature on use-of-force incidents lacks generalizability because most studies can rely only on a single agency (Klinger et al., 2015; Lee, Vaughn, and Lim, 2014) or limited pool of incidents (Nix et al., 2017; Hine et al., 2016). But, for the profession as a whole, the new national system should help answer fundamental questions about police use-of-force trends.

Another federal response to the lack of comprehensive data collection is through the Death in Custody Reporting Act (DICRA; Pub. L. 106-297), a 2000 law implemented primarily through the Bureau of Justice Statistics. DICRA called for data on all deaths taking place within the process of arrests or within custody of the criminal justice system (Bureau of Justice Statistics, 2017). Data were collected covering 2003–2011, with improvements in coverage over time. DICRA was reauthorized in 2013, with a hope of building on previous lessons to improve coverage through open-source data to augment official data (Banks, Couzens, and Planty, 2015).

In the meantime, a number of private organizations and individuals have started operating their own databases in an attempt to quantify civilians' fatal encounters with law enforcement. Two news organizations in particular—the *Washington Post* and *The Guardian*—have created extensive use-of-force databases that rely on open-source data, such as news reports, public records, and other sources. For 2015, the *Washington Post* found that 991 individuals were shot and killed by U.S. police officers (*Washington Post*, no date). *The Guardian*, which records both fatal shootings and other in-custody deaths, reported 1,134 deaths in 2015 (Swaine et al., 2015). Additionally, the two news databases are revealing estimates about the nature of those encounters not measured elsewhere. For example, the *Washington Post* analysis found that in close to 60 percent of the fatal shootings the subject was either shooting at officers or someone else (28 percent) or was pointing a gun (31 percent). However, these and other efforts remain a work in progress.

Video Recording and Policing

One factor that has helped to propel police use of force to the forefront of law enforcement issues in the United States is the growing presence of video. Whether captured on bystanders' cell phones, private security systems, or police dashboard and body-worn cameras, video has drastically changed the public's ability to get an up-close, though often incomplete, look at encounters between the police and members of the public. The ubiquitous nature of video may also alter public expectations around whether, and how quickly, they will be able to view police-captured video, especially following a use-of-force incident.

Not only are there more cameras capturing more police-citizen encounters—video images, especially those captured by the public, are now being shared more widely and instantaneously over social media (Bayly, 2016). If a critical incident such as an officer-involved shooting is captured on private video, agencies must expect that the video will be viewed almost instantaneously by thousands of people across the country and around the world. They must also know that, in today's environment, a single controversial incident captured on video can immediately thrust an officer and an agency into the 24-hour, worldwide news cycle.

That was the case in April 2015, when North Charleston, South Carolina, police officer Michael Slager pulled over Walter Scott for a broken tail light. Scott got out of his car and

started to run. In his report of the incident, Officer Slager said he struggled with Scott and that Scott attempted to take his electronic control weapon (ECW), prompting the officer to shoot and kill Scott. It was not until a bystander's video of the encounter was released that a different narrative emerged: Following the struggle, Officer Slager deployed his ECW but Scott continued to run away. At that point, Officer Slager drew his service weapon and fired eight shots, striking Scott in the back. The video further showed that Officer Slager went back to retrieve an object from the ground, presumably his ECW, and then dropped it near the body to support his version of events (Knapp, 2015). Officer Slager pled guilty to a federal charge of deprivation of rights under the color of law in May 2017 (Yan, Shah, and Grinberg, 2017).

In another high-profile incident captured on a police dash-cam, 17-year-old Laquan McDonald was walking in the middle of a street holding a knife when he was shot 16 times and killed by Chicago police officer Jason Van Dyke in October 2014. Initial reports from a representative of the Chicago Fraternal Order of Police suggested that McDonald acted in a menacing fashion and lunged at officers when he was shot. However, the dash-cam video, released publicly more than a year after the incident, revealed that McDonald was not acting aggressively and may have been walking away from police when he was shot (Shoichet, 2015).

In both of these cases, initial police reports were inconsistent with video evidence, causing anger and protests in these communities and further undermining public trust in the police in general.

The McDonald case and others illustrate another challenge confronting police agencies: when to release video of an officer-involved shooting or other in-custody death. On the one hand, some evidence shows that releasing video in a timely manner can demonstrate good faith and transparency on the part of the police, and it serves to refute any claims of an official cover-up (White, 2014). These may be important steps for building community trust and police legitimacy, especially in the aftermath a high-profile use-of-force incident (White, 2014). But some police and prosecutors warn that releasing video before an investigation is completed can compromise both criminal and internal probes of the incident (Miller, Toliver, and Police Executive Research Forum, 2014).

A growing number of jurisdictions are enacting laws or regulations governing when and how videos will be released (National Conference of State Legislatures, 2016). In October 2016, North Carolina joined Illinois, Texas, South Carolina, and other states in enacting one of the more restrictive laws in the country. It declares that police-generated videos are not public records and can be released only with a court order (North Carolina General Assembly, 2016). By contrast, District of Columbia law grants the public access to most footage captured by police body-worn cameras (Council of District of Columbia, 2015). Overall, there is wide variance across states on body-worn camera legislation governing when and where cameras can be used, public access to footage, video storage time, and public record stipulations (Urban Institute, 2017).

The Challenge of Race and Perceptions of Police

As police use of force has come to dominate the conversation about law enforcement in the United States, the broader issue of race has taken center stage. Issues of race in policing are not exclusively contemporary, as seen in differential crime/arrest rates across race in Chicago School research (Shaw and McKay, 1942) or the findings of the President's Commission on

Law Enforcement and Administration of Justice (1967). In many instances, it may be currently impossible to disentangle the true impact of race on crime (Massey and Sampson, 2009), though a recent study by the Center for Policing Equity at the University of California, Los Angeles, suggests that racial disparities in police use of force remain robust after controlling for other potential explanations, such as violent crime and racial distribution of local arrest rates" (Groff et al., 2015).

Even while the literature provides mixed results, racial tensions toward police can correlate with national media trends. According to a 2015 Gallup poll, 52 percent of all Americans expressed "a great deal" or "quite a lot" of confidence in the police, the lowest level in the 22 years that Gallup has polled on that question (Jones, 2015). Although reported public confidence rose to 56 percent in the 2016 Gallup poll, already wide differences in how white and nonwhite Americans view the police continued to grow (Newport, 2016). While 62 percent of white Americans expressed confidence in the police in 2016, just 39 percent of nonwhite Americans felt the same way.

The Gallup findings track with results from a Pew Research Center survey also conducted in 2016 (Morin and Stepler, 2016). The Pew survey looked specifically at public perceptions of equal treatment and use of force by the police and found vast differences of opinion between African-Americans and whites. Seventy-five percent of whites said the police treat different racial and ethnic groups fairly; three-quarters of whites also said police use the right amount of force for each situation. African-Americans' views on these issues were dramatically less positive. Just 35 percent of African-Americans said officers treat all groups fairly, and only one-third felt that officers generally use the right amount of force.

This "racial confidence gap" in how black and white Americans view the police creates enormous hurdles for law enforcement. This is especially true in many large cities, where high rates of residential segregation, crime, poverty, and unemployment (Schuck, Rosenbaum, and Hawkins, 2008; Weitzer, Tuch, and Skogan, 2008) have traditionally led to tension between the police and some communities (Dai and Jonson, 2009; Berg et al., 2016).

Increased Scrutiny from the Community and the Federal Government

With the expansion of technology among citizens and increasing data expectations from the public, police agencies are confronted with an unavoidable reality: increased scrutiny from members of the community (including a burgeoning activist movement), the news media, and the federal government.

The past few years have seen the growth of a large and energized community-based movement advocating for change in the criminal justice system, especially in the area of police use of force against African-Americans and other communities of color.

Many of these community-based activists have come together under the Black Lives Matter umbrella. The movement grew out of the use of social media and smartphone technology among the public under the social media hashtag #BlackLivesMatter, which took root in 2012 and 2013 following the shooting death of African-American teenager Trayvon Martin in Sanford, Florida, and the subsequent acquittal of Neighborhood Watch volunteer George Zimmerman in the shooting (Craven, 2015). The movement picked up momentum following the deaths of Eric Garner and Michael Brown in the summer of 2014. Currently, the activist movement is a largely decentralized network of locally based entities. This difference in orga-

nizational structure from past groups can create challenges for police leaders looking to open up dialogue with leaders in the activist movement, especially among agencies lacking a strong social media or technology-savvy presence.

In addition to the public, local police agencies encountered increased involvement from the federal government prior to 2017 (U.S. Department of Justice, Civil Rights Division, 2017). During the Obama administration, DOJ's Civil Rights Division opened approximately two dozen investigations into police agencies and enforced numerous agreements, most of which are formal consent decrees (i.e., legal agreements in which an agency agrees to make specified changes, with the implementation of those changes overseen by a court) (U.S. Department of Justice, 2016). In the first five fiscal years of the Obama administration, DOJ opened more than twice as many investigations than were initiated in the previous five fiscal years (U.S. Department of Justice, 2014). DOJ continues to oversee court-enforceable consent decrees in such major jurisdictions as New Orleans, Seattle, Portland (Oregon), Albuquerque, Cleveland, and Newark. Federal consent decrees are almost always comprehensive, multi-faceted agreements that take years and millions of dollars to fulfill (Ross and Parke, 2009; Walker, 2003; Levenson, 2001). As noted, however, the Attorney General has recently signaled a change in direction in this area.

Officer Safety Concerns

As community protests over police use of force have grown in recent years, so too have concerns over the safety of law enforcement officers. The number of officers shot and killed in the line of duty increased by 78 percent during the first seven months of 2016. Of the 32 officers killed by gunfire from January 1 through July 20, 2016, 14 were killed in ambush-style attacks on unsuspecting officers. That compares with just three ambush fatalities during the same period of 2015 (National Law Enforcement Officers Memorial Fund, 2016).

In two of the most high-profile ambush incidents, in Dallas, Texas, and Baton Rouge, Louisiana, the gunmen indicated that they were angry over police killings of African-Americans and wanted to kill white people, in particular white police officers. Ironically, the July 7, 2016, tragedy in Dallas, in which five law enforcement officers were shot and killed, occurred at the end of a peaceful protest that was being protected by the Dallas Police Department and during which numerous officers stopped to pose for pictures with demonstrators. That marked the deadliest day for law enforcement officers in the United States after September 11, 2001 (Fernandez, Pérez-Peña, and Bromwich, 2016).

Ten days later, on July 17, a gunman ambushed and killed three officers in Baton Rouge. This followed by ten days the fatal shooting of an African-American man by white officers outside a convenience store in Baton Rouge, an incident captured on cell phone video. The gunman in this incident rented a car in Kansas City, where he lived, drove to Baton Rouge, and specifically stopped at a location where he could attack police officers.

Even with the recent spate of fatalities, U.S. police officers today are still far safer than they were in recent decades. Over the past ten years, a total of 1,439 officers died in the line of duty, or an average of about 144 per year. By comparison, officer fatalities averaged 162 per year in the 1990s, 232 per year in the 1970s, and 243 per year in the 1920s, which was the

deadliest decade in U.S. law enforcement history (National Law Enforcement Officers Memorial Fund, 2017).[3]

Increases in Violent Crime

In 2015 and continuing into 2017, a rise in homicides and other violent crimes became an important part of the national discussion about law enforcement. After decreasing the previous two years, the number of violent crimes increased almost 4 percent nationally between 2014 and 2015. Murders rose by 10.8 percent, to their highest annual total in seven years.[4] Murders and overall violent crime increased in metropolitan, nonmetropolitan, and suburban areas alike and in all six of the population size groups that the FBI analyzes.[5] In this respect, the recent increase in violent crime has been a national phenomenon, although it is important to put the numbers in perspective. Part of the reason the recent increases in violent crime draw attention is that they come against the backdrop of a steady and significant drop in crime over the past 25 years (Pew Research Center, 2017).

In addition, the national trends obscure the fact that increases in violent crime can often be attributed to large increases within a relatively small number of major urban areas. For example, four cities—Baltimore, Chicago, Milwaukee, and Washington, D.C.—accounted for more than one-fifth of the total increase in homicides in the United States in 2015, even though they represent only about 1 percent of the nation's population.[6] According to a 2016 mid-year survey of large cities conducted by the Major Cities Chiefs Association (MCCA), six jurisdictions—Chicago, Las Vegas, Memphis, Phoenix, Prince George's County (Maryland) and San Antonio—accounted for 255 of the 366 additional murders recorded by the MCCA, or almost 70 percent of the total increase (Major Cities Chiefs Association, 2016). Almost 29 percent of the increase could be attributed to Chicago alone, which had 105 additional homicides through the first six months of 2016.

The MCCA survey revealed a similar finding with 2016 nonfatal shootings, which rose by 347: A relatively small number of cities accounted for the vast majority of the overall increase. Interestingly, outside of Chicago and Las Vegas, the jurisdictions driving the increase in nonfatal shootings were not the same as those where homicides have increased the most. In some cases, homicides rose sharply (for example, 63 percent in Memphis), while nonfatal shootings fell (43 percent in Memphis) during the first half of 2016.

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[3] These totals include officers who died from all causes, not just those who were shot and killed.

[4] Federal Bureau of Investigation, *Crime in the United States*, 2015, Table 1, "Crime in the United States by Volume and Rate per 100,000 inhabitants, 1996–2015."

[5] Federal Bureau of Investigation, *Crime in the United States*, 2015, Table 12, "Crime Trends, by Population Group, 2014–2015."

[6] Of the 1,532 additional homicides recorded in 2015 as compared to 2014, these four cities recorded 312 more homicides (Federal Bureau of Investigation, *Crime in the United States*, 2015, Table 8, "Offenses Known to Law Enforcement, by State and City, 2015"; Federal Bureau of Investigation, *Crime in the United States*, 2014, Table 8, "Offenses Known to Law Enforcement, by State and City, 2014").

The Possible Role of the "Ferguson Effect"

One theory to explain recent increases in crime is the "Ferguson effect" (otherwise known as the "YouTube effect" or the "viral video effect") (Nix and Wolfe, 2016; Wolfe and Nix, 2016). It posits that the steady stream of high-profile, videotaped encounters between police and residents has had the effect of causing some officers to be more cautious and less proactive in their policing. Police are pulling back, the theory goes, because they fear the media scrutiny and public disapproval that come from being the next officer caught on video in a controversial encounter. Their disengagement, in turn, is emboldening criminals, who then feel free to commit more crimes without fear of a proactive police response (Pyrooz et al., 2016). The disengagement can also lead to community disengagement from police, resulting in less police-community cooperation, including fewer crimes and related information being reported, which in turn leads to higher crime rates (Desmond, Papachristos, and Kirk, 2016).

The evidence for this version of the Ferguson effect has been mixed, and generally hampered by a lack of necessary data. Nationally, arrests for violent crime offenses increased 1.5 percent from 2014 to 2015; arrests for murder were up 6.7 percent.[7] However, it is impractical to expect an impact on national trends across relatively nondiscretionary arrests, such as for murder, unless the effect size was extremely large. Data at the city level for more discretionary crimes/arrests (disorder, simple assault, drug possession) are far harder to come by for purposes of analysis, yet would provide greater insight.

There is some evidence for localized "Ferguson effects." A recently published study leveraged calls for service to 911 following a highly publicized incident of police violence against an unarmed African-American man in Milwaukee, finding a 17 percent drop in resident crime reporting—a total of 22,000 fewer calls to 911—from what would have been expected, after controlling for a wide range of demographic factors (Desmond, Papachristos, and Kirk, 2016). Research on violent crime trends in major U.S. cities suggests no systematic or widespread change in overall trends in the 12 months following the incident in Ferguson. While the evidence for a national Ferguson effect is lacking, some cities may be seeing increases consistent with the Ferguson effect hypothesis, particularly cities with large African-American populations.[8] Further research is needed to isolate and identify causal factors through more granulated data (Pyrooz et al., 2016).

The Recruiting and Retention Challenge

As law enforcement agencies tackle the dual challenges of rebuilding trust with the community and combating crime and violence, they are faced with another dilemma: how to recruit, hire, and retain the personnel they need to tackle the job. Having sufficient officers is a key factor in reducing crime; Heaton (2010) found a strong correlation between hiring more officers and reducing crime rates. While simply getting enough officers on board is part of the challenge, especially in some large cities—as noted, the 2016 Pew poll of officers found that 86 percent

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[7] Federal Bureau of Investigation, *Crime in the United States*, 2015, Table 36, "Current Year over Previous Year Arrest Trends."

[8] Federal Bureau of Investigation, *Crime in the United States*, 2015, Table 36, "Current Year over Previous Year Arrest Trends."

felt their agencies had inadequate staff, which rose to 95 percent in large cities—it also involves hiring a diverse mix of officers with the skills needed to police effectively in the current environment (Police Executive Research Forum, 2017).

Nationally, police departments added large numbers of officers in the 1990s and early 2000s, as cities adopted community policing strategies and the federal government made funding available for states and municipalities to hire officers. Between 1992 and 2008, state and local law enforcement agencies added 157,000 new officers, a jump of more than 25 percent (Reaves, 2011).

The national economic crisis of 2008 had an immediate impact on law enforcement budgets and, by extension, agencies' ability to hire and retain personnel (Police Executive Research Forum, 2010). Currently, new pressures exist to hire and replace the large numbers of officers hired in the 1990s who are now retiring. Agencies such as Washington, D.C. (Government of the District of Columbia Metropolitan Police Department, 2015), Chicago (Johnson and Guglielmi, 2016), Phoenix (City of Phoenix, Department Staffing Function Assessment Committee, 2016; Cassidy, 2016), Albuquerque (Eden, no date), and numerous jurisdictions across California (Martin, Lofstrom, and Hayes, 2016) are well below authorized strength for sworn personnel.

For these and other cities, there is an imperative need not only to replenish their ranks, but to do so with officers suitable for the challenges of policing in the 21st century. This can be daunting in the current environment, in which negative perceptions of the police, more opportunities in the private sector, and sometimes archaic police hiring policies and standards are making it difficult to attract new recruits (Wilson et al., 2010). Additionally, agencies are struggling with such issues as how to treat applicants' past use of drugs and whether to require that candidates have at least some college credits (Police Executive Research Forum, 2017). A unique challenge for many agencies is hiring and retaining a diverse complement of officers who reflect the communities they serve. While diversity alone cannot guarantee fair and effective policing, there is a growing consensus that having a diverse workforce can help police agencies improve their relations with the community, reduce racial bias, and, in some communities, break down language barriers (DOJ and Equal Employment Opportunity Commission, 2016). Recent work has sought to incorporate data analytics and modeling to aid police departments with key issues in hiring, such as diversity, efficiency, and identification of untapped recruiting pools (Lim et al., 2009).

The Challenge of Managing Data

Even as police agencies face the already daunting tasks of combating crime and violence, building public trust, and maintaining qualified and diverse workforces, they are also confronted with another, seemingly relentless challenge: managing increasingly large amounts of data. Much of the data are being generated by the agencies themselves—for example, through sophisticated record management and geographic information systems, gunshot detection systems, and, most recently, body-worn cameras and other video. In other instances, agencies are collecting (or attempting to collect) new forms of data that will help them prevent, investigate, and solve crimes (Perry et al., 2013). At the same time, agencies are facing new data collection and reporting requirements, including the FBI's proposed transition from the Uniform Crime

Reporting Program to the National Incident-Based Reporting System (NIBRS)[9] and detailed information on use of force.[10] For many agencies, the sheer magnitude and complexity of data management can be overwhelming, but this is the new reality that law enforcement must deal with.

The changing nature of digital evidence collection and processing illustrates the complexities—and the opportunities—facing police agencies today (Goodison, Davis, and Jackson, 2015). While "digital evidence" has existed for decades (think land-line telephone records), the proliferation of personal and increasingly mobile technology has caused the amount of potential digital evidence to explode. The ubiquitous nature of the Internet, email systems, personal computers, and especially smartphone devices has made the collection and analysis of digital evidence not only possible but also crucial for solving crime (Goodison, Davis, and Jackson, 2015). And in today's "CSI" world, digital evidence is becoming increasingly important—indeed, expected—by juries in many criminal cases. How (or if) that digital evidence is collected and handled can literally make or break cases (National Institute of Justice, 2008). This challenge is further complicated by tricky jurisdictional issues. Data may reside on servers and networks that are states or even countries away (Oriwoh et al., 2013). As researchers that are part of the Priority Criminal Justice Needs Initiative noted, digital evidence "taps into interconnected criminal justice issues that go beyond law enforcement's typical role in collecting evidence" (Goodison, Davis, and Jackson, 2015).

Moving Forward

As noted in the introduction, U.S. law enforcement is today facing multiple complex challenges. Some challenges were in part precipitated by technology, such as community reactions to recorded video. While there are many avenues to address these challenges, it is clear that the use of technology (whether directly through new innovation or indirectly through increased efficiencies and capabilities) will play a key role in the solutions for police agencies. Innovations in technology, policy, and practice can assist agencies in addressing all of these challenges. The work of LEAP 2 points the way to a number of promising opportunities for investment in support of law enforcement operations. Further, these opportunities are not starting from a blank slate. Many technologies and systems have been in place in agencies for years; further, there is a large and growing body of resources to provide agencies (and developers) with information on technologies and best practices for operations and acquisition (Koper et al., 2015). In Chapter Three, we describe the baseline of technologies and development resources that exists today.

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9 Federal Bureau of Investigation, "The Transition to NIBRS," podcast, December 14, 2015.

10 Federal Bureau of Investigation, "National Use of Force Data Collection," web page and video, no date.

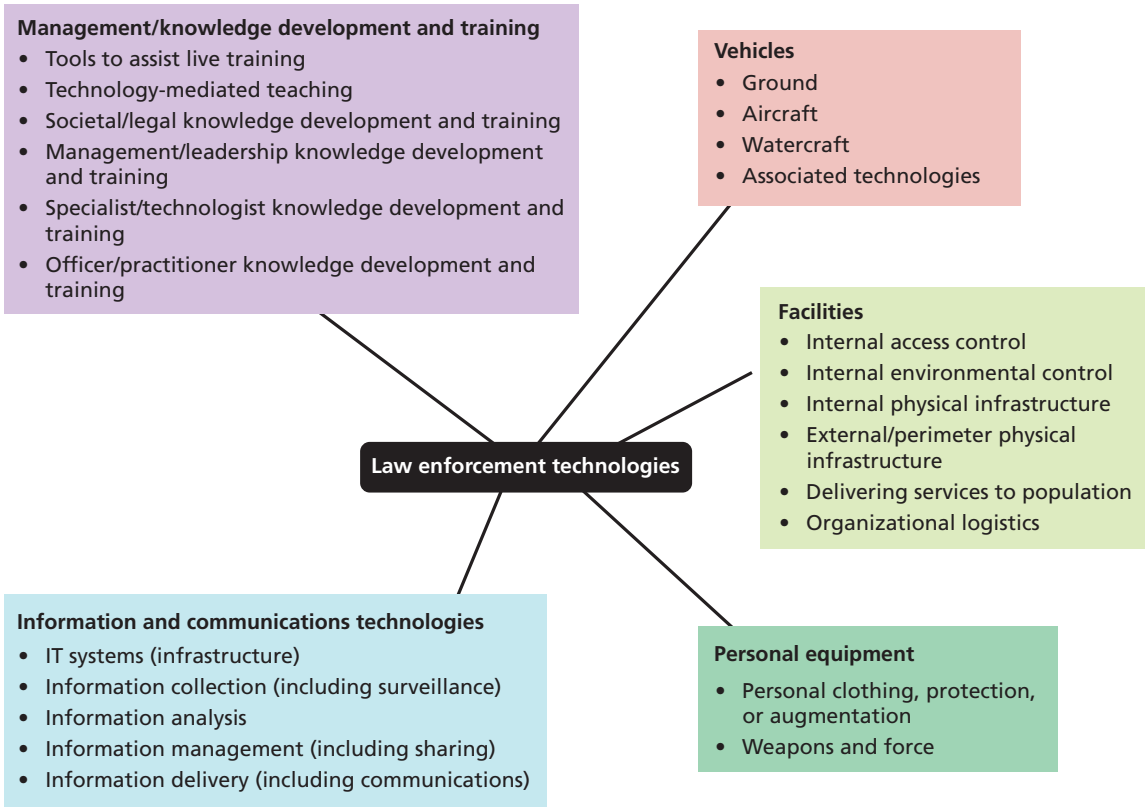
CHAPTER THREE

Law Enforcement Technology and Practice Today

A Taxonomy of Law Enforcement Technology and Practice

To help characterize both current capabilities and needs for investment, RAND has developed a taxonomy of law enforcement and other criminal justice (courts, corrections) technologies (including both materiel and nonmaterial technologies, with the latter including policies and training). Figure 3.1 shows the top two levels of this taxonomy in mind-map format. There are five top-level capability domains.

Figure 3.1
Top Levels of the Law Enforcement Technology Taxonomy



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The initial taxonomy framework that grew out of early advisory panels and workshops continues to be modified as the needs of law enforcement change. Building on that initial framework, the taxonomy grew not only to capture current needs but to demonstrate where the future of law enforcement technology is heading, and how older technologies may need to be modified to be used in new ways to adjust for the changing environment of law enforcement and criminal justice in general. Given the wide range of law enforcement duties and tasks, the taxonomy is broad, to capture the various dimensions in which technology plays a role. This ranges from administrative systems used to manage personnel, to weapons, to the cars law enforcement personnel drive, to the clothing officers wear.

This taxonomy was developed based on the available literature, lists of technology and vendors from law enforcement–related conferences, and the input of participants in the various workshops and advisory panels hosted by RAND. This taxonomy is fluid in that it is constantly adjusting in order to provide the most accurate picture possible of the categories of technology needs in law enforcement.

The full names and descriptions of the five central categories are as follows:

1. **Information and Communications**, including IT systems, communication devices and techniques, information-sharing systems, information analysis systems and tools, and various categories related to collecting and analyzing evidence and information. Surveillance equipment and forensics of all types are included in this domain under the "Information Collection" category.
2. **Doctrine, Tactics, Management, and Behavioral Knowledge Development and Training**, which covers the business side of law enforcement and the administrative and staff development needs of running a successful department. Related categories within this main topic include various methods of training at all levels.
3. **Facility Operations and Population Services**, which includes all aspects of maintaining the buildings and structures, as well as the related security. This topic also includes management of infrastructure and logistics, and the services provided to citizens in their association with these facilities.
4. **Vehicles**, which includes ground, air, and water vehicles and any associated modifications or attachments.
5. **Person-Worn Equipment and Weapons/Force**, which covers all technologies related to uniforms and clothing, including armor, eyewear, and respiratory protection; the tools that officers wear and the belts that carry them; and both lethal and nonlethal weapons.

Each of these categories branches into classes of growing specificity within the framework, resulting in example technologies that exist for each category. At the 2016 Law Enforcement Panel Meeting, participants were encouraged to add notes to the taxonomy, adding technologies or categories that were perhaps overlooked in the initial development of the framework. The complete law enforcement taxonomy is in Appendix E, presented in outline form. RAND also provides the complete taxonomy in graphical form as an interactive web object and a poster that is 74 inches wide by 39 inches high.

Below, we discuss the current state of law enforcement technologies, covered by taxonomy domain. We then conclude this chapter with a review of prior needs for law enforcement research and technologies, focusing on the top needs from LEAP 1.

The State of the Art Today

The role of technology is quickly expanding in the field of criminal justice. To drive the research on the law enforcement technology of the future, a clear understanding of the current needs is essential. Where is there a lack of technical solutions? Where has technology failed to take into account the specialized needs of law enforcement? Are current solutions effective in a law enforcement setting? The development of effective technology for law enforcement stems from an understanding of the answers to these questions and more. As noted by the Center for Evidence-Based Crime Policy in its 2015 report on technology in policing:

> Understanding the effects of technological change is a critical issue in contemporary policing. In recent decades, there have been many important developments with respect to information technologies (IT), analytic systems, video surveillance systems, license plate readers, DNA testing, and other technologies that have far reaching implications for policing. Technology acquisition and deployment decisions are high-priority topics for police, as law enforcement agencies at all levels of government spend vast sums on technology in the hopes of improving their efficiency and effectiveness. (Koper et al., 2015, p. 3)

It is not clear whether these changes have made police more effective. Evaluation research on police technology has tended to focus more on operation and outputs—for example, whether a technology works and makes a process faster—than on its effectiveness in reducing crime or improving service to citizens. And the evidence that is available on technology and police performance suggests that technology's impacts may be limited or offset by many factors, ranging from technical problems to officer resistance. Developing a better understanding of technology's impacts and how they can be optimized is thus an important challenge for police agencies, particularly those hoping to leverage new technologies as a force multiplier to offset budget and staffing limits (Koper et al, 2015). The notable exception concerns the "technology" of police interventions and strategies; as discussed below under the "Doctrine" domain, there are a number of interventions and practices that have been evaluated to be effective in improving a policing metric under experimental conditions.

In addition to the functions of added technologies and their intended uses, technology may also have an impact on workflow and the completion time of specific tasks, saving time with implementation. Garciano and Heaton (2010) note that

> police departments that obtained IT . . . also implemented other organizational changes, becoming larger and more specialized and employing a more highly skilled workforce. This evidence is consistent with the possibility that IT is only one component of a larger system of reorganization that is required in order to improve the productivity of policing.

To provide a framework for organizing technology and highlighting where the need for innovation may exist, RAND's research team developed the taxonomy of law enforcement technology. The goal of this framework is to highlight the existing need for new innovation and to drive development in the direction that fits the needs of law enforcement. As with any comparable endeavor, it is difficult to capture all of the possibilities that exist within the law enforcement environment; the current framework instead provides a starting point for discussion and serves as the impetus for the development of technologies in areas where current solutions are lacking or inadequate.

Information and Communications

Access to information and the role of communications are central to recent innovations in law enforcement technology. A diverse area of technology, the information and communications category is the largest and includes technology ranging from videoconferencing to officer performance management systems to social media monitoring tools. Below, prominent examples of technology are presented in each subcategory.

Information Collection

The collection of information is vital to performing day-to-day law enforcement operations, and currently many information collection tools are available to law enforcement. Basic data collection includes incident reports, arrest reports, and field contact cards and reports, typically stored in record management systems (RMSs, which are described in more detail under "Information Management," below). Internal data collection technology provides an administrative and oversight function, ensuring that law enforcement agencies are run smoothly and that supervisors are able to monitor officers to gauge job performance and to ensure that personnel are receiving the services that they need. Laboratories across the country process forensic information to assist officers in identifying suspects.

Surveillance technologies allow law enforcement to detect and investigate various crimes in addition to supporting decisionmaking for a range of law enforcement functions. These systems also raise significant policy and training issues on what surveillance data to collect, how, and under what conditions, in order to protect privacy and civil rights. A conference on privacy and civil rights implications of law enforcement use of surveillance technologies was held in Washington, D.C., in October 2015. Findings focused on the need for transparency and community input on how surveillance tools are being used and development of expertise to ensure that the tools are used in ways that protect against disparate racial and socioeconomic biases rather than generate them (Datacivilrights.org, 2015).

Gierlack et al. (2014) review applications for automated license plate readers that go beyond the initially intended application of finding stolen cars, as well as review systems management and privacy issues. Other surveillance technologies starting to be fielded include gunshot detection systems, in-field portable biometric readers (primarily digital fingerprint readers), and increasing numbers of fixed and mobile cameras. In 2017, the Priority Criminal Justice Needs Initiative is hosting expert panels to consider criminal justice needs specifically for developing and leveraging social media, video analytics, and sensor fusion technologies.

A key example of technology in the field is body-worn cameras, often referred to as on-officer video cameras, for which many options are currently available. Several research studies have found cameras to be a useful tool, both in documenting officer behavior and in reducing violent interactions with the public. In a 2015 study by Arizona State University, researchers found that officers with body-worn cameras used more proactive methods (initiating contact with the public to identify infractions, issuing citations) than officers without cameras (Ready and Young, 2015). Farrar and Ariel (2103) found that body-worn cameras were associated with a 50 percent decrease in use-of-force incidents. Similarly, a University of Cambridge study found a 93 percent decrease in complaints against the police after officers began wearing cameras (Ariel et al., 2017).

Information Technology—Basic Systems

IT in the context of law enforcement includes the infrastructure for collecting and maintaining computerized records. Much of this category includes basic infrastructure common to any organization—computers, servers, telecommunications equipment, and so on.

This category also includes baseline information security protections. The rise in cybercrime has affected law enforcement agencies, including the theft of law enforcement system data through ransomware, such as CryptoLocker or Cryptoware. Since 2013, multiple police departments, including the Tewksbury (Massachusetts), Swansea (Massachusetts), and Midloathian (Illinois) Police Departments, have paid ransoms to recover encrypted records (Bray, 2015). Such stories reinforce the need for strong cybersecurity measures in police departments, coupled with backup strategies to safeguard data in the event of malware attacks.

Standard policies and training for these areas are starting to be developed by the IACP and others. As examples, the IACP has created model policies that address security, privacy, and civil rights provisions for both specific technologies and novel technologies in general (the latter being the *IACP Technology Policy Framework* [IACP, 2014]). The IACP, with Bureau of Justice Assistance (BJA) and RAND support, has also created an online Law Enforcement Cyber Center (IACP, 2016a).

Looking to the future, a prior Priority Criminal Justice Needs Initiative report (Hollywood, Woods, et al., 2015) examines emerging Internet technologies, such as the Internet of Things and intelligent agents, and identifies needs for criminal justice to take advantage of these new technologies, as well as needs for building out software and hardware infrastructure to use these technologies securely in ways that protect civil and privacy rights.

Information Delivery (Including Communications)

Communications infrastructure covered by this category include legacy fixed and mobile radio communications and newer broadband communications. For the latter, RAND recently conducted an expert panel on broadband communications developments and needs for law enforcement (Hollywood et al., 2016). The top theme from this panel was the recognition of an emerging future hybrid architecture in which law enforcement personnel will be able to communicate data and voice securely over whatever wireless communications network is the best fit, including government-sponsored (principally the FirstNet network),[1] commercial (LTE/4G/5G), and wireless Internet from both public and private hosts.

From an information delivery perspective, we have seen an upsurge in the number of vendors offering systems with common operational picture-type displays, which show annotated maps, trend charts, and/or drill-down reports on law enforcement data being updated in near-real time. We have also seen an upsurge in public crime mapping tools, apps that provide public alerting and public tip reporting features, and social media presences. Perry et al. (2013) gives examples of such "situational awareness" displays.

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[1] FirstNet is a federally funded and operated broadband network for public safety, focused on supporting incident and disaster response, being developed and built out now using a combination of leased commercial and built assets. It leverages two noncontiguous bands of spectrum (for a total of 20 MHz) in the 700 MHz range (D-block/Band 14: 763–775 MHz and 793–805 MHz). Kennedy (2015) and First Responder Network Authority (2015) provide general information and updates.

Information Management (Including Sharing)

This category covers dedicated information management and sharing systems both within an agency and across agencies. Perhaps the best-known law enforcement IT systems within an agency are the RMS—which serve as a master database of law enforcement incidents (crimes, calls, etc.), involved persons, locations, and assets—and the computer-aided dispatch system (CAD) for tracking calls for service and responses to them. The Law Enforcement Information Technology Standards Council (LEITSC) provides functional specifications for features that should be in an RMS (LEITSC, 2009, 2010) and a CAD (LEITSC, 2006, 2008), along with a guide to systems acquisition (LEITSC, 2009). Groff and McEwen (2008) describe these systems, as well as record collection tools that feed them and crime analysis systems that leverage the resulting data to support the efficiency, effectiveness, and enabling of police functions, based on extensive interviews with practitioners.

In recent years, as law enforcement faces more and more incoming digital evidence (notably from body-worn, fixed, and mobile camera systems), there has been an increasing demand for management and storage of large amounts of data. Storage solutions have included a full range of options, from simply buying hard drives on a regular basis to contracting with a vendor for cloud storage and management.

Looking across agencies, the success of law enforcement operations can commonly depend on information sharing. Timely data exchange can make the difference between successfully recognizing and arresting a suspect for a homicide in another state and erroneously letting that person go, for example.

A great deal of work has been done to improve the sharing and use of information. Federally supported examples alone include, but are not limited to, the following:

- The National Information Exchange Model (NIEM) is a common technical framework for sharing structured data (National Information Exchange Model Program Office, 2016). Data standards can be built as Information Exchange Package Documents (IEPDs) that build off of NIEM specifications.
- DOJ's Global Justice Information Sharing Initiative works on a variety of information-sharing standards and efforts, including a number of IEPDs.
- The FBI's Criminal Justice Information Services Division has several systems that are de facto standards for sharing information.[2] These include the National Crime Information Center, which provides real-time data, such as outstanding warrants, and the National Data Exchange (N-DEx), which shares investigatory data.
- The Program Manager, Information Sharing Environment (part of the Office of the Director for National Intelligence) supports a number of information-sharing efforts, including Project Interoperability (see below).
- The above have supported pilot initiatives in which a few agencies used the aforementioned standards and tools to build information-sharing exchanges.
- For government-sponsored dissemination of technical material on information sharing and safeguarding, there is the Justice Information Sharing website (IT.OJP.gov) and Project Interoperability (http://project-interoperability.github.io/).

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[2] Federal Bureau of Investigation, "Criminal Justice Information Services (CJIS)," FBI.gov, 2016; Federal Bureau of Investigation, Criminal Justice Information Services, *Law Enforcement Records Management Systems (RMSs) as They Pertain to FBI Programs and Systems*, Washington, D.C.: U.S. Department of Justice, no date.

NIJ has funded efforts on improving information sharing and use, as well: RAND assessed law enforcement information sharing for NIJ in *Improving Information-Sharing Across Law Enforcement: Why Can't We Know?* (Hollywood and Winkelman, 2015). NIJ also recently funded a CNA study of common operational pictures—tailored displays for law enforcement that typically provide maps overlaid with key large enforcement information—and has funded several organizations to study the impact of social media on policing.

There are substantial practitioner and commercial association efforts on information sharing. The practitioner association dedicated to supporting information sharing is the Justice Information Sharing Practitioners Network. The Standards Coordinating Council is an advisory group of commercial developer associations and data standard organizations. The IJIS Institute is an industry association that seeks to improve information sharing and safeguarding. The IACP is actively involved in information sharing, to include sponsoring several IEPD standards packages; it maintains a center on social media, as well.

At a lower level, we have seen an upsurge in vendors offering information integration services.

However, there are a number of ongoing challenges related to information sharing and use. The first is that with the exception of a few federal databases (such as the FBI Criminal Justice Information Services Division systems) and the state-owned Nlets interstate justice data exchange (Nlets, 2016), there are few, if any, initiatives that are genuinely nationwide. The second is that there are such a large number of efforts that it is difficult to keep track of what is going on, and, in some cases, the results overlap and conflict. The third is the difficulty of organizing and presenting all of the content needed to share and use information, tailored to those in different roles (commanders versus purchasers versus developers, for example). It is difficult for new agencies seeking interoperability and developers seeking to provide it to learn about all the necessary tools and resources.

Information Analysis

Much technology on analyzing law enforcement information falls under the auspices of crime analysis. The International Association of Crime Analysts (2016) defines the profession as follows:

> The professionals who perform crime analysis, and the techniques they use, are dedicated to helping a police department become more effective through better information. The information that analysts provide can help:
>
> - Solve crimes
> - Develop effective strategies and tactics to prevent future crimes
> - Find and apprehend offenders
> - Prosecute and convict offenders
> - Improve safety and quality of life
> - Optimize internal operations
> - Prioritize patrol and investigation
> - Detect and solve community problems
> - Plan for future resource needs
> - Enact effective policies
> - Educate the public.

The International Association of Crime Analysts' introductory crime analysis book, *Exploring Crime Analysis* (Gwinn et al., 2008), provides a detailed explanation of crime analysis, along with examples of crime analyses, tools, and deliverables. Primary tools used in crime analysis include geographic information systems, base statistical packages, and spreadsheets.

In recent years, there has been a surge of interest in so-called *predictive policing*. Despite hype about a computer being able to act as a crystal ball, predictive policing in practice reduces to using a machine learning tool to incrementally improve crime analysts' abilities to do analyses in support of the functions above. Perry et al. (2013) provides RAND's technical assessment of predictive policing.

Doctrine, Tactics, Management, and Behavioral Knowledge Development and Training

DOJ and other organizations have put a great deal of resources into creating online resources for disseminating law enforcement–related knowledge. As the first of just a few examples, NIJ maintains the CrimeSolutions.gov site (NIJ, 2016a), which reviews the effectiveness of both specific law enforcement interventions and broader practices; this is the one domain that has seen a great deal of formal evaluation and experimentation documented in scientific journal articles. The BJA's Smart Suite programs alone have ten different online repositories (see Bureau of Justice Assistance, 2016). BJA also funds the Violence Reduction Network (2016) to run the Violence Reduction Clearinghouse, which offers links to many publications having to do with reducing various forms of violence through various techniques. The National Criminal Justice Reference Service provides the online equivalent of a card catalog for many criminal justice–related publications, including scientific journal articles (U.S. Department of Justice, Office of Justice Programs, 2016). The Center for Problem-Oriented Policing's repository offers almost 100 guides with ideas to address various crime problems (Center for Problem-Oriented Policing, 2016). The IACP carries out many initiatives, a number of which have their own topical priorities (for an index, see IACP, 2016b); it also maintains a library of model policies for law enforcement agencies (IACP, Law Enforcement Policy Center, 2016). The Campbell Collaboration supports and disseminates systematic reviews and meta-analyses of different types of criminal justice practices (along with education, development, and social welfare practices; Campbell Collaboration, 2016). The NIJ-supported Justice Technology Information Center's portal, justnet.org, provides links to numerous articles and other online resources broadly having to do with criminal justice technology (Justice Technology Information Center, 2016).

Table 3.1 shows a list of these and other educational resources that law enforcement agencies might find useful to learn about technologies and practices. These examples are very far from a complete list of the numerous resources that are available to law enforcement agencies. These postings and sites are widely dispersed, with little more than Google (or other general Internet search engines) to serve as the central portal and indexing service.

Facility Operations and Population Services

This domain covers the full range of physical facilities, including police headquarters, stations, training facilities, and PSAP facilities, as well as facilities, services, and logistics provided within these buildings.

There has been demand for maintaining and upgrading evidence rooms and forensic lab facilities, especially to address analysis backlogs. NIJ offers a range of grants to address forensic backlogs, although most, except for the general Paul Coverdell Forensic Science Improvement

Table 3.1
Sample Technology and Practice Resources for Law Enforcement Agencies

Need	Resource	Description	Link
Research results on what works in policing: summaries	CrimeSolutions.gov (NIJ)	Rates and summarizes effectiveness of specific programs and broader policing practices based on reviews of peer-reviewed research about them	https://www.crimesolutions.gov/about.aspx
Research results on what works in policing: details	Campbell Library (Campbell Collaboration)	Detailed research reviews of the effectiveness of specific programs and broader policing practices	https://www.campbellcollaboration.org/library
Research results on what works in policing: overarching themes	Evidence-Based Policing Matrix (Center for Evidence-Based Policing, George Mason University)	Visualization and brief summaries of what types of policing strategies tend to be more effective	http://cebcp.org/evidence-based-policing/the-matrix/
Research results on what works in policing: quick reference guide	*Evidence Based Policing Playbook* (Center for Evidence-Based Policing, George Mason University)	Booklet to provide patrol and specialized units with ideas based on research evidence	http://cebcp.org/evidence-based-policing/the-matrix/matrix-demonstration-project/playbook/
Research results on what works in policing: resource catalog	National Criminal Justice Reference Service (Office of Justice Programs)	Online equivalent of a card catalog of criminal justice articles	https://www.ncjrs.gov/
Practices information and training: community building	Institute for Community Police Relations (IACP/DOJ Office of Community Oriented Policing Services [COPS Office])	Repository of fact sheets, guides, and training related to improving community relations and trust with law enforcement	http://www.iacp.org/ICPR
Practices information and training—officer safety	VALOR Officer Safety Initiative (BJA)	Free officer safety training, along with links to safety and wellness resources	https://www.valorforblue.org/Home/About
Technology information and training: cyber	Law Enforcement Cyber Center (IACP, BJA, and other partners)	News and training on cybersecurity and cyber investigations	http://www.iacpcybercenter.org/
Technology information and training: body-worn camera	Body-Worn Camera Toolkit (BJA)	General, technical, policy, and training information related to body-worn cameras	https://www.bja.gov/bwc/
Practices information and training: violence reduction measures	Violence Reduction Clearinghouse (BJA Violence Reduction Network)	Repository of reports, educational material, training, and technical assistance of violence reduction measures	https://www.vrnetwork.org/Clearinghouse
Practices information and training: resolving crime-generating problems (problem-oriented policing)	Center for Problem-Oriented Policing (University at Albany/Office of Community Oriented Policing Services)	Repository of over 100 guides with ideas to address different types of crime-generating problems	http://www.popcenter.org/

Table 3.1—continued

Need	Resource	Description	Link
Policies: library of models	IACP Model Policies	Repository of a wide range of model policies (IACP membership required to access)	http://www.iacp.org/Model-Policies-Alphabetical-Order
Technology information: social media	IACP Center for Social Media (IACP/BJA)	Technology and practice information and resources related to social media	http://www.iacpsocialmedia.org/
Technology information: free software	Open Source Policing (Weblog—Lt. G. Mills, Burlington, Mass., PD)	Links and descriptions of free and open-source software	http://opensourcepolicing.org/free-resources/
Technology information: general	Justice Technology Information Center (NIJ)	Articles and links to resources about law enforcement technologies	https://www.justnet.org/
Mental health issues: information and training	Police-Mental Health Collaboration (BJA)	Resources to develop police–mental health provider collaborations to respond to people with mental illnesses	https://pmhctoolkit.bja.gov/
Information-sharing: end-to-end process for sharing data across multiple organizations	*Information Sharing and Safeguarding Playbook* (IJIS Institute)	Describes an end-to-end, comprehensive process for getting multiple agencies to share specified types of information; points to resources for each step in the process	http://www.standardscoordination.org/sites/default/files/docs/ISS_Environment_Playbook.pdf
Information-sharing: repository of technical resources	Global Information Sharing Toolkit (Global Justice Information Sharing Initiative, 2016)	Large repository of technical resources for sharing and safeguarding information	https://it.ojp.gov/about-gist

Grants, are reserved principally for improving DNA analyses. (National Institute of Justice, 2017a, provides a list of recent grant opportunities, including those for forensic backlogs).

Note that some law enforcement agencies are responsible for managing local jails. LEAP 2 did not address jails directly; they were covered by our earlier expert panel and report on corrections needs (Jackson et al., 2015).

Vehicles

This domain covers the full range of vehicles used by law enforcement, starting with "typical" vehicles—cars and SUVs. It also covers aircraft and watercraft, along with sirens, warning indicators, and other equipment installed in and on vehicles. An area of high interest in vehicles has been on improving safety, as motor vehicle–related incidents are the leading cause of officer deaths in the line of duty. The National Institute for Occupational Safety and Health (2016) maintains a portal on motor vehicle risks and potential solutions.

This domain does cover unmanned or remotely piloted vehicles—aerial, ground, and on the water. Unmanned aerial vehicle (UAV) use in policing has been controversial. There has been substantial interest in the use of such vehicles for law enforcement purposes, for use cases such as surveillance during active shooter and other standoff situations, accident scene capture, and wide-area monitoring of large crowds during events (Varah, 2015). There are also concerns about their use violating privacy and civil rights, with 26 states having passed "drone-related privacy laws" as of mid-2015 (Bond, 2015). The IACP has developed both a model policy and a concepts and issues paper for UAV use (IACP, Law Enforcement Policy Center, 2015).

The domain also covers tactical vehicles, including third-party built and government surplus vehicles. In recent years, the U.S. Department of Defense (DoD) has been providing surplus Mine Resistant Armored Personnel (MRAP) vehicles to law enforcement agencies. DoD had transferred about 200 MRAPs, with about 800 agencies on a wait list, as of early 2014 (Parsons, 2014). This program has proven to be controversial, criticized as part of the "militarization" of police (see, for example, O'Brien, 2014, on political controversies surrounding a jurisdiction receiving an MRAP). In response, police organizations have launched education campaigns about the importance that MRAPs and other armored vehicles may have (Marcou, 2016).

Integrating IT and vehicles, a number of agencies have mobile command vehicles that provide for on-site command and communications support to respond to major events and incidents. Dees (2015) discusses real-world advantages and disadvantages of mobile command vehicles.

Person-Worn Equipment and Weapons/Force

This domain covers equipment worn and employed by officers. This category includes clothing (including clothing embedded with sensors, overlapping with "Information Collection"), armor and other protective gear, respiratory equipment, credentials, duty technology/basic tools, lethal weapons, less-lethal weapons, and restraints. Historically, there has been high interest in the size, weight, comfort, and effectiveness of these items. Also of recent interest is how the appearance of officers may affect police-community relations (Cox, 2016, for example, comments on negative consequences of a "military" appearance).

In response to controversies surrounding lethal police use of force, there has been an upsurge of interest on development and deployment of less-lethal weapons. The Chicago Police

Department recently announced widespread fielding of conducted energy weapons to its officers, for example (D'Onofrio, 2016).

Prior Law Enforcement Needs: The First Law Enforcement Advisory Panel (LEAP 1) and Related Studies

There have been a number of studies on law enforcement agencies' needs for technologies over the past several decades. As notable examples:

- *Challenges and Choices for Crime-Fighting Technology: Federal Support of State and Local Law Enforcement* (Schwabe, Davis, and Jackson, 2001) surveyed law enforcement agencies about desired technologies and barriers to the adoption of new technologies.
- *Law Enforcement Priorities for Public Safety: Identifying Critical Technology Needs* (IACP, 2005) surveyed departments on which technologies were of greatest priority to them.
- *Law Enforcement Technology Needs Assessment: Future Technologies to Address the Operational Needs of Law Enforcement* (Koper, Taylor, and Kubu, 2009) surveyed agencies and conducted an expert panel to assess operational needs, priorities for technologies, and barriers to implementation.
- NIJ's internally developed *High-Priority Criminal Justice Technology Needs* (NIJ, 2010) provided a list of needs for criminal justice technology research, development, test, and evaluation.

As noted, the direct predecessor of LEAP 2 was the first LEAP. This event was held in 2013 under the auspices of the Information and Geospatial Technologies Center of Excellence (COE), which was part of the National Law Enforcement Corrections Technology Center. While the LEAP was open to a complete range of needs, by definition the panel focused primarily on information- and communications-related needs. Panelists generated and prioritized 81 needs across three focus groups covering operations in the field, back-end command and administration, and crime analysis and investigations. Following the panel, RAND grouped the top-ranking needs (Tier 1 needs) from the LEAP, as well as a few other top-ranking needs from other studies performed by the COE,[3] into 11 crosscutting themes grouped into three areas, shown in Table 3.2.

The needs and themes are discussed in detail in the COE's final report, *High Priority Information Technology Needs for Law Enforcement* (Hollywood, Boon, et al., 2015). Figure 3.2 shows the top-level breakdown of needs from that report.

We discuss the themes and progress to date on addressing them below.

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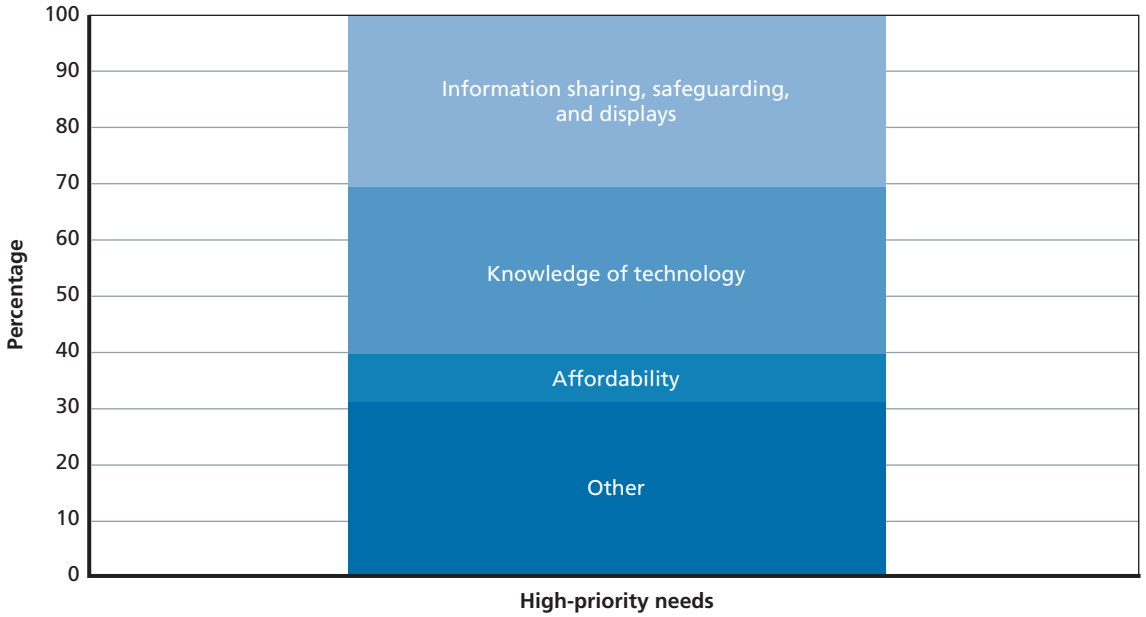
[3] Other studies contributing a handful of Tier 1 needs: Gordon et al. (2012) conducted a preliminary assessment of high-level technology needs from a content analysis of interviews with two-dozen agency representatives. Hollywood, Boon, et al. (2015, appendix) conducted a market survey of law enforcement technologies and contemporary grant awards, comparing their numbers ("supply") to needs from LEAP 1 and other COE studies. The study identified more "demand" (as measured by needs) for common standards, common operational pictures, health monitoring systems, and law enforcement process initiatives than there was "supply." Finally, top themes in keynote addresses in IACP conferences from 2011 to 2014 were also reflected as top-ranking needs, of which the most notable was a need to mitigate severe budget pressures after the 2008 recession.

Table 3.2
Summary of Themes in Top Law Enforcement Needs

Area	Theme
A. Improving Law Enforcement's Knowledge of Technology and Technology Practices	1. Improve the law enforcement community's knowledge of technology and technology practices 2. Improve the dissemination of best practices related to technology management and process improvement
B. Improving the Sharing and Use of Law Enforcement–Related Information	3. Improve the sharing of law enforcement information 4. Improve display and use 5. Improve mechanisms to communicate with the public
C. Other	6. Improve health systems 7. Improve privacy, security, and civil rights policies 8. Improve the affordability of technology 9. Improve practices to reduce crime 10. Improve major event response technology 11. Improve deployable sensors

Figure 3.2
Top-Level Breakdown of Needs from *High-Priority Information Technology Needs for Law Enforcement*



RAND *RR1814-3.2*

Improving the Law Enforcement Community's Knowledge of Technology and Technology Practices (Area A)

We begin with reviewing two knowledge-related themes. The first was to improve the law enforcement community's knowledge of specific technologies and how to employ them effectively. It included improving federal technology outreach, notably by supporting a knowledge repository on technology best practices and tools. Panelists requested training and guidance related to incident command (disasters and major crimes), health (stress management and general health), resiliency, social media, and cybersecurity, privacy, and civil rights safeguards.

The second theme reflected more general needs for assistance on technology management and business process improvement rather than knowledge of specific technologies. It included improving law enforcement's knowledge and capabilities for strategic planning, requirements and systems acquisition, process improvement, program management, and change management.

As noted, DOJ and other organizations have made substantial investments to create and disseminate material on technologies, with Table 3.1 providing a small list of examples. However, the persistence of these themes reflects needs that have been unmet to date, even given existing efforts.[4] Specific questions have included: How can sponsors make practitioners better aware of technology information and training? How can sponsors make it easier for practitioners to find the information they need? How can the presentation of information be better tailored for practitioners who have experience levels ranging from novice to expert?

Improving the Sharing and Use of Law Enforcement–Related Information (Area B)

Here, we review three information-centric needs. The first concerns sharing law enforcement information across systems and organizational boundaries. It included calls for improving communications infrastructure; developing and enforcing criminal justice data standards; improving RMS, CAD, and other systems in general; and studying how to use data more effectively.

The second concerns displaying and using that information effectively. It included calls on how to better create common operational pictures—tailored displays for law enforcement that typically provide maps overlaid with key large enforcement information—and how to use these at levels ranging from command-level COMPSTAT (computer statistics unit) down. It also included calls on developing personnel tracking and management and providing tactical analysis support to the field.

The third need concerns the special case of sharing and displaying information for the public. It included calls for general improvements, as well as using social media more effectively (calls for both better training and social media tools better suited to law enforcement).

The remaining area of top needs, Area C, broadly covers "other" themes in general; these themes are discussed independently, below.

Other (Area C)

Improving Health Systems

This theme identified an overarching need to improve methods and systems monitoring and supporting officers' health, especially mental health. The theme includes early warning monitoring systems, improvements to incident and stress management measures, and scheduling and staffing approaches that improve officers' quality of life. (Theme 10, on training, also includes a relevant need relating to training leaders for resiliency.) RAND has seen substantial interest from practitioners in this area but is aware of few packages or systems to date.

Improving Privacy, Security, and Civil Rights Policies

Law enforcement's use of technology has been challenged by civil and privacy rights concerns and objections and directly attacked by cybersecurity threats. Panelists have described needs for greater development of standard policies and procedures related to civil rights, privacy, and

[4] As an example, problems disseminating technology information were discussed at BJA's February 2016 Criminal Justice Technology Forecasting Group meeting (meeting facilitated by RAND).

security. This theme specifically included calls for policies, procedures, and guidance related to video surveillance, sensor systems, and cybersecurity. This continues to be an area where RAND sees high demand from both practitioners and external organizations for additional guidance and knowledge.

Improving the Affordability of Technology

Given the recent recession and lingering budget cuts, panelists reported needs to improve the affordability of technology, as measured by the total life cycle costs of systems.

With regard to IT affordability, RAND has observed some migration toward shared services/cloud models and centrally funded IT portals. Examples include states or regions providing RMS services to a number of smaller agencies. There has also been an emergence of comparatively affordable RMS/CAD packages for smaller and disadvantaged agencies, with examples including systems both coded by agencies (or agency contractors) themselves and developed by commercial providers. More broadly, RAND has learned of purchasing cooperatives that help agencies collectively buy equipment and services at reduced prices. That said, technology affordability across the life cycle continues to be a major demand.

Research and Evaluation on Practices to Reduce Crime

This theme concerns further research and evaluation (R&E) on criminal justice practices that preempt crime, especially given budget cuts and declines in prison populations. Specific needs in this category included R&E on alternatives to mass stops and arrests for low-level crimes, ways to reduce crime from high-repeat offenders, and ways to reduce high-volume types of crime.

Much of NIJ's Office of Research and Evaluation policing portfolio is relevant for helping to address these needs, so a large part of addressing this theme falls under the category of federally sponsored dissemination. That said, demands for additional research that go beyond currently reported findings continue—for example, demands to go beyond "hot spot policing works" to "What should we do in a hot spot?"[5]

Improving Major Event Response Technology

Practitioners have expressed a good bit of interest in IT for responding to major events and disasters. This theme included calls for tracking systems for responders during major events, improved unified command training for large-scale responses, developing reference memoranda of understanding for multiagency responses, and reducing the cost of homeland security supplies in general. It has been noted that addressing these needs will require improved partnerships with U.S. Department of Homeland Security (DHS) agencies.

Improved Deployable Sensor Technologies

Finally, this theme called for wider development and dissemination of a variety of sensor systems. These included calls for very light-weight body-worn cameras (note that LEAP 1 was held before the massive increase in demand for body-worn cameras); deployable biometric devices with a range of biometric sensors and connectivity needed to positively identify someone within a minute; a device that can extract photos, texts, and other electronic evidence from

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[5] Recent articles starting to examine what police should do in a hot spot include Groff et al. (2015) and Taylor, Koper, and Woods (2011). Both report on experiments testing different types of hot spot policing strategies within a particular jurisdiction. RAND is currently sponsoring a project to identify specific elements and attributes of policing strategies that tend to make them more effective and equitable.

witnesses' cell phones within minutes; and portable closed-circuit television systems that could be dispatched and set up as needed, in response to, for example, a predicted temporary hot spot. Issues were less about developing these systems (all exist to some extent) than continuing to improve practitioners' awareness of them, reduce their cost, improve their performance, and develop appropriate information integration and safeguarding capabilities for them.

CHAPTER FOUR

From Law Enforcement Today to Law Enforcement Tomorrow: Identifying and Prioritizing Innovation Needs in Technology, Policy, and Practice

To identify needs to improve law enforcement effectiveness and efficiency going forward, RAND and the Police Executive Research Forum reconvened an advisory panel of practitioners and subject-matter experts to identify and prioritize areas of potential opportunity and concern. LEAP 2 took place over the course of three days, broken into two 1.5-day sessions.

Panelists were identified and recruited using existing professional networks and by conducting literature searches for individuals who had previously published relevant articles. The professional networks included those maintained by the Police Executive Research Forum, RAND, and NIJ. NIJ's nominees included Law Enforcement Advancing Data and Science (LEADS) scholars.[1] When recruiting through professional networks, we asked practitioners to nominate the "technology evangelists" in their organizations. Specifically, we asked for those who usually advocate the use of new technologies or who take the lead in integrating them into daily operations. The questions asked to those in professional networks included the following:

- Who is the person in your organization who is always trying to pull new technologies into your organization or operations?
- Who is the person you think of first when you need someone to take the lead on integrating a new technology into your organization or operations?
- Is there a person in your organization who is a "technology evangelist?" This would be someone who other agencies call to get advice on how to integrate a new technology into their organizations and operations?
- Are there any people in your organization who publish articles to inform other agencies on how to integrate new technologies into their organizations and operations?
- Who comes to mind when you think about these questions? Would they be interested in participating in a focus group on law enforcement technology?

When identifying practitioners through publications, we focused on identifying forward-thinking and forward-leaning practitioners and academics. We looked for those writing and publishing articles on capability gaps that modern law enforcement practitioners face and for those working toward solutions to fill those gaps.

[1] LEADS is a partnership between NIJ and the IACP that "is designed to develop law enforcement officers who are committed to advancing and integrating science into law enforcement policies and practice" (National Institute of Justice, 2017b).

The full list of panelists is in Appendix A. In recruiting panelists, we focused on recruiting a combination of mid- and senior-level practitioners (both sworn and nonsworn technology personnel) and researchers who are on the leading edge of one or more areas of technology use in law enforcement. When consolidating the list of potential invitees, consideration was given to ensure broad representation from across the United States and to agencies of different sizes.

The first session of LEAP 2 was devoted to operational policing issues; the second session was devoted to strategic-level and administrative issues. Participants had the option to stay for the entire three days if they wished to participate in both sessions. *Operational policing* focused on needs in support of officers out in the field, including patrol, crisis intervention/field mental health, criminal investigations in the field, and special units, such as SWAT, canine, narcotics, vice, and aviation. *Strategic and administrative policing* focused on command at agency and district levels; PSAPs, which are best known as 911 call and dispatch centers; agency IT; crime analysis; forensic labs; legal affairs; media relations; and personnel and general administration. Panelists reflected a range of different types and sizes of agencies (see Appendix A for a list of members).

The intention with LEAP 2 was to build on, extend, and go beyond prior results. While we did not want to simply redevelop an entirely new list of needs, we also did not want to be restricted to updating LEAP 1 needs. To orient participants to the results of the first panel, we reviewed the top themes from LEAP 1 with LEAP 2 panelists, as well as what has been done in the specified areas since 2013 (and provided information on both areas to them in read-ahead materials). Panelists also discussed how the operational context of policing has changed since the original LEAP in 2013. Panelists then identified issues facing law enforcement, focusing on issues that go beyond what LEAP 1 covered in 2013, and brainstormed and developed specific needs to address the issues. The panel then prioritized needs based on three criteria: potential importance to the law enforcement community, technical feasibility, and operational feasibility.

The Law Enforcement Advisory Panel Process for Generating and Prioritizing Needs

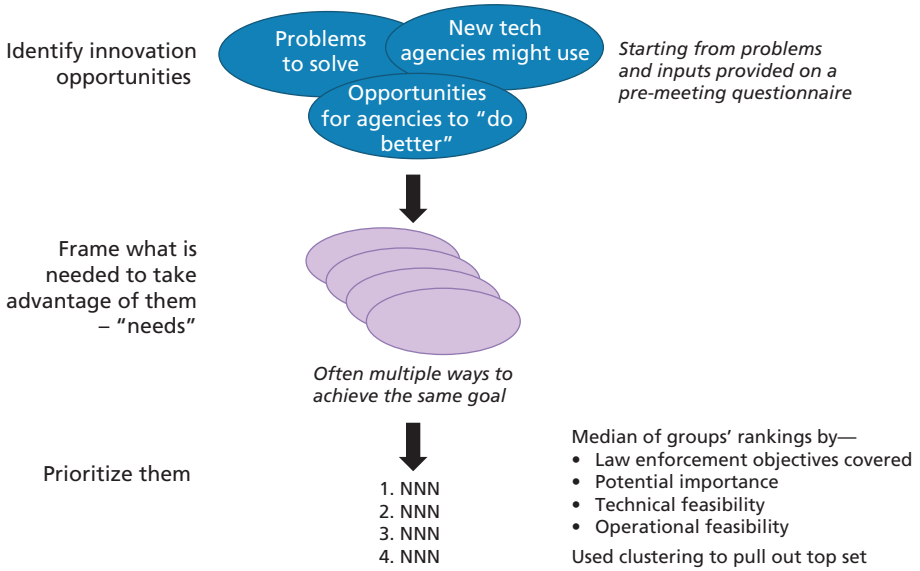
The process to generate and prioritize needs during LEAP 2 is summarized in Figure 4.1.

The first step in the process (not shown) was for panelists to weight the importance of each of a set of law enforcement objectives. As part of LEAP 1, RAND and the panelists identified a set of law enforcement objectives (described in detail in Hollywood, Boon, et al., 2015). We retained these objectives for LEAP 2. Panelists weighted the objectives via an online pre-workshop questionnaire, presented in Appendix B.

The second step in the process was for the panel to brainstorm opportunities for innovation. These included operational problems with equipment and technologies that need to be solved, emerging opportunities and external pressures for agencies to "do better" on particular performance dimensions, and emerging technologies that law enforcement might be able to leverage. Panelists nominated an initial list of problems and opportunities on the pre-workshop questionnaire (Appendix B). We then reviewed, edited, and expanded this initial list during the in-person sessions.

The third step in the process was to develop one or more needs to address each problem or opportunity. As noted in Chapter One, a *need* is a requirement from the panelists for

Figure 4.1
Summarizing the LEAP Process



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research, development, and/or dissemination of a product or service to help solve a problem or take advantage of an opportunity. *Products* and *services* may include materiel items, such as improved equipment or software, and nonmateriel items, such as new policies, regulations, processes, and organizational structures.

The fourth step in the process was to have panelists prioritize the needs. We use an *expected value* (EV) approach to assess how much emphasis should be placed on meeting a need. Here, a need's overall score depends on the potential importance of meeting the need toward furthering one or more law enforcement objectives, as described below. The score also depends on the chance for satisfying the need successfully from both operational and technical perspectives. We then used a clustering tool to identify those needs that are top-rated in a mathematical sense. Needs in the top-rated group are considered Tier 1; we also identified needs in the top of Tier 1, since needs that rose to the top of the highest tier likely merit particular attention and focus. Needs in the middle-rated group are in Tier 2, and needs in the bottom-rated group are in Tier 3.

These steps are explained in more detail below. Appendix C provides the agendas for the operational and strategic/administrative sessions. Appendix D discusses generating and clustering the needs, from a detailed technical perspective, including the specific equations and algorithms used.

Prioritizing Objectives for Law Enforcement

The potential importance of a need is not assessed just in generic terms—it is assessed with how much it might contribute to furthering law enforcement objectives. These objectives reflect overarching goals for law enforcement agencies to accomplish. As part of the work for the first LEAP (Hollywood, Boon, et al., 2015, p. 6), RAND and the panel identified a set of eight core objectives for law enforcement. These objectives draw heavily from earlier reviews of policing

objectives employed both in the United States and internationally (Moore and Braga, 2003; Davis, 2012). Table 4.1 shows the eight objectives and their definitions.

We asked members of the panel to weight the relative importance of each of objective. To do this, we first asked panelists to identify the objective they rated to be most important and give it a weight of 100. We then asked the panelists to weight the remaining objectives with respect to how important those objectives were in relation to the most important objective. For example, if a panelist felt an objective was half as important as the most important objective, they would weigh the objective as being worth 50. Panelists were allowed to weigh objectives with any value between 0 and 100; thus, for example, if a panelist felt three objectives all tied for being the most important, they could give all three a weight of 100. We then calculated the average weight for each objective. Figure 4.2 shows the result.

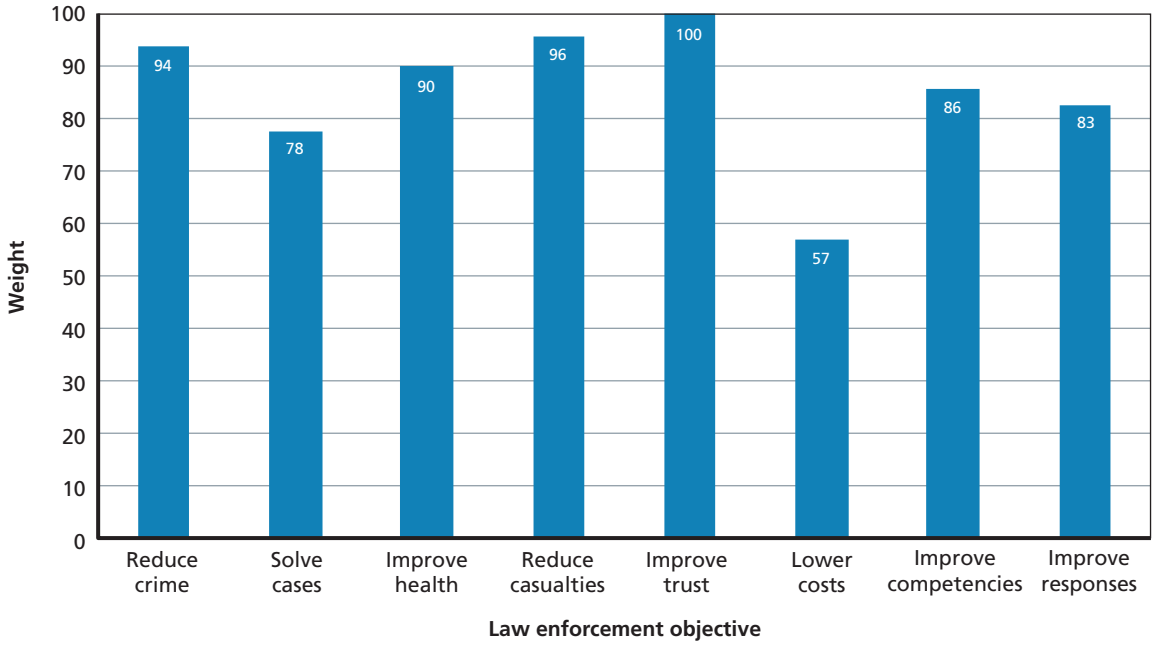
For the 2016 LEAP 2 participants, improving the public's trust in law enforcement was the most important objective, followed closely by reducing casualties and reducing crime. The other objectives were weighted a bit lower, with lowering costs being weighted, on average, far lower than the others.

The 2013–2014 LEAP 1 showed a somewhat different pattern of weights on the objectives. That panel rated reducing crime as the most important, followed by improving competencies and solving more cases. Improving trust and reducing casualties were weighted as the

Table 4.1
Law Enforcement Objectives

Objective	Definition
Reduce crime and disorder	Decrease the numbers of violent crimes, nonviolent crimes, and civil disturbances. Metrics include tracking various types of crime and calls-for-service counts over time, as well as reductions in recidivism.
Solve more cases	Reduce the numbers of open criminal investigations (i.e., increase the fractions of cases cleared by arrest). Metrics include tracking the numbers of criminal cases of different types considered solved over time.
Improve the health of law enforcement personnel	Improve the physical and mental health of law enforcement personnel. Metrics include tracking the numbers of sick days, long-term leave days, and health-related departures from agencies over time.
Reduce casualties in the line of duty	Reduce the numbers of serious or fatal injuries to law enforcement, bystanders, and suspects from all causes (including accidents and use-of-force situations). Metrics include tracking the numbers of casualties for officers, bystanders, and suspects.
Improve the public's trust of law enforcement	Increase the public's trust of law enforcement, as well as reduce the public's fear of crime. Metrics include surveys asking about agency legitimacy, agency accountability, and residents' fear of crime.
Lower costs	Reduce the costs (both in money and time) of law enforcement operations while maintaining effectiveness. Metrics include tracking expenses and labor hours over time, as well as tracking other effectiveness metrics to check for decreases in performance.
Improve law enforcement competencies	Improve the training, education, and readiness of law enforcement personnel. Metrics include both numbers of events and certifications and test results showing that staff have achieved proficiencies.
Respond to incidents and events more effectively	Increase agencies' abilities to prepare for, respond to, and recover from incidents and events ranging from day-to-day emergency and support calls to large-scale disasters. Metrics include tracking timeliness and quality of responses in both actual and simulated events.

Figure 4.2
Collective Weights on Law Enforcement Objectives from LEAP 2



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fourth and fifth most important objectives, respectively. Lowering costs ranked sixth at the time, and in absolute terms had a substantially higher weight than for LEAP 2.

The LEAP 1 panel occurred before the officer-involved shootings and riots in Ferguson, Missouri, and Baltimore, Maryland, and ongoing controversies about police-community relations and uses of force. At the same time, budgetary pressures have been reduced since the height of the 2008 recession. We find it likely that these changes in priorities reflect changes in the social, political, and budgetary environments facing law enforcement agencies today.

Identifying Problems, Opportunities, and Needs

Prior to the in-person panel meeting, we sent panelists a questionnaire (Appendix B) that asked panelists for the problems and opportunities in six areas, as follows:

- **Information and Communications**—including communications infrastructure, IT infrastructure, sensors and biometrics, data analysis, data management, and tailored displays
- **Vehicles**—including ground vehicles, aircraft, watercraft, UAVs, and any associated equipment
- **Facilities**—including issues associated with agency headquarters, stations, operations centers, PSAPs, custody areas, and laboratory facilities
- **Personal Equipment**—including everything that officers, investigators, and other law enforcement personnel carry day to day, such as uniforms, protective gear, and other duty technology
- **Weapons and Force**—including lethal, less-lethal, restraints, and related technologies

- **Management, Personnel Development, and Training**—including departmental policies, strategy and tactics, training, education, management and business processes, and other concerns.

These six areas correspond to the top-level domains in the law enforcement technology taxonomy introduced in Chapter Three. We seeded the panelists' discussions with the problems and opportunities identified from the questionnaires and had panelists brainstorm additional problems and opportunities for each technology area, as well.

During the panel discussions, we went through each problem or opportunity and worked with the panelists to develop corresponding *needs* to address them. A need has two parts. The first is the text of the problem or opportunity to be addressed. The second is a specific way ahead to address the issue. Examples might include:

- *technology*: call for a new device or software upgrade
- *policy*: call for a new model policy
- *practice*: call for research to determine best practices (and practices not to do) to address an operational problem
- *training*: call for developing curricula for a new training course, either online or in-person.

These are just a few examples of types of possible needs; Appendix F shows the complete list of needs generated during LEAP 2. At the end of both sessions of LEAP 2, we had 82 needs from the Operational session and 72 needs from the Strategic and Administrative session.

Prioritizing Needs

The first step in prioritization was to capture the objectives that each need supported during the panelists' discussion. After the panel, three researchers reviewed the assignments of objectives to needs and adjusted the assignments to ensure that they were consistent in two ways. The first was that the assignments were logically consistent, checking that there were not clear definitional errors. The second was to ensure that similar needs were assigned to the same objectives.

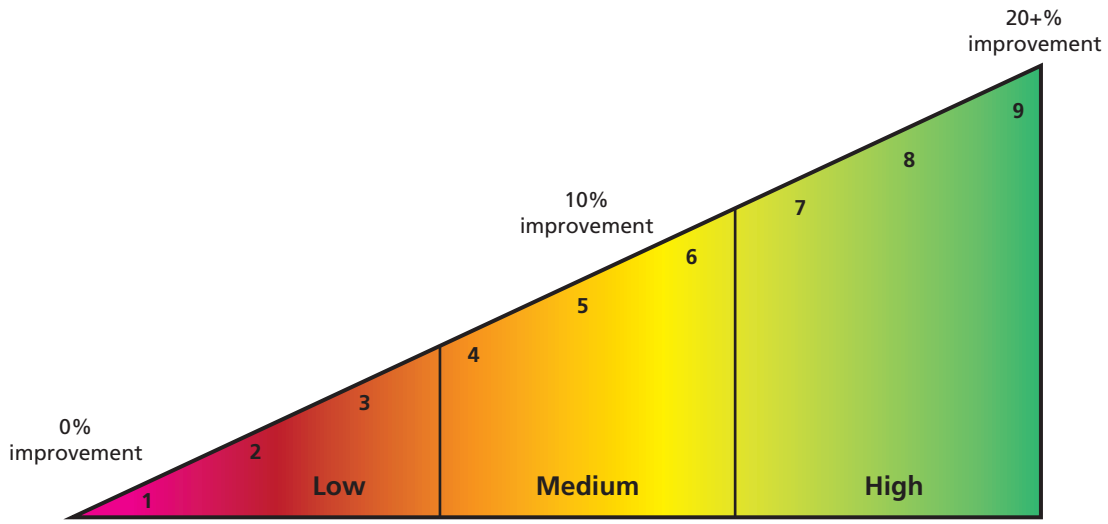
We then had the panelists take an online questionnaire to rate the needs along three dimensions. These questions were:

How Much Impact Could Addressing This Need Have on Law Enforcement? The top rating meant that a solution to a need was a potential "game changer." Here, "game changer" meant that a solution would improve performance with respect to at least one of the eight objectives by 15–30 percent in places where that solution was used. As historical examples, hot spot policing is associated with crime reductions of around 15–20 percent (Braga, Papachristos, and Hureau, 2014)—thus affecting the objective of reducing crime—and it has been estimated that deaths in the line of duty could be reduced by 30 percent if all officers wore body armor—thus affecting the objective of reducing casualties (Bir et al., 2011).

Panelists were asked to rank each need's potential impact on a scale from 1 to 9, with 1 low and 9 high. Figure 4.3 shows a visualization of how to interpret each rating.

We asked panelists to assign the 1–9 rating in two stages of "thinking in thirds." The first was to consider whether the need should be in the high range (closer to a 20 percent—or 1 part in 5—improvement), in the low range (closer to no improvement) or somewhere in the

Figure 4.3
Visualization of Impact Ratings



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middle. The second was to consider whether the need should be toward the top, bottom, or middle of each range.

What Is the Likelihood a Solution Would Succeed, Technically? Here, high ratings (7–9) implied that an effort to solve a need was likely to succeed from a technical perspective, typically because it just required adapting existing technology (70–90 percent chance of success). Low ratings implied significant technical risk, typically because of all-new technology development being required (10–30 percent chance of success). Medium ratings are in between (40–60 percent chance of success).

What Is the Likelihood a Solution Would Succeed, Operationally? Here, "success" from an operational perspective means that a solution to a need would be broadly deployed and used. This implies that a solution does not have any substantial barriers to fielding, in such areas as

- cost to the fielding agencies
- policy and politics, notably including security, privacy, and civil rights concerns
- culture
- human factors (solution not too hard to use).

High-rated solutions were seen as likely to succeed in the field, with no significant operational, cost, or political problem foreseen (70–90 percent chance of success). Low-rated solutions had major operational or political barriers present (10–30 percent chance of success). Medium ratings reflected some, or uncertain, operational and political risks (40–60 percent chance of success).

We then combined the answers to each of the questions to generate an EV score. Appendix D presents the equations employed, but in words, the score is

- Weighted number of objectives the need supports

- Times the potential impact of a solution to the need
- Times the likelihood of technical success
- Times the likelihood of operational success.

We then took the median of all EV scores generated by the responses from each panelist to get an overall EV score for each need.

We then used the *hierarchical clustering algorithm* (details in Appendix D) to divide the needs into three tiers (Tier 1, top priority; Tier 2, medium priority; and Tier 3, low priority) by their overall EV score. We used the same algorithm to identify the group of top-ranking needs within Tier 1, or "Top." Figure 4.4 and Figure 4.5 show the results of clustering. They show the breakdown of overall need scores by tier, for operational needs and strategic/administrative needs, respectively. As shown, the tiers break the needs roughly into thirds, but also account for breakpoints in the needs' scores. The "Top" label captures needs whose scores are noticeably above the main concentrations of needs from each group.

Toward an Innovation Agenda for U.S. Law Enforcement

Considering the Identified Needs as a Whole

Figure 4.6 breaks down all 154 needs from LEAP 2 by tier and by top level of the technology taxonomy (taxonomy domain). As shown, about one-third of the needs related to information and communications; one-third related to doctrine, tactics, management, and knowledge development and training (i.e., nonmateriel needs); and the remaining one-third of the needs were distributed across other domains. Note that even though forensics is nominally part of

Figure 4.4
Operational Needs, by Overall Score and Tier

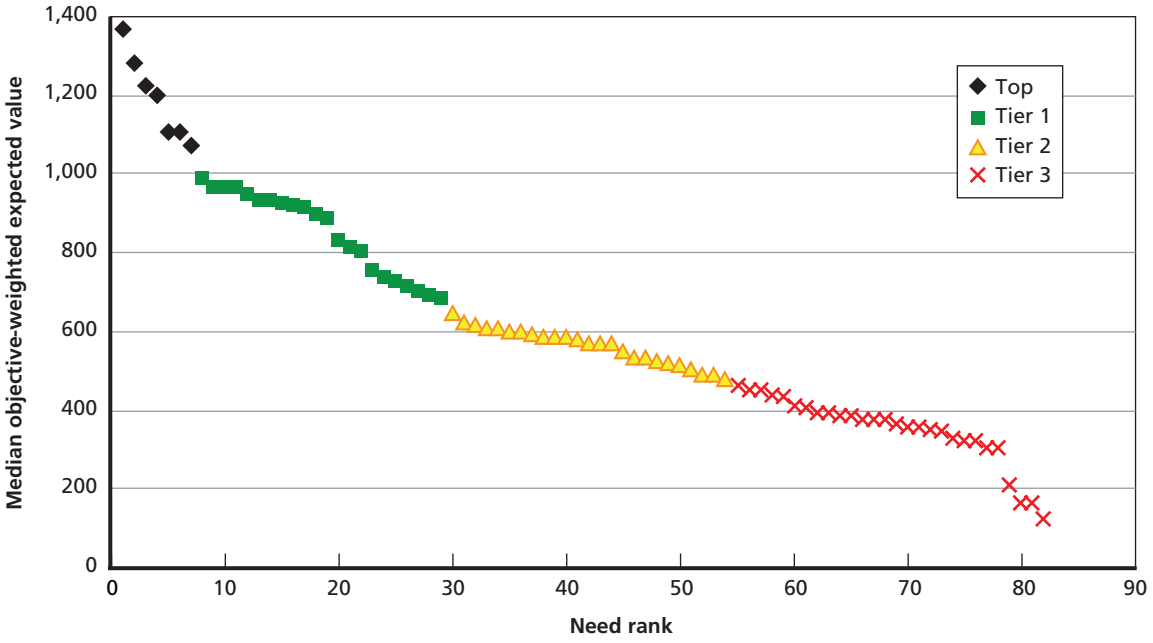

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Figure 4.5
Strategic and Administrative Needs, by Overall Score and Tier

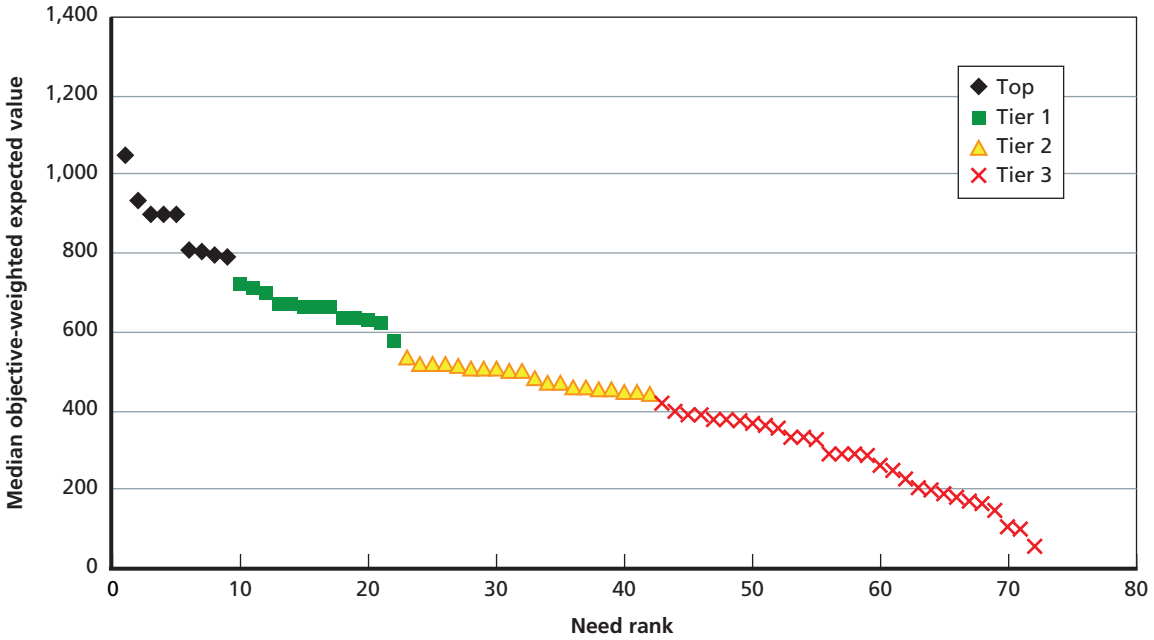

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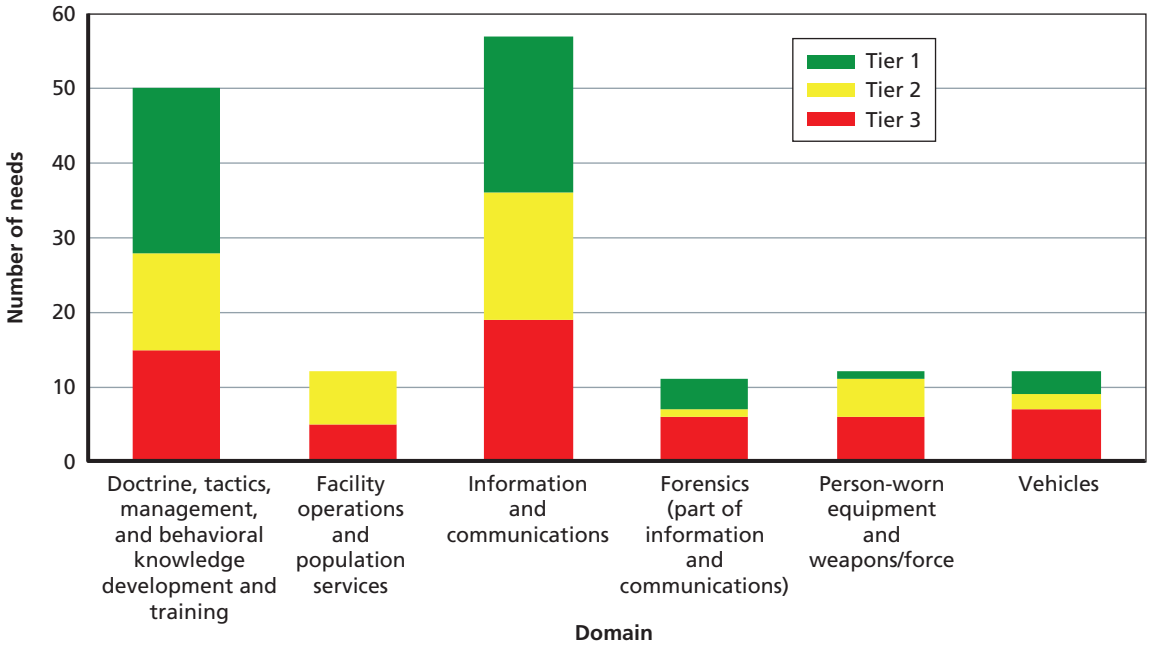
Figure 4.6
LEAP 2 Needs, by Priority Tier and LEAP Technology Taxonomy Domain



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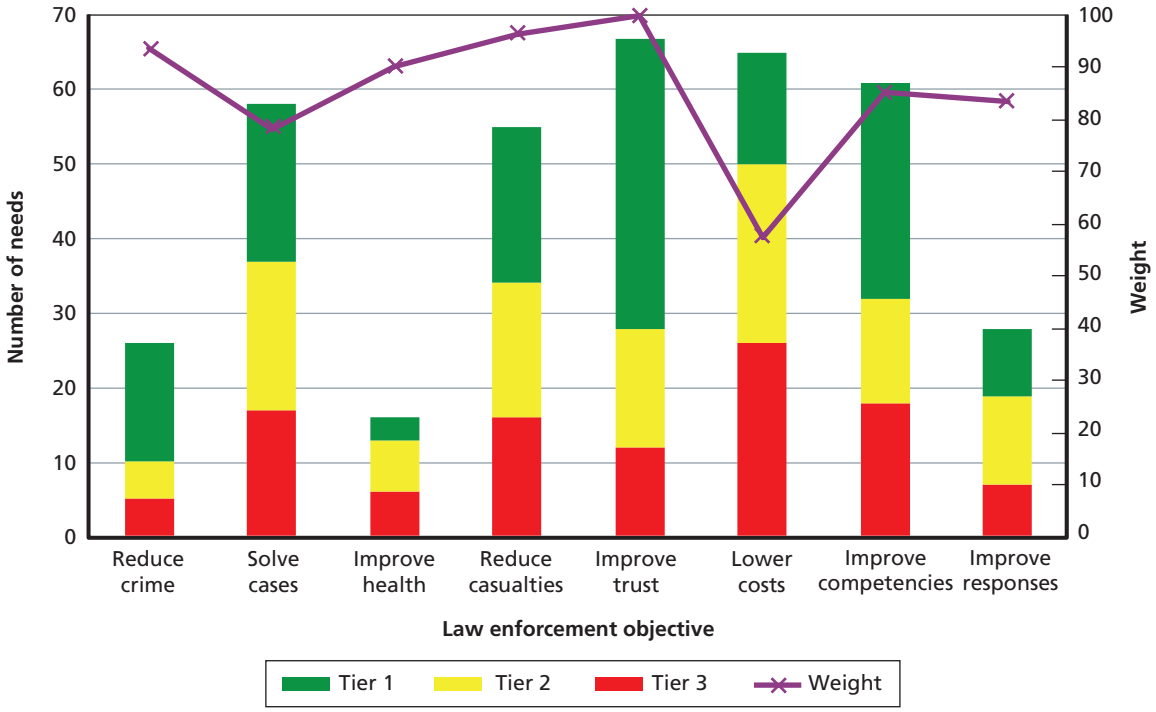
the information and communications domain (since it collects various forms of data), we have broken forensics out in Figure 4.6 for the sake of clarity.

In contrast, in the needs from LEAP 1 and related studies (Hollywood, Boon, et al., 2015), information and communications needs constituted a majority (about 53 percent), knowledge development and training needs constituted about 45 percent, and there were only a handful of needs from other domains (2 percent). So while information and communications and knowledge development and training needs continued to predominate in LEAP 2, they were no longer completely dominant.[2]

Considering the distribution of Tier 1 needs, we see that many are concentrated in (1) knowledge development and training and (2) information and communications, as would be expected given the prevalence of needs in those domains. However, some of the top-rated needs were concentrated in forensics and vehicles, as well. In contrast, facility operations has no Tier 1 needs, and person-worn equipment and weapons/force had only a few.

Figure 4.7 shows the LEAP 2 needs by tier and by the objective they support. The figure also overlays the weights that the panel put on each objective, for comparison, showing how the weight assigned to the objective (which was included in the prioritization algorithm to increase the ranking of needs that addressed highly weighted objectives) corresponded to the number

Figure 4.7
LEAP 2 Needs, by Priority Tier and Law Enforcement Objectives Supported



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[2] The predomination of information and communications and knowledge development needs in Hollywood, Boon, et al. (2015) likely had to do with the studies being under the auspices of the then-named NIJ Information and Geospatial Technologies Center of Excellence, which RAND managed. Although RAND did make efforts to identify needs from non-information domains during LEAP 1, we did not systematically identify needs in each domain, and the nature and name of the center may have led to some anchoring on IT issues.

of highly ranked needs. Despite the objectives' importance, there were only a few needs supporting the objective to improve officer health and only a few more supporting the objectives to reduce crime and improve incident responses. In contrast, there were many needs that related to lowering costs to agencies, although this objective was weighted as least important by a fairly substantial margin.

In contrast, in looking at Tier 1 needs, there were substantial numbers of top-tier needs supporting the objectives to reduce crime and, to a lesser extent, improve responses. There were only a few top-tier needs supporting the objective to improve health, however. Improving trust had the greatest number of supporting Tier 1 needs, consistent with the panel designating it as the highest-weighted objective. Improving competencies also had a high number of supporting Tier 1 needs.

Figure 4.8 shows how the Tier 1 needs broke down by type of technology, now taken down to three levels of detail (taxonomy domain plus two additional levels). This type of chart is called a *flow* or *Sankey* diagram. Each branch from left to right shows how the needs are categorized at increasingly lower levels of the taxonomy. The height of each branch is proportional to the number of needs in each category. For example, starting with all 51 Tier 1 needs on the left side of the diagram, 25 needs break off into the information and communications domain. Of those, seven break off into in the "Information Collection" category. Then, as shown on the right side of the diagram, of those seven, two needs are in the "Internal Data" subcategory, four needs are in the "Forensics" subcategory, and one need is in the "Surveillance" category.

Within the "Vehicles" domain, all Tier 1 needs dealt with UAVs. Within the "Person-Worn Equipment" domain, the one Tier 1 need dealt with improving armor. Within the "Information and Communications" domain, the biggest group of top needs dealt with systems to improve communications between the police and the public. Other categories seeing fairly large numbers of needs were "Forensics" and "Information Sharing." Finally, within the "Knowledge Development and Training" domain, the largest groups of top needs dealt with developing improved policing strategies, practices, and tactics.

Figure 4.9 compares the taxonomy categorizations of Tier 1 needs between LEAP 1 and LEAP 2. LEAP 2 adds Tier 1 needs outside of the "Information and Communications" and "Knowledge Development and Training" categories, including needs on physical forensics, UAVs, personal equipment, and dispatch center (i.e., PSAP) operations. Consistent with this panel's emphasis on improving community trust, there also was a dramatic increase in needs related to communicating with the public. There were also slight increases in needs for research and evaluation on crime reduction tactics, as well as needs to improve practitioners' knowledge of technologies.

In contrast, LEAP 1 had many more Tier 1 needs related to improving core attributes of IT systems, including needs related to information-sharing mechanisms; technology management; policies on privacy, security, and civil rights; and overall affordability. As will be seen from the review of the panel's discussion, these categories tended to be seen as (1) covered in LEAP 1 and (2) attributes to be embedded in needed technologies rather than as separate needs on their own.

Figure 4.8
Tier 1 Needs from LEAP 2, by Law Enforcement Technology Taxonomy

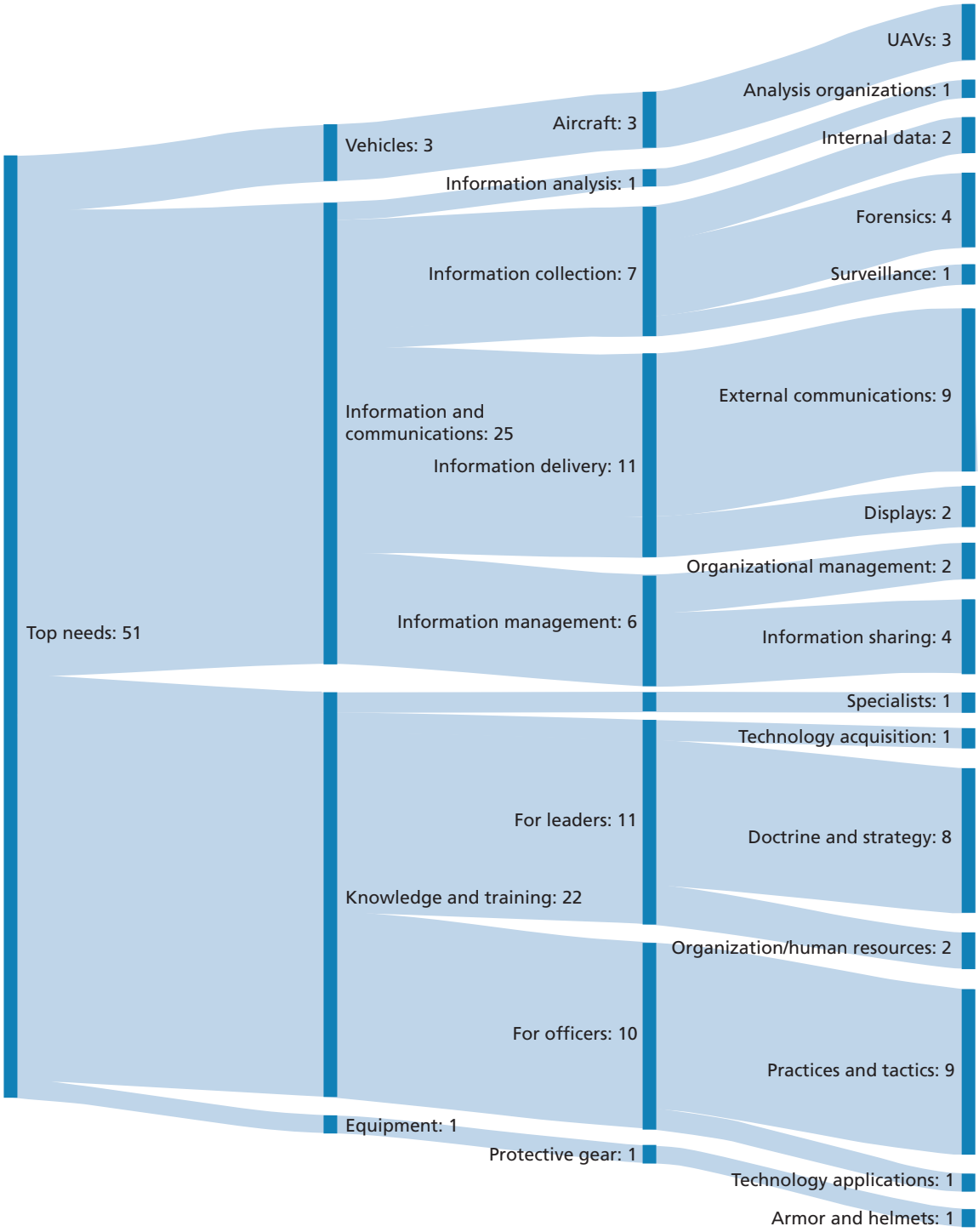

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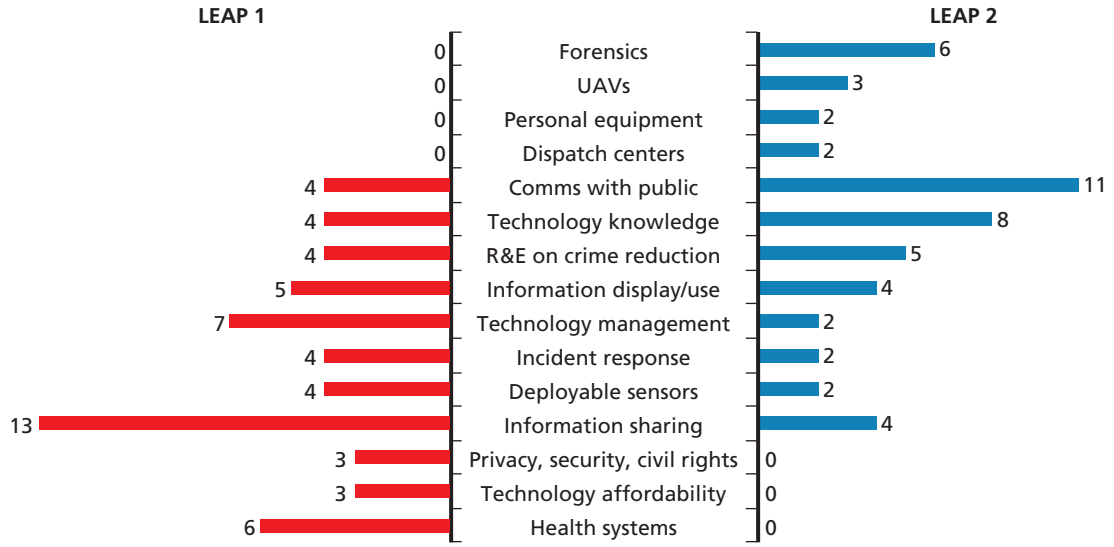
Figure 4.9
Comparing Clusters of Tier 1 Needs Between LEAP 1 and LEAP 2



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Top-Priority Law Enforcement Needs from LEAP 2

Table 4.2 presents a complete list of all Tier 1 needs from LEAP 2. Needs are subdivided by the top two taxonomy categorizations (domain and top-level category), then sorted by subcategory and overall EV within each subcategory. For each need, we show

- technology category
- issue (problem or opportunity) being addressed
- the description of the need, including both the issue (problem or opportunity) being addressed and the specific response
- the need's group, which is "O" if the need was from the operational session and "S" if the need was from the strategic/administrative session
- whether the need was at the top of Tier 1.

Addressing Specific Law Enforcement Objectives: Special Priority Needs

Because of the way that the prioritization is designed, needs that are relevant to many objectives get rated more highly than ones that relate to only a few. While this identifies the most important needs from an overall value perspective (as a need that contributes to many objectives simultaneously provides more widespread benefits), it risks missing needs that might be very valuable for law enforcement but that support only one or two objectives. If improvement on those objectives was viewed as particularly important by the panelists, then neglecting to identify those needs would potentially miss an opportunity to do so.

Another way to look at this is that we want to identify needs that panelists thought had especially high *unweighted* EVs (importance to law enforcement × technical feasibility × operational feasibility), which measure how much value panelists thought a need had for law enforcement in general terms. However, because such needs applied to only one or two objectives, they did not have an overall EV score that was high enough to get into the top tier.

Table 4.2
Top-Rated (Tier 1) Needs from LEAP 2

Category	Issue (Problem or Opportunity)	Associated Need	Group	Top
Doctrine, Tactics, Management, and Behavioral Knowledge Development and Training				
Management/ Leadership Knowledge Development andTraining	Lack of adequate mental health/ crisis/social services—both offered by law enforcement and external to law enforcement.	Assess adequacy of resources for mental health response and treatment at the regional or lower level, and implications on law enforcement of current situation.	O	*
	Overcoming "us versus them" mentalities between departments and communities.	Develop and disseminate best practices on sectoral policing and/or community relations.	O	*
	There is not a common understanding of the definition of what it means to use "evidence-based management."	Develop a very short document/ publication that discusses the various definitions and how common they are.	S	*
	Change management within law enforcement agencies is often insufficient or inadequate. Younger generations may have a greater desire to know "why" things are changing.	Develop easy-to-use, law enforcement–specific guidance on change management.	S	*
	Overcoming "us versus them" mentalities between departments and communities.	Disseminate and share best practices with respect to using existing resources across multiple priority areas.	O	
	Overcoming "us versus them" mentalities between departments and communities.	Need best practices for implementing restorative justice programs to mediate between the police and the community.	O	
	There are a lot of misconceptions of what community policing is and how it should be implemented.	Develop assessments of community policing implementations to determine which ones are more successful.	S	
	Evidence-based management practices are often not generalizable across different agency sizes and environments.	Examine ways to better present to decisionmakers assessments of what is known and what the "most promising" options are, given uncertainty in the specific situation and prior evidence.	S	
	Evidence-based management practices are often not generalizable across different agency sizes and environments.	Evaluate reports need to show information about when and where interventions/technologies are more or less effective—notably including qualitative.	S	
	Agencies often do not have sufficient analytic support (or tools).	Collect and disseminate "best practice" case studies on how to leverage existing free tools or free/ part-time analysts.	S	
	The pipeline from law enforcement to the court system is extremely slow and time intensive and may not always contribute to the best outcomes.	Explore law enforcement alternatives to the court system (alternative dispute resolution, restorative justice, arbitration/mediation, diversionary programs). In particular, assessments of cost and efficiency can have the greatest impact.	S	

Table 4.2—continued

Category	Issue (Problem or Opportunity)	Associated Need	Group	Top
Officer/ Practitioner Knowledge Development and Training	Important research results are not widely known by the practitioner community.	Need a research repository that (1) makes it easy for law enforcement to find and understand research results relevant to a problem and (2) pushes out pressing results they need to know.	O	*
	Training is often stovepiped into such categories as "firearms" or "tactical" and is rarely tied together until it is used in the field.	Need research and measures to assess the effectiveness of different modes, methods, qualities, and types of training integration.	O	*
	Lack of integrated training on problematic engagements.	Develop and evaluate training curricula on how to handle problematic encounters specifically, covering and integrating persuasion, crisis intervention, physical, and weapon elements.	O	*
	Training often concludes with repetitive use of force but often does not repetitively train on de-escalation.	Develop research and measures to assess the importance and effectiveness of additional de-escalation training.	O	
	Training best (and worst) practices and instructional design are either not well known or not implemented widely.	Develop a taxonomy or set of categories and supporting information that can be used to *evaluate* individual trainings on their compliance with promising practices (approaches and content).	O	
	Reduce information overload and lack of accessibility of academic/ technical papers.	Academics need to work with practitioners to create documents and training that can be read and understood quickly.	O	
	Training best (and worst) practices and instructional design are either not well known or not implemented widely.	Develop a taxonomy or set of categories and supporting information that can be used to *design* individual trainings on their compliance with promising practices (approaches and content).[a]	O	
	Lack of training on procedural justice methods.	Need research and measures to assess the effectiveness of different modes, methods, quality, and types of procedural justice training tools.	O	
	Even "known" research results tend to be known at top levels of an organization, not by officers in the field who need to implement them.	Need research on and dissemination of materials and practices that can push results—that can be easily understood—out to the field.	O	
	Size and amount of personally carried equipment can be burdensome/uncomfortable.	Need research on and dissemination of effective practices for selecting and carrying gear. Such practices should account for officer health, mission flexibility, and citizens' perception of appearance, to include informing the public of why gear is carried in certain ways.	O	

Table 4.2—continued

Category	Issue (Problem or Opportunity)	Associated Need	Group	Top
Specialist/ Technologist Knowledge Development and Training	There are varying levels of experience that are required to effectively handle digital evidence.	Assess training materials for all levels of responding and investigating and make recommendations for improvements.	S	
Information and Communications				
Information Analysis	Many agencies do not have crime analysis capabilities.	Need research on and dissemination of how to have crime analysis capabilities embedded in all agencies, including small/low-resource agencies.	O	
Information Collection (including Forensics)	Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources.	Examine and highlight the impacts of forensic backlogs on justice system processes and efficiencies.	S	*
	Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources.	Work to develop forensic backlog reduction grants beyond what already exists for DNA backlogs.	S	*
	Crime labs often need major updates.	Widen grants from DNA backlogs to include updates of other types of forensic equipment (physical and digital).	S	*
	Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources.	Examine the potential effects of "sharing arrangements" to optimize forensic analyst labor across state and local demands.	S	*
	Police use of social media for investigative purposes needs to be improved.	Explore and disseminate partnerships with universities, community colleges, and federal training programs (enrollment limited) that already provide training and support on Internet investigations, to make it a routine part of training and operations. Training must be free/very low cost and scalable.	O	
	There is a high cost for storage, cataloging, redaction, and deletion of body-worn camera video.	Develop best practices and best practice business rules for body-worn camera video.	O	
	There are significant business rule considerations in coordinating when cameras are turned on manually, automatically, and in a coordinated fashion.	Develop best practices for camera on/ off business rules.	O	
Information Delivery (including Communications)	Insufficient public and political recognition of just how endemic (or not) police misconduct situations are.	Invite researchers and "industry" organizations (e.g., IACP) to produce materials that raise the level of public information and increase the amount of context that the public and politicians have access to.	S	*
	Many information displays result in information overload for responding officers.	Assist software vendors with identifying the pieces of information that are relevant to officers at particular stages in a response or an investigation.	O	

Table 4.2—continued

Category	Issue (Problem or Opportunity)	Associated Need	Group	Top
	Overcoming "us versus them" mentalities between departments and communities.	Need tools and online environments to facilitate the level of feedback and two-way information exchange expected by the public. ("Bring the police department to the people" and "real listening.")	O	
	Law enforcement officers do not have much control over how they are portrayed in popular culture (the military does a better job in this regard).	Develop strategies and best practices for ensuring that the community has sufficient information about law enforcement activities and events.	O	
	Overcoming "us versus them" mentalities between departments and communities.	Research on IT databases and systems that can support police-community engagement, providing officers with the ability to capture and share information they learn from the community.	O	
	Existing "business intelligence" systems do not capture and make best use of the data that are already being collected.	Develop best practices for integrating and using existing internal and community data for evaluating operational success.	O	
	Many officers are experiencing data overload and information overload.	Need measures and methodologies for deciding whether new technologies are sufficiently mature and truly value added.	O	
	Mass media stories are often riddled with inaccuracies.	Collect and share best practices where social media can be used to correct inaccuracies disseminated by mass media.	S	
	Open data/transparency may give the public the incorrect impression of what is actually going on (e.g., "shots fired" ended up being firecrackers, "dangerous area" is a busy shopping mall).	Develop best practices surrounding ensuring that the appropriate levels of context are available to consumers of "open" data (less frequent events—e.g., officer-involved shootings provide an opportunity to include narrative context).	S	
	The public is generally unaware of the benefits of certain technologies carried by officers (pistols vs. rifles), which often results with only inferior technologies being authorized for use.	Assess the state of existing public education materials for these situations.	S	
	The public is generally unaware of the appropriate tactics and techniques for responding to active shooter situations in group settings.	Assess the state of existing public education materials for these situations.	S	
Information Management (including Sharing)	Consolidation efforts for dispatch centers often focus on the personnel and cost benefits, but not on other risks, such as lack of familiarity with the local area.	Study the risks and benefits of dispatch center consolidation.	S	*
	Data systems are often not compliant with data interchange standards (and vendors are resistant to facilitating data interchange).	Have DOJ publish model interoperability language that can be readily dropped into requests for proposals for new RMSs. Language will need to support being configured for different sizes and types of agencies.	S	*

Table 4.2—continued

Category	Issue (Problem or Opportunity)	Associated Need	Group	Top
	Could use entity resolution/federated search tools to pull together related information across multiple government databases.	Explore application of entity resolution technologies from private sector to criminal justice applications, to include assessing effectiveness and long-term costs of existing commercial tools.	O	
	Some PSAP operators are confined to a fixed script that makes it difficult to get the full set of information in a way that is the most useful for law enforcement (sometimes it is optimized for fire and emergency medical services [EMS]).	Research the locally optimal sets of questions (with branching) to gather the critical information and be able to dispatch law enforcement, firefighters, and EMS.	S	
	Agencies unwilling to share data.	Gather and disseminate positive use cases (e.g., Law Enforcement Information Exchange [LInX] program).	S	
	Lack of capability for firearm dealers to digitally and rapidly transmit suspicious activity reports and have those reports evaluated and shared.	Study the state of the problem and provide recommendations for potential data-sharing solutions.	S	
Person-Worn Equipment and Weapons/Force				
Personnel Clothing, Protection or Augmentation	Body armor needs to be lighter and cooler, with coverage expanded and effectiveness improved.	Examine ceramic/advanced technology effectiveness and cost in body armor.	O	
Vehicles				
Aircraft	There are concerns from the community/local governments about using UAVs.	Need a model policy for basic law enforcement use of UAV technologies.	O	*
	There are concerns from the community/local governments about using UAVs.	Identify and publicize specific use cases for UAVs (barricaded subjects, crime scene investigations) that have high utility and no privacy concerns.	O	*
	Insufficient research and policies exist on how to limit collateral property or privacy damage from law enforcement use of UAVs.	Conduct research on the risks and benefits of UAV use in law enforcement.	O	

[a] At first glance, this need appears to be a duplicate of one two rows above. However, the first need is about a taxonomy for evaluation; the second need is about a taxonomy for designing training. It is anticipated that the two taxonomies would be somewhat different.

(Top-tier needs typically apply to three or more objectives.) We refer to these needs as *special priorities*. Table 4.3 shows the seven special priority needs, organized by the primary law enforcement objective they support. As shown, three needs focused on helping law enforcement solve more cases; one on improving community trust; one on lowering costs for agencies; one on improving (cyber) competencies; and one on improving incident response.

Additional High-Value Needs and "Low-Hanging Fruit" Needs

In considering building research and development portfolios, needs that have high EV (our top-priority needs) or focus on special priorities represent the core components—they are the

Table 4.3
Special Priority Needs Supporting Particular Objectives

Objectives Supported	Group	Issue (Problem or Opportunity)	Associated Need
Solve more cases	S	Insufficient data exist to adequately measure the impact of forensic backlogs and other bottlenecks on criminal justice system efficiency and throughput.	Do a study to measure the impact of forensic backlogs on case solution and justice outcomes. *Note*: This need also supports the objective of lowering costs.
	S	Significant amounts of excess evidence are being retained well beyond retention standards.	Study the costs of storing evidence (and excess evidence). *Note*: This need also supports the objective of lowering costs.
	S	Significant amounts of excess evidence are being retained well beyond retention standards.	Study the state of evidence-prosecutor-court data interchange to facilitate helping agencies to decide when evidence is no longer needed. Potentially examine the effect of adding "expiration dates" to evidence records to trigger the discussion about whether evidence should be retained. *Note*: This need also supports the objective of lowering costs.
Improve community trust	O	Overcoming "us versus them" mentalities between departments and communities.	Develop measures for evaluating the success of activities for improving the relationship between law enforcement and the community.
Lower costs	S	After products and services are acquired, sustainment funding is often difficult to identify.	Ensure that model acquisition contracts consider or include multiyear sustainment costs at the time of acquisition.
Improve competencies	S	Law enforcement agencies are increasingly using IT to conduct business and, as a result, are increasingly vulnerable to cyber attacks (much as other U.S. offices are).	Develop "red team" services that are available to law enforcement agencies to test their personnel behavior and other defenses. *Note*: This need also supports the objective of lowering costs.
Improve response		Ongoing non-interoperability of radio networks—cost of upgrades is a major factor.	Explore ways to improve adoption of existing technological solutions for radio interoperability by agencies and their funders. *Note*: this need also supports Lowering Costs

needs that are both highly valued and likely to succeed. However, for building a balanced portfolio, two other possible categories may be relevant. If there are needs that are extremely valuable to the field but whose EV was lowered because they were considered very risky, targeted efforts to reduce risk might still be worthwhile. We term this potential subset of needs "high-value needs" because they were rated by the panel as valuable but were viewed as too risky to be high priorities. At the other end of the spectrum, there may also be needs that are viewed as extremely low-risk—that is, the panel viewed them as highly likely to succeed—but whose ratings for value were too low for them to be considered high-priority. In considering a research portfolio, those needs should never be the core (since their value might be only middling compared with other needs), but including some of these needs could help reduce the risk

of the portfolio overall. We term this potential subset "low-hanging fruit" to emphasize their easy but less important character.

Translating this to our ranking scales, *high-value needs* are those needs with a median importance score of 8 (the top median importance score seen), which means that panelists thought they were highly important with respect to at least one objective, although the panelists also rated them as having substantial risks. Table 4.4 shows six such needs that are not already in Tier 1 (Table 4.2) or not a special priority (Table 4.3), this time by the two law enforcement objectives they principally support.

We also looked for needs that can be considered "low-hanging fruit," which are needs that had top-rated median risk scores (defined as technical feasibility score × operational feasibility score). All low-hanging fruit needs were already captured either as Tier 1 or special priority needs, so no additional needs were identified in that set.

Table 4.4
High-Value Needs

Objectives Supported	Group	Issue (Problem or Opportunity)	Associated Need
Solve more cases	O	Data and evidence are on disparate systems in disparate formats and are difficult to collate into a single "record" that can be shared, viewed, redacted, and deleted as a set.	Implement a system for collective record management. *Note*: This need also supports the objectives of improving community trust, lowering costs, and improving competencies.
	S	Data systems are often not compliant with data interchange standards (and vendors are resistant to facilitating data interchange).	Ensure that federal grants supporting the purchase of data systems require compliance with data interchange standards. *Note*: This need also supports the objective of lowering costs.
	S	It is difficult to integrate forensic and case information in an automated fashion (which can include or exclude suspects across a large set of cases).	Conduct research to assess the state of the problem and recommend potential solutions. Some solutions might include adapting and integrating existing solutions for real-time analysis (e.g., CrimePad, Visionaire, OSSI). *Note*: This need also supports the objective of lowering costs.
	S	It is extremely difficult to monitor and track the progress and disposition of court cases.	Develop data interchange standards (including business rules) to facilitate making the connection between law enforcement records and court records. *Note*: This need also supports the objective of lowering costs.
Reduce casualties	O	Need more-reliable and safer incapacitation weapons than the status quo (conducted energy weapons, beanbags, pepperballs).	Need research to develop weapons and practices that have consistent effects in stopping suspects.
	O	Insufficient pursuit mitigation/vehicle immobilization technologies to address changes in pursuit policies.	Need research on remote immobilization technologies.

CHAPTER FIVE

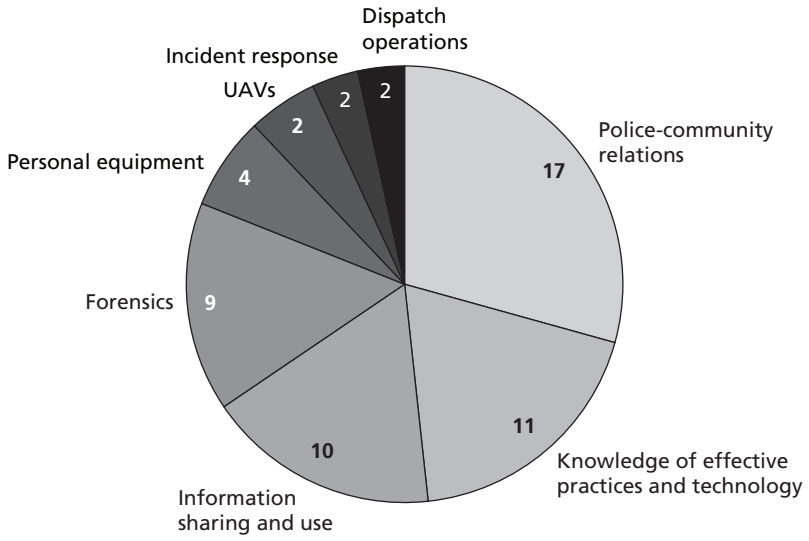
Conclusions

The Law Enforcement Advisory Panel covered a wide range of issues and needs (see Appendix F for the complete listing). After prioritization, however, the top needs were more focused around a few key themes. Figure 5.1 shows the themes and the number of high- and special-priority needs contributing to each theme.[1]

The top-ranked needs can be divided roughly into five categories:

- About 30 percent were needs to improve police-community relations.
- About 20 percent were needs to improve law enforcement's knowledge of effective practices and technology.
- About 17 percent were needs to improve law enforcement's sharing and use of information.
- About 15 percent were needs to improve law enforcement's forensic capabilities.

Figure 5.1
Building the Law Enforcement Innovation Agenda



RAND *RR1814-5.1*

[1] Figure 5.1 reflects both Tier 1 needs and special priority needs, as discussed in Chapter Four.

- The remaining 18 percent were in a variety of other areas, including personal equipment, UAVs, incident response, and dispatch operations.

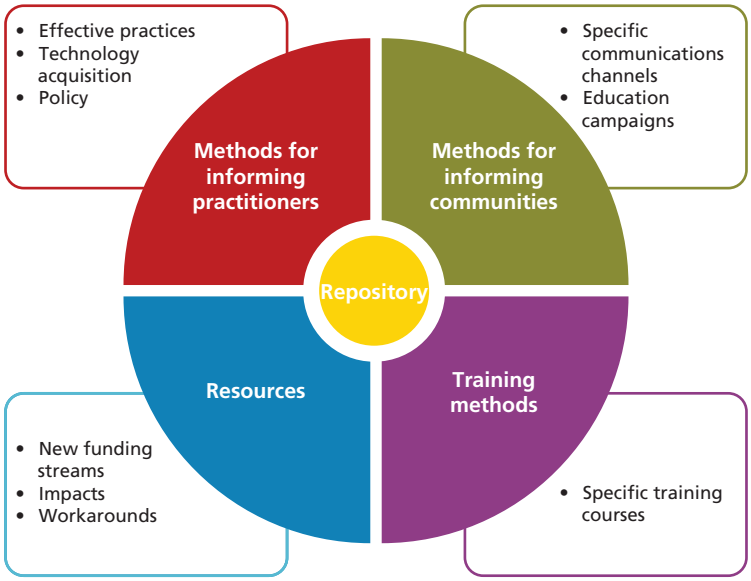
We discuss these themes below, starting with improving practitioners' knowledge of effective practices and technology. While this theme has notably fewer needs than improving police-community relations does, from the panel's discussion, it is an underlying necessary condition to make progress in all the other areas, including police-community relations. We also include points of discussion from the panel when those points provide useful context. We conclude with a near-term roadmap for action, focusing on the highest-ranked needs within Tier 1, as well the special priority needs, followed by concluding remarks on fostering innovation in U.S. law enforcement.

Improving Practitioners' Knowledge of Effective Practices and Technology

As in LEAP 1, assisting practitioners in learning about effective practices and technology was a top theme of LEAP 2. Beyond the specific needs, panelists noted that enhancing knowledge was an underlying theme for the LEAP 2 needs in general, as well as a broad necessary condition for being able to implement innovations widely. To see how, Figure 5.2 provides an information map on how LEAP 2 needs are largely about educating practitioners.

At the edges of the map are calls for assistance in specific areas of concern, which were often calls for *knowledge products*, such as guidance, best practices, and model policies. These are supported by an inner ring of needs to improve how scientific results, technologies, and funding opportunities are disseminated to law enforcement generally, At the center, enabling dissemination in support of all other needs, is a common repository for capturing and sharing

Figure 5.2
A Radial Structure of Prioritized Needs



RAND *RR1814-5.2*

law enforcement knowledge. Below, we discuss the themes and needs represented in Figure 5.2, starting with the repository and working outward.

Need for a Research Repository

Panelists noted that important research and technology results are not widely known by the practitioner community. In this top-ranked need, they called for a repository that (1) makes it easy for law enforcement to find and understand research results relevant to a problem and (2) pushes out pressing results law enforcement needs to know. The call for a centralized repository of criminal justice knowledge has been seen previously; LEAP 1 had a top need titled "Create a repository of promising practices with supporting evidence and tools" (Hollywood, Boon, et al., 2015, p. 52).

There has been a great deal of progress in posting articles and educational material on practices and technologies to the web. Table 3.1 showed a just a small sample of educational resources for law enforcement agencies about technologies and practices. These examples are very far from a complete list of the numerous resources that are available to law enforcement agencies. However, these postings and sites are widely dispersed, with little more than Google (or other general Internet search engines) to serve as the central portal and indexing service. There is little to specifically match users and their needs to the right resources, much less mechanisms for prioritizing the resources with which a user should start or pushing out to users the latest and most important findings. Instead, users are typically left to navigate numerous sites and lists of documents and links within sites. The knowledge largely is out there; what is left is the challenge of making it better accessible and useful to practitioners in an integrated way.

In terms of what types of knowledge should be on the portal, panelists made clear that the repository should provide information on technologies, including reviews of specific systems, in addition to information on what works for practices and programs. There was a pronounced desire for the repository to serve as a "Consumer Reports" or "Yelp" of law enforcement technology, providing reviews from practitioners and discussions on pricing and other contractual details and conditions.

With regard to cost, participants hoped for a portal for data on what agencies had paid previously, whether there were ongoing maintenance costs for given pieces of equipment, and model contracts that included full costing (including sustainment costs). Participants were also interested in information on bulk purchasing agreements. In addition, they wanted the repository to include cost-benefit analysis information about major investment decisions, such as credentialing programs, major technology purchases, consolidations, and whether other major changes were "worth it," and under what conditions.

Panelists were also interested in having the repository point to information on privacy, civil rights, and cybersecurity protections for new technologies. LEAP 2 had few top-rated needs on these topics; instead, the discussion focused on privacy, civil rights, and security as attributes that needed to be embedded by default. One panelist noted that a majority of the issues discussed raised legal risks and that legal expertise needs to be brought in to help develop strategies, policies, and core requirements for new technologies as they are brought into law enforcement.

In addition, panelists were also very interested in a single source to learn about all of the grants, funding, and other resourcing opportunities that were available, for different purposes. The repository was seen as a home for this source, as well. Panelists were also interested in the repository providing information on model policies and contracts.

Needs for Research on the Dissemination of Research and Technologies

Panelists called for "research on research"—improving how research and evaluation results are documented and disseminated to practitioners. We have seen similar needs previously. For example, RAND's Law Enforcement Futuring Workshop had a top-rated need on "research on methods to disseminate innovative, promising practices" (Silberglitt et al., 2015, p. 42). Panelists brought up a number of points to consider when sponsoring research to improve research and dissemination.

First, panelists noted that while there is a strong appetite among law enforcement for research, it must be translated to a format that is easily consumable. Participants stressed the need for findings that are presented in the most accessible format possible ("We don't want to read your 100-page study" was a comment many panelists agreed with). Where possible, findings should be actionable, suggesting a course of action that could be taken. More broadly, panelists noted the importance of better presenting uncertainties to decisionmakers in ways that would get them to make more-logical decisions.

Second, panelists noted that there is no "one-size-fits-all" solution. Agency size is one of the most important, but not the only, characteristic that must be accounted for when attempting to identify a solution or best practice. Efforts should be made to identify contexts, agency characteristics, or other differentiators in which a given solution is more or less likely to work.

Third, panelists noted that when referring to best practices, who determines which practices are "best," and how "best" is defined, can be controversial. Some of this plays into the need to better define "evidence" in the context of police practices (more on this below).

Fourth, panelists noted that identifying "worst practices" and "do not do's" is as valuable as identifying best practices, and may be more realistic. One potential example cited was public commentary by law enforcement officials; while a need for more and better training was cited, it was also acknowledged that it can be difficult to foster the instincts needed for strong public commentary and that it may be more realistic to simply provide lists of "things to definitely not do."

One starting point for "research on research" will be findings and methods from translational criminology, which assesses, and seeks to improve, the means by which scientific findings from criminological research get converted into practice (see, for example, Lum and Koper, forthcoming). Translational criminology has been an ongoing focus of NIJ, starting in 2011, when it was a theme of the annual NIJ Conference (Laub, 2011).

Needs for Improving Management Practices

There were two high-priority needs related to helping agencies improve general management practices, one on assisting agencies with understanding "evidence-based management," and one on assisting agencies with change management. For the former, several participants noted that the term *evidence-based policing* was one of many phrases that can effectively encompass so many competing practices as to essentially be meaningless. Participants expressed a desire to focus the aperture so that it would be possible to know what was truly evidence-based (in the rigorously academic, statistical "proof" sense) and what was not.

In the change management area, panelists noted that technology and public expectations and norms as they related to law enforcement are changing rapidly, and agencies need help managing these changes, leading to a need for brief, easy-to-use guidance on using change management techniques within law enforcement. Several participants indicated that law enforcement agencies in general are poor at change and need practical training in this area. However, several

participants cautioned that, realistically, most agencies do not have the budget, time, or ability to devote attention to deal with learning change management strategies and that any such guidance or training needs to be very easy and short. Panelists also noted that, in some circles, there is acute resistance to changes. There are a number of counter articles against police reforms. As examples, a Los Angeles Police Officer writing under the pseudonym Jack Dunphy has called for a return to aggressive policing techniques (Dunphy, 2015, 2016). FBI director James Comey has similarly claimed "that a viral video effect could well be at the heart" of the recent crime spike in some U.S. cities, as "There's a perception that police are less likely to do the marginal additional policing that suppresses crime—the getting out of your car at 2 in the morning and saying to a group of guys, 'Hey, what are you doing here?'" (Lichtblau, 2016). Change management strategies will need to be able to respond to such objections directly.

Desires for change management specifically included calls for help in evolving agency structure, hiring, retention, and human resources. For example, panelists discussed whether agencies should reconsider preconceptions regarding the appropriateness and desirability of sworn and civilian personnel for specialized jobs, such as IT. More broadly, panelists discussed how agencies may want to explore new models and practices for human resources in a more technology-intensive age.

Needs for Research on Training Methods

Panelists called for core training methodologies to be improved along several dimensions, starting with developing a core taxonomy of effective training methodologies that could be used to design or evaluate specific trainings. In this context, *taxonomy* means a classification scheme and outline list that specifies various types of trainings and curricula that are most appropriate for different educational purposes. Panelists also noted that work needs to be done to address "information overload" involved in training, as today's officers are being overloaded with administrative memos, online training, and PowerPoint presentations.

Panelists noted that training is often disjointed, with stovepiped courses on single areas, such as lethal weapon training, tactical training, communications skills, and reporting skills. However, they noted that officers have to use these skills together in a coordinated way in the field, leading to a top-rated need to assess approaches to integrating related training skills.

As a core example, panelists noted that training related to addressing problem encounters is disjointed, with separate courses on deescalation, mental health crisis intervention, physical grappling, and use of less-lethal and lethal weapons. The panelists top-rated a need to develop an integrated curriculum that combines all of these elements, as an officer may have to use any of them at any time during a problematic contact.

Improving Police-Community Relations

Improving police-community relations had the highest number of top-tier needs; the law enforcement objective to improve trust and cooperation with the community similarly was rated as the most important objective for law enforcement. From the discussion, this theme is largely in response to the social and political tensions raised in recent years, following the officer-involved shootings and civic unrest in Ferguson, Missouri, and Baltimore, Maryland.

As noted in Chapter One, given the importance of trust and police legitimacy for legal compliance and cooperation, community relations are a critical component of policing. Tech-

nology can help or hinder them, but, as panelists noted, the problems are clearer than the solutions. Technology would seem to be an obvious means to help support improved relations; however, while the potential for new technology to create new problems is clear (for example, the failure to use social media or to use it effectively), the solutions are less clear. Needs in support of community relations fell into several groups.

Improving How Agencies Inform the Public

Four top-tier needs dealt with helping agencies better explain law enforcement operations to the public. In addition to increased community tensions, panelists noted that poor explanations could lead to adverse political decisions being made that could jeopardize officer and community safety. This led to calls to help agencies get their story out on how and why law enforcement operates, what particular pieces of equipment really do, and how frequent police misconduct really is—panelists noted that police misconduct was much rarer than is expressed in the media. A final need called for helping agencies better leverage social media to respond in "real time" to information, especially erroneous information.

A related need concerned educating the public about how to interpret law enforcement data. Participants acknowledged that open data and transparency initiatives are inevitable and desirable, but some expressed concern that they had been undertaken too quickly, creating circumstances ripe for misinterpretation by the public.

Community-Centric Policing Strategies

Panelists noted that one of the most frequently cited solutions for improving community relations, as well as substituting for aggressive policing tactics, is to employ community-policing techniques. They also noted that there is a great deal of variation, confusion, and misperception as to what community policing is. In response, they called for best practices on community policing strategies, as well as practices for agencies to work collectively, sharing resources to implement these strategies. Panelists also called for assessing law enforcement–initiated alternatives to criminal justice court proceedings, such as alternative dispute resolution, restorative justice, arbitration/mediation, and diversionary programs.

Improving Encounters with the Public

Problematic encounters with the public—especially those that proceed to uses of force—have been a major driver of problems in the police-community relationship. As a result, panelists called for additional research, evaluation, and curricula development for two classes of interventions commonly suggested for improving how officers deal with the public: deescalation and procedural justice training.

Tools for Community Engagement

Panelists called for communications tools and databases they could employ to get feedback from community members and take action correspondingly. A key point of the discussion was that agencies need to actually listen to the feedback, "truly listening" to concerns from the community, and to create a feedback loop so that the community would have evidence that law enforcement had heard their concerns, even if law enforcement has not necessarily taken every action or made every change desired by the community.

Addressing Mental Health Shortfalls

Panelists noted that there is a lack of adequate mental health, crisis, and social services resources for both the community and law enforcement practitioners. They called for a study to assess the extent of the shortfalls in regional and local treatment, as well as the implications.

Improving Information Sharing and Use

Despite the opportunities represented by new and emerging technologies, many IT discussions came down to improving basic systems and information sharing among components of the criminal justice system, as well as the processes (including contract language, as noted in a top-tier need) needed to acquire and employ them. While newly available equipment presented intriguing opportunities, many discussions returned to a common theme: Law enforcement agencies often lack basic IT systems and processes that have been common for some time among the private sector and in other industries. Panelists called for IT improvements in the areas of crime analysis, alleviating information overload, and a variety of other topics.

Improving the Reach of Crime Analysis

Panelists greatly appreciated the role of crime analysis in support of law enforcement operations and discussed how all agencies should employ crime analysis. Across agencies, panelists called for examining how all law enforcement agencies could get access to crime analysis capabilities, especially small and rural agencies, as well as agencies with few resources to pay for full-time analysts and tools. Within agencies, there was interest in making crime analysis more affordable and cost-effective.

Panelists proposed two strategies to improve the accessibility of crime analysis. The first was to prepare best practice case studies describing how agencies have used free and low-cost analysis tools. The second was to assess and disseminate alternative business models for crime analysis besides hiring full-time analysts, which panelists noted was not affordable for small agencies and agencies with very limited resources. These alternative models included the use of part-time analysts and analysts contracted through a company (an example might be that the contracted company would provide canned analyses, such as crime maps and alerts, as well as a certain number of expert analyst hours per month to address specific crime problems).

Mitigating Information Overload

One point of discussion was that "officers are getting sick of technologies—they just want to do their jobs." Panelists noted that since agencies already do not feel they are able to train officers sufficiently on topics such as technology, even on the basics, new tools and systems can leave officers worn out and overloaded.

To address this, panelists called for methods to assess whether a potential IT system provides enough operational value, and is sufficiently mature, to be worth deploying in the field. Panelists also called for working with software vendors to help them better recognize what pieces of information officers actually need, and how they need to see (or hear) it, during different law enforcement activities.

Improving Other Capabilities to Share Information

Panelists identified a number of other top-ranking IT needs:

- Develop and disseminate positive use cases for information sharing. This was seen as important to help overcome agencies' ongoing cultural resistance to sharing information, as it would show them what could be gained, operationally, through sharing.
- Explore the use of entity resolution technologies for federated search across government and commercial systems, which would be useful for a variety of law enforcement applications in which one wants to get all available criminal justice information about a subject from sources across the country (e.g., to determine whether the subject has a criminal record or is wanted elsewhere).
- Develop and dissemine model interoperability language for use in RMS (and other data management system) requests for proposals. This was seen as something that could help agencies overcome vendor resistance to making their systems comply with data exchange standards.
- Disseminate—and work to improve the adoption of—existing radio interoperability solutions. Panelists noted that technologies needed to get agencies to be able to talk over radio systems across agency boundaries have been fielded for some time; the focus needs to be on publicizing the solutions.

Improving Forensics Capabilities

Addressing Backlogs

The bulk of the discussion and needs in forensics had to do with forensic backlogs, their adverse impacts on the criminal justice system, and that these problems were primarily due to a lack of resources. Participants also noted that while much attention and resources have been placed on DNA forensic, backlogs have tended to be worse in other areas. As a result, participants identified a series of top-ranked needs addressing resource shortfalls in forensics, including studying backlog DOJ and shared-service models for forensics. The most substantive needs, however, called for DOJ to broaden forensic grants to address modes besides DNA.

Panelists also discussed challenges in storing large backlogs of physical evidence. Panelists noted that having to store volumes of physical evidence indefinitely may result in both higher facility costs and higher labor costs to find, access, and manage all of the evidence when needed. They even noted that problems in finding and maintaining evidence in large stores could result in problems solving particular cases.

Capabilities for Digital Investigations

Participants noted that there is a rising tide of digital evidence collection that will have implications for everyone involved in criminal justice, including practitioners across all spectrums and academia. New, already available, and yet-to-be-developed technology for collecting digital evidence is likely to have rippling effects across all roles in the criminal justice system. Consequently, participants called for assessing and improving training materials for digital evidence. On the topic of the use of social-media in investigations, participants suggested partnering with universities and federal agencies to develop training programs. They also emphasized that

the classes need to be very low-cost (and ideally free) and scalable to reach large numbers of investigators.

Integrating Data Needed in Investigations and Court Cases

Panelists identified a set of high-risk, high-reward needs that collectively deal with integrating all the data needed in a given criminal investigation or court case. These include calls for solutions to integrate connections between criminal incident records, criminal investigative records, forensic analysis results, and court case records, allowing users to create and pull a single "record" with all key data related to a particular investigation, subject, or court case.

Priority Needs for Personal Equipment

Body-Worn Cameras

Participants noted that body-worn cameras represent one of the first waves in a likely series of exposures to new information regarding law enforcement to which the public did not previously have access. The prevalence of body-worn cameras, as well as privately owned cameras and recording devices, means that the public is rapidly becoming exposed for the first time to images of law enforcement activity that have not previously been broadly seen. There is a danger of misinterpretation and inappropriate reaction. As a result, participants called for assistance in developing best policies and practices for body-worn cameras.

Body Armor

Participants noted needs for body armor that is lighter, cooler, more effective in stopping rounds, and that covers a larger area. They recommended examining ceramics and other technologies to see whether these could be used to increase performance at lower cost.

General Size, Weight, and Appearance of Personal Gear

Panelists noted that the size and weight of personal gear can be burdensome, and that the appearance of gear can cause tensions with the public. They called for research and dissemination of practices for selecting gear, carrying gear, and informing the public of why different types of personal gear are needed.

Technologies to Reduce Casualties: Incapacitation Devices

Panelists noted that current less-lethal weapons, including conducted energy weapons, beanbags, and pepperballs, have major effectiveness, reliability, safety, and human factor limitations. They identified a high-risk, high-reward need to develop technologies that are more consistently effective in stopping violent suspects.

Priority Needs for Vehicles

Policies and Use Cases for Unmanned Aerial Systems

UAV use by law enforcement was a high-interest topic during LEAP 2, with panelists noting both major potential benefits and major risks. Panelists noted that local communities and governments often have high concerns over law enforcement agencies using UAVs. In response,

they first recommended developing and publicizing cases they expected to be both highly useful and noncontroversial, with examples including overwatch of barricaded subjects and crime scene investigations. Panelists noted the opportunity of using UAVs to deliver payloads onto an incident scene and recommended that the analyses developing UAV use cases consider that concept, as well. They also noted a lack of knowledge on how to limit both physical property damage and collateral privacy and civil rights damages by using UAVs, leading to a request to develop approaches to mitigate privacy and civil rights risks. Finally, panelists recommended developing a model policy for basic law enforcement uses of UAVs; note that the existing IACP "Recommended Guidelines for the Use of Unmanned Aircraft" (2012) were not discussed, so there was no consideration on whether and how the guidelines should be revised to serve as the model policy.

Technologies to Reduce Casualties: Remote Vehicle Immobilization

Panelists discussed that new limitations on pursuits meant that suspects were more likely to be able to escape law enforcement (and ongoing risks of high-speed pursuits remain of high concern). They identified a high-risk, high-reward need for research and development (R&D) of technologies capable of safely stopping and immobilizing a vehicle trying to flee from law enforcement.

Priority Needs to Improve Dispatch Center Operations

At LEAP 2, there was a push-pull tension among participants regarding the merits of consolidation and resource sharing, focused on public safety access points (911 call-taking and dispatch centers). Panelists agreed on the value of joint purchasing agreements, and somewhat on joint asset ownership, especially for rarely used equipment. However, there was an equally strong sentiment that asset sharing and consolidation could be "disastrous" in some cases, with several participants citing problematic consolidations of fire and police dispatch. Participants wanted operational and financial efficiencies but also wanted to retain ownership, direction, and control of important assets. Participants also called for research into improving the specific question trees used by PSAP operators.

Priority Needs for Improving Defenses Against Active Shooters

LEAP 2's panelists discussed the importance of improving law enforcement's capabilities to respond to mass shootings and other acts of terrorism. To preempt active shootings, panelists called for ways to improve how suspicious activity reports from federally licensed firearms dealers are reported, evaluated, and shared. This need responded to concerns that processes to solicit and handle tips from firearm dealers about suspicious weapon purchases need to be improved, starting with ensuring that reports can be transmitted digitally. Panelists expressed concerns that, in some cases, dealers had reported suspicious activities by people who went on to be active shooters.[2]

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[2] ABC News reported that the shooter responsible at the Pulse Nightclub in Orlando, Florida, was reported to the FBI after he tried to purchase very high-end body armor and bulk quantities of ammunition. However, because the store did not

Externally, panelists called for assessing materials intended to educate the public on how to respond to mass shootings. They discussed that despite ongoing education campaigns, the public is largely unaware of how to respond to an active shooter effectively.

Fostering Innovation in U.S. Law Enforcement: A Short-Term Roadmap

Below, we present a roadmap describing potential ways ahead to address the highest-priority needs emerging from LEAP 2. Table 5.1 presents needs and potential innovation options for the top-scoring needs within Tier 1 and special priority needs (needs with the highest score with respect to any single objective). We have placed the needs and options in the same order as the themes above: practitioners' knowledge of effective practices and technology, police-community relations, information sharing and use, forensics, and others.

Topics for Further Study

In looking at the results of LEAP 2, we do see a few topics and law enforcement objectives that are comparatively lacking in priority needs. The top such area concerns processes and technologies for improving officers' physical and mental health. This was a highly ranked law enforcement objective but had the fewest supporting needs in both LEAP 1 and LEAP 2, and may be well worth a follow-on expert panel.

Of lesser priority would be getting additional needs related to improving law enforcement response to major incidents and improving capabilities to reduce crime. Both objectives were also somewhat lacking in priority needs. That said, efforts on incident response would need to be coordinated with the development and education efforts of DHS, such as with DHS's First Responders Group (U.S. Department of Homeland Security, First Responders Group, 2016). Needs to reduce crime were well-covered in LEAP 1, and a number of top priority needs in LEAP 2 relate to reducing crime, as well.

Finally, as with LEAP 1 (albeit to a much lesser extent), knowledge/process and IT needs were dominant. It may be worthwhile to have a panel that looks specifically at physical plant furniture and equipment needs, covering personal gear, weapons, chemical forensics, and vehicles. As one example, a point of discussion in LEAP 2 was that vehicles are the biggest cause of line-of-duty deaths for officers, and that ways to reduce vehicular deaths are not being looked at adequately by car companies, gear suppliers, and agencies.

Concluding Remarks

If we were to summarize the results of LEAP 2, we would say there are four top takeaways:

- There needs to be a major effort to make progress on the persistent, underlying problem of practitioners being unaware of key technologies (both physical systems and model policies and processes), much less understanding how to acquire and use them effectively and efficiently.

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have the shooter's contact information (he left without making a purchase), the subsequent investigation was very limited (Ross, Wagschal, and Schwartz, 2016).

Table 5.1
Roadmap of Short-Term Innovation Options

Theme	Need	Innovation Options
Knowledge of effective practices and technologies: repository	Research results repository **General comment:** All the findings resulting from studies and analyses done in response to priority needs from LEAP 2 and other expert panels will need to be added to the repository.	Rapidly develop a prototype site that links (and supports federated search) to key articles in other resources. As examples, link to CrimeSolutions.gov for practices; justnet.org for materiel information; and BJA, other government agencies, and associations on a wide range of policies, processes, and technical references (see Table 3.1).
	Model contracts (in repository) that include sustainment costs	Work with other government agencies and associations to prepare the model language and identify examples.
Knowledge of effective practices and technologies: improving management practices	Brief explanation of evidence-based management	Develop a flyer explaining evidence-based management and listing key evidence-based program repositories (e.g., CrimeSolutions.gov).
	Guidance on change management	Review change management references to produce a quick guide on using core techniques in law enforcement.
Knowledge of effective practices and technologies: improving training	Training methods taxonomy	Review prior training materials to produce an initial taxonomy.
Police-community relations: strategies	R&E on sectoral/community policing practices	Review prior references to produce a quick guide on what seems to work best.
	Measures for evaluating community-relations activities	Review prior references to produce an article on suitable measures.
Police-community relations: problematic encounters	R&E on de-escalation and procedural justice training	Conduct a brief study on current training materials and prepare a quick assessment for practitioners.
Polce-community relations: educating the public	Articles on true prevalence of police misconduct	Review prior references to produce an article on what is known and what is not.
Information sharing and use: RMS integration	Model interoperability language for RMS	Work with Global Justice Information Sharing Initiative, other government agencies, and associations to develop the needed language. The language needs to list specific, testable standards with which the RMS should comply.
Forensics: backlogs	Mitigate forensic backlogs	Develop new grants and/or extend existing grants to cover non-DNA backlogs for various forensic testing. Conduct studies on the extent of the problem and resource-sharing workarounds. Conduct a survey study on the impacts of the backlogs on the criminal justice system.
Forensics: excess evidence	Impact of excess evidence	Conduct a study on the impacts of excess evidence Review prior legal references to identify a framework for evidence discard decisions.
Other: UAVs	Model policy and use cases	Work with the IACP to extend and publicize the IACP model policy and concepts documents in this area and identify relevant information from other groups examining UAV deployment (e.g., DOJ, Federal Aviation Administration).

- There needs to be a major, multifaceted effort to leverage science and technology to help improve trust and relationships between law enforcement agencies and the communities.
- There need to be efforts to improve the sharing and use of information, starting with developing business cases that show the value of interagency data sharing and developing business models that will allow all law enforcement agencies to benefit from crime analysis capabilities.
- There needs to be a major effort to understand and remediate forensic backlogs, ensuring the quality of the analyses in the process.

Further, addressing the top-priority needs, whether part of the top takeaways or not, consistently must be multistakeholder efforts, bringing together state and local practitioners, associations more broadly, federal sponsors, and technical experts (academics plus commercial developers in some cases). Without involvement of multiple stakeholders, any efforts to meet these top needs are likely to have technical performance problems, operational suitability problems, and problems being publicized to the law enforcement discipline as a whole.

Law enforcement today is facing a number of challenges, including erosion in public trust and confidence, a rise in homicides and other violent crime that includes a spike in attacks on officers, and continued budget pressures and shortages of officers. Technology and research, informed by practitioner and technical expertise and combined with effective means of disseminating the results, provide an important pathway to help address these challenges. It is the hope of the panel and the authors that the needs discussed in this report will help prioritize research, development, and dissemination efforts in ways that will provide the greatest value to our law enforcement practitioners.

APPENDIX A

LEAP 2 Members

Name	Affiliation
Ashan Baig	Manager of Information Systems, Oakland (California) Police Department
Daniel Brauer	Lieutenant, Glendale (Wisconsin) Police Department
Josh Brunty	Assistant Professor, Marshall University, West Virginia
James Byrne	Professor, University of Massachusetts
Larry Campbell	Deputy Chief, Edmond (Oklahoma) Police Department
Gregory Carlin	Captain, Camden County (New Jersey) Police Department
Crystal Cody	Director of Computer Technology Solutions Division, Charlotte-Mecklenburg (North Carolina) Police Department
Andrew Ferguson	Professor, University of the District of Columbia Law School
Jay Fortenbery	Chief of Police, Edenton (North Carolina) Police Department
John Kapinos	Fairfax County (Virginia) Police Department (ret.)/LEAP21 Consulting
Mark Landahl	Sergeant, Frederick County (Maryland) Sheriff's Office
Jonathan Lewin	Deputy Chief, Chicago (Illinois) Police Department
James MacGillis	Lieutenant, Milwaukee (Wisconsin) Police Academy
Tarrick McGuire	Lieutenant/Sector Commander, Arlington (Texas) Police Department
Linda Merola	Associate Professor, George Mason University (Virginia)
Glen Mills	Lieutenant, Burlington (Massachusetts) Police Department
Cory Nelson	Lieutenant, Madison (Wisconsin) Police Department
Monica Nguyen	Director of Crime Analysis Division, Charlotte-Mecklenburg (North Carolina) Police Department
James Nolette	Sector Lieutenant, Fayetteville (North Carolina) Police Department
Steve O'Dell	Director, Forensic Services Division, Baltimore City (Maryland) Police Department
Michael Oteri	Sergeant, Daytona Beach (Florida) Police Department
Jason Potts	Sergeant, Vallejo (California) Police Department
Nicole Powell	Sergeant, City of New Orleans (Louisiana) Police Department
Kathryn Seigfried-Spellar	Assistant Professor, Purdue University (Indiana)
Charles Thorpe	Captain, Law Enforcement Division, Sarasota County (Florida) Sheriff's Office
Eva A. Vincze	Program Director, Criminal Justice Program, George Washington University (D.C.)
James Wayman	Senior Fellow, Office of Research, San Jose State University (California)
Gary Woodruff	Deputy Chief, Lawrence (Indiana) Police Department
Harlan Yu	Principal, Upturn (D.C.)
Mike Yu	Detective, Montgomery County (Maryland) Police Department

APPENDIX B

Pre-Meeting Questionnaire

Thank you for agreeing to participate in the Law Enforcement Advisory Panel as part of the Priority Criminal Justice Needs Initiative, sponsored by the National Institute of Justice. The panel will bring together experts to prioritize law enforcement needs and help NIJ develop its future law enforcement technology research goals. The outcomes will also inform technology providers about improved or new technologies to better aid law enforcement agencies.

You are free to skip any questions that you do not wish to answer, but we hope input from the panel is as complete as possible to help us frame the workshop discussion. Your responses to the questions below will provide us with initial discussion topics that will maximize our time together on the days of the panel.

1. Prioritizing Law Enforcement Objectives

First, we would like your input on the importance of several law enforcement objectives, on the form on the next page. This will inform the panel discussion by allowing us to weight different potential innovations that might be useful in achieving different law enforcement objectives.

Please assign levels of importance (0 to 100) for each objective. Your score should reflect the importance of each objective relative to the other objectives.

The objective that you believe is most important should be given a score of 100. Then assign scores to each other objective reflecting its importance relative to that most important objective. For example, if another objective is equally important, it should be scored as 100 also. An objective that is half as important as the top goal would be scored as 50. An objective that you view as unimportant would get a score of 0.

Each objective can have any number. For example, if you think all these objectives are equally important, all would be scored as 100. If you think they are each of different levels of importance, each score would be different.

Objective Name	Objective Definition	Score (0 to 100)
Reduce Crime and Disorder	Decrease the numbers of violent crimes, non-violent crime, and civil disturbances. Metrics include tracking various types of crime and calls-for-service counts over time, as well as reductions in recidivism.	
Solve More Cases	Reduce the numbers of open criminal investigations (i.e., increase the fractions of cases cleared by arrest). Metrics include tracking the numbers of criminal cases of different types considered solved over time.	
Improve the Health of Law Enforcement Personnel	Improve the physical and mental health of law enforcement personnel. Metrics include tracking the numbers of sick days, long-term leave days, and health-related departures from agencies over time.	
Reduce Casualties in the Line of Duty	Reduce the numbers of serious or fatal injuries to law enforcement, bystanders, and suspects from all causes (including accidents and use-of-force situations). Metrics include tracking the numbers of casualties for officers, bystanders, and suspects.	
Improve the Public's Trust of Law Enforcement	Increase the public's trust of law enforcement, as well as reduce the public's fear of crime. Metrics include surveys asking about agency legitimacy, agency accountability, and residents' fear of crime.	
Reduce Costs	Reduce the costs (both in money and time) of law enforcement operations while maintaining effectiveness. Metrics include tracking expenses and labor hours over time, as well as tracking other effectiveness metrics to check for decreases in performance.	
Improve Law Enforcement Competencies	Improve the training, education, and readiness of law enforcement personnel. Metrics include both numbers of events and certifications and test results showing that staff have achieved proficiencies.	
Respond to Incidents and Events More Effectively	Increase agencies' abilities to prepare for, respond to, and recover from incidents and events ranging from day-to-day emergency and support calls to large-scale disasters. Metrics include tracking timeliness and quality of responses in both actual and simulated events.	

2. Law Enforcement Technology Problems and Opportunities

To set up our discussion during the workshop of ways that new innovations or technologies might help law enforcement, we are going to ask you two things:

- First, what you see as the big challenges or issues facing law enforcement today where innovation could help agencies better achieve their missions.
- Second, we are going to ask you about six technology and practice areas. For each area, we will ask the same two questions:
  - Problems/shortfalls in current tools and practices where improvements are possible and
  - Opportunities you see where more significant changes in policy, technology or practice could help agencies perform better or more efficiently.

The areas we will ask about are:

- **Information and Communications**—including communications infrastructure, IT infrastructure, sensors and biometrics, data analysis, data management, tailored displays
- **Vehicles**—including ground vehicles, aircraft, watercraft, unmanned, and any associated equipment
- **Facilities**—including issues associated with agency headquarters, stations, operations centers, public safety access points, custody areas, and lab facilities
- **Personal Equipment**—including everything that officers, investigators, and other law enforcement personnel carry day to day including uniforms, protective gear, and other duty technology
- **Weapons and Force**—including lethal, less-lethal, restraints, and related technologies
- **Management, Personnel Development, and Training**—including departmental policies, strategy and tactics, training, education, management and business process, and other concerns.

Question (Q) 1. Overall, what are the **top three challenges or issues** facing law enforcement today?

1.
2.
3.

Q2. What problems or shortfalls exist in the area of **information and communications** that hurt LE agencies' ability to achieve their missions effectively and efficiently? (List as many or as few as you would like)

1.
2.
3.

What opportunities do you see—by applying new technologies, changing law enforcement strategies or practices, or other innovation—in the area of **information and commu-**

nications that would improve LE performance or efficiency? (List as many or as few as you would like)

1.
2.
3.

Q3. What problems or shortfalls exist in the area of **vehicles** that hurt LE agencies' ability to achieve their missions effectively and efficiently? (List as many or as few as you would like)

1.
2.
3.

What opportunities do you see—by applying new technologies, changing law enforcement strategies or practices, or other innovation—in the area of **vehicles** that would improve LE performance or efficiency? (List as many or as few as you would like)

1.
2.
3.

Q4. What problems or shortfalls exist in the area of **facilities** that hurt LE agencies' ability to achieve their missions effectively and efficiently? (List as many or as few as you would like)

1.
2.
3.

What opportunities do you see—by applying new technologies, changing law enforcement strategies or practices, or other innovation—in the area of **facilities** that would improve LE performance or efficiency? (List as many or as few as you would like)

1.
2.
3.

Q5. What problems or shortfalls exist in the area of **personal equipment** that hurt LE agencies' ability to achieve their missions effectively and efficiently? (List as many or as few as you would like)

1.
2.
3.

What opportunities do you see—by applying new technologies, changing law enforcement strategies or practices, or other innovation—in the area of **personal equipment** that would improve LE performance or efficiency? (List as many or as few as you would like)

1.
2.
3.

Q6. What problems or shortfalls exist in the area of **weapons and force** that hurt LE agencies' ability to achieve their missions effectively and efficiently? (List as many or as few as you would like)

1.
2.
3.

What opportunities do you see—by applying new technologies, changing law enforcement strategies or practices, or other innovation—in the area of **weapons and force** that would improve LE performance or efficiency? (List as many or as few as you would like)

1.
2.
3.

Q7. What problems or shortfalls exist in the area of **management, personnel, development, and training** that hurt LE agencies' ability to achieve their missions effectively and efficiently? (List as many or as few as you would like)

1.
2.
3.

What opportunities do you see—by applying new technologies, changing law enforcement strategies or practices, or other innovation—in the area of **management, personnel, development, and training** that would improve LE performance or efficiency? (List as many or as few as you would like)

1.
2.
3.

3. Additional Topics for the Workshop

Q8. **Final question**: Are there any issues, problems, or opportunities that you see that don't easily fit into any of the areas we defined on this questionnaire? Is there anything you think we have missed that you think is important to cover in the workshop?

1.
2.

APPENDIX C

Panel Agenda

Operational Session, June 21–22

	Day 1—June 21
9:00 AM	Welcome and Introductions
10:00 AM	Operational Needs Discussions
11:30 AM	Buy Lunch at the Mall—Return to RAND for Working Lunch
12:00 PM	Operational Needs Discussions (end at 5:00 PM)
	Day 2—June 22
9:00 AM	Review and Final Brainstorming Session
10:00 AM	Prioritize Needs
11:30 AM	Brief out and Next Steps (*Joint with Strategic and Administrative*)
12:30 PM	End of Workshop (Strategic group buys lunch at mall)

Strategic and Administrative Session, June 22–23

	Day 2—June 22
1:00 PM	Welcome and Introductions
2:00 PM	Strategic/Administrative Needs Discussions (end at 5:00 PM)
	Day 3—June 23
9:00 AM	Continue Strategic/Administrative Needs Discussions
11:30 AM	Buy Lunch at the Mall—Return to RAND for Working Lunch
12:00 PM	Complete Discussions/Review
2:30 PM	Prioritize Needs
4:00 PM	Brief out and Next Steps
5:00 PM	End of Workshop

APPENDIX D

Detailed Methodology

Chapter Four presented the overall process used to generate and prioritize needs, which can be summarized as follows:

1. Weight the importance of law enforcement objectives.
2. Brainstorm opportunities for innovation (problems and opportunities).
3. Develop one or more needs to address each problem or opportunity.
4. Have panelists rate the importance, technical feasibility, and operational feasibility of an initiative to meet each need.
5. Give panelists the opportunity to review their working group's distributions of ratings for each need, and discuss reasons for disagreements over needs with a particularly wide dispersion of ratings. Then give panelists the opportunity to re-rate needs.
6. Generate priority scores for each need.
7. Divide the needs into overall priority tiers.

In this appendix, we present technical details for steps 4–7, generating priority scores and dividing the needs into overall priority tiers.

Rating, Discussing, and Re-Rating the Needs

The ratings process is a variant of RAND's Delphi method, which was first introduced in the 1950s (for example, Dalkey and Helmer, 1963). As RAND's portal on the Delphi method notes,

> The method entails a group of experts who anonymously reply to questionnaires and subsequently receive feedback in the form of a statistical representation of the "group response," after which the process repeats itself. The goal is to reduce the range of responses and arrive at something closer to expert consensus. (RAND Corporation, no date)

Panelists provided an initial set of ratings for the importance, technical feasibility, and operational feasibility of an initiative to address each need using an online questionnaire created on the Qualtrics platform (Qualtrics LLC, 2016). Panelists also had the opportunity to type in comments about ratings for which they felt especially strongly. As discussed in Chapter Four, each rating was on a scale from 1 to 9.

Following the initial set of ratings, each panelist received a printout showing the distribution of importance, technical feasibility, and operational feasibility ratings of each need, as

well as the comments about the ratings. The panelists in each working group (operational and strategic/administrative) then worked through those needs that had the greatest variation in their ratings, discussing reasons for their ratings.

Following the discussion, the online questionnaire was re-opened, and panelists had the opportunity to change any ratings for needs based on the comments and discussion.

Generating Priority Scores

We use an EV approach to prioritizing needs, in which each need's score reflects a potential importance to law enforcement (if that need can be satisfied) times the probability it might be satisfied. Such a score represents how much real-world benefit we can expect from an effort to meet a need, "on average." EV approaches are fundamental in assessing the value of options under uncertainties (see, for example, de Neufville, 1990, pp. 312–313). This approach is also an evolution of prior approaches used in RAND research on criminal justice technology needs, including LEAP 1 (Hollywood, Boon, et al., 2015), prior sector studies for corrections and courts needs (Jackson et al., 2015; Jackson et al., 2016), and, most recently, broadband communications needs for law enforcement (Hollywood et al., 2016). The approach broadly derives from an earlier set of research reports on making optimal science and technology investment decisions (Silberglitt and Sherry, 2002; Chow, Silberglitt, and Hiromoto, 2009; Silberglitt et al., 2004; Landree et al., 2009).

We first generated an EV score from each panelist for each need. Mathematically, the EV of need i for panelist j, $E(V_{ij})$, is:

$$E(V_{ij}) = \left(\sum_{k=1}^{8} C_k I_k \right) (M_{ij} X_{Tij} X_{Oij}) .$$

Here,

- The first summation in the formula reflects the weighted number of objectives that the need supports. C_k represents the weight for each objective (recall this was generated by asking panelists to rate the relative importance of each objective, as described in Chapter Four). I_{ik} is an indicator variable that is 1 if need i supports objective k, and 0 otherwise.
- M_{ij} is the potential impact rating, from 1 to 9, that panelist j gave to need i. Recall that a score of 9 meant that meeting the need would improve at least one key policing performance metric by 15–30 percent in places where that solution was used. A score of 1 meant, at most, a very small (close to 0) improvement.
- X_{Tij} is the likelihood that an effort to meet need i is likely to succeed, technically, as scored by panelist j on a scale from 1 to 9. A score of 9 corresponds to a high likelihood of success; a score of 1 corresponds to a low likelihood of success. Specifically, $X_{Tij}/10$ is the estimated probability that an effort to meet the need would succeed, technically. Note that probabilities of 0 and 1 (which would have corresponded to ratings of 0 and 10, respectively) were barred to allow for inherent uncertainty in whether a solution would be successful or not.

- X_{Oij}, similarly, is the likelihood that an effort to meet the need is likely to succeed, from an operational perspective.
- The latter three-term product in the EV score equation, $M_{ij}X_{Tij}\,X_{Oij}$, has a real-world interpretation. The expected percentage by which a potential solution to need i will improve a law enforcement outcome in places where the solution is used is

$$E(\Delta Y_{ij}) = \frac{(22.5 \pm 7.5)(M_{ij}X_{Tij}X_{Oij})}{1000}.$$

The maximum possible expected percentage change a need could have, then, is

$$\max[E(\Delta Y_{ij})] = \frac{(22.5 \pm 7.5)(9 \times 9 \times 9)}{1000},$$

which computes to an expected (16.4 ± 5.5) percent change in a law enforcement objective.

- The initial summation in the EV equation weights this expected percentage change by the number and importance of the law enforcement objectives that the need supports. This term prioritizes needs that support more, and more heavily weighted, objectives, as they provide more overall value to law enforcement.

For each need, we took the overall EV score to be the median of the panelists' individual EV scores. The median was used for two reasons. The first is that it is robust—it estimates the center of a set of values (in this case, EV scores) in a way that is resistant to the effect of outliers. The second is that it does not require making any assumptions about the underlying statistical distribution of the scores.

We (and the panel) do not assume that the resulting overall EV scores are reliable estimates of what would happen to key law enforcement objectives. However, this approach does ground the potential outcomes of an effort to meet a need with a real-world benefits perspective. The approach provides for much more rigor than simply asking panelists how important each need is.

Categorizing the Needs into Priority Tiers

We used a hierarchical clustering algorithm, specifically Ward's method (Ward, 1963; Murtagh, 1985) to group the needs into priority tiers. We implemented hierarchical clustering using the "hclust" package in the R statistical environment, called using both native R code and the Wessa statistical web portal (Wessa, 2012).

This algorithm is an iterative process. During each iteration, the two needs and/or subgroups of needs that are at minimum "distance" (using a mathematical distance function) from each other are merged into a large group of needs. Upon completion, the algorithm generates a *dendrogram*, which is a tree diagram showing when different needs ("leaves") and subgroups ("branches") were merged into each other. Ward's (1963) method assesses "distance" to be the weighted squared Euclidean distance between the *centers* of each subgroup. In our case, "centers" are the average of the EV scores for all needs within that subgroup.

To group the needs into the three priority tiers, we simply group the needs by the three largest branches they are on. The branch with the highest-scoring needs is Tier 1; the branch with the lowest-scoring needs is Tier 3; and the remaining branch of middle-scoring needs is Tier 2. To identify Tier 1+ needs (the needs discussed in the body of the report as those needs rising to the top of the Tier 1 grouping), we further subdivide the Tier 1 branch into its two largest subbranches; the subbranch with the highest scoring needs is Tier 1+.

Hierarchical clustering is one of the major clustering algorithms. It has the advantage that it shows a full hierarchy of groups and subgroups rather than just a simple set of clusters (Manning, Raghavan, and Schütz, 2008, p. 377; Frontline Systems, Inc., 2015). For tiering needs, this feature means that in rare cases in which the largest branches are not operationally feasible (when the algorithm returns only a few Tier 1 needs or tries to make more than half the needs Tier 1), we can review the second-level branches and manually adjust how the needs are grouped into priority tiers. It also permits identifying operationally meaningful groups of needs below the top level of priority tiers, with identification of Tier 1+ needs (i.e., the upper branch of needs within Tier 1) being the principal example.

Figure D.1 shows the dendrogram (hierarchical clustering chart) for the 82 operational needs, generated using the Wessa portal. The numbers on the right side of the dendrogram are the *ranks* of the median EV score for each need. Thus, "1" represents the need that had the highest score, and "82" represents the need that had the lowest score. The pattern of branches shows when each need or group of needs was combined into a larger group, with the length of each branch reflecting the distance between the two subgroups and/or needs. Longer branch lengths reflect greater distances between the subgroups being combined. On the right side, the color bars show which needs (by EV rank) fell into each tier, as well as which needs fell into subgroup Tier 1+. The color bars also show the EV score cutoff to be in each tier following clustering. Thus, Tier 3 needs had scores lower than 470; Tier 2 needs had scores between 470 and 665; Tier 1 needs had scores higher than 665; and Tier 1+ needs had scores higher than 1,030.

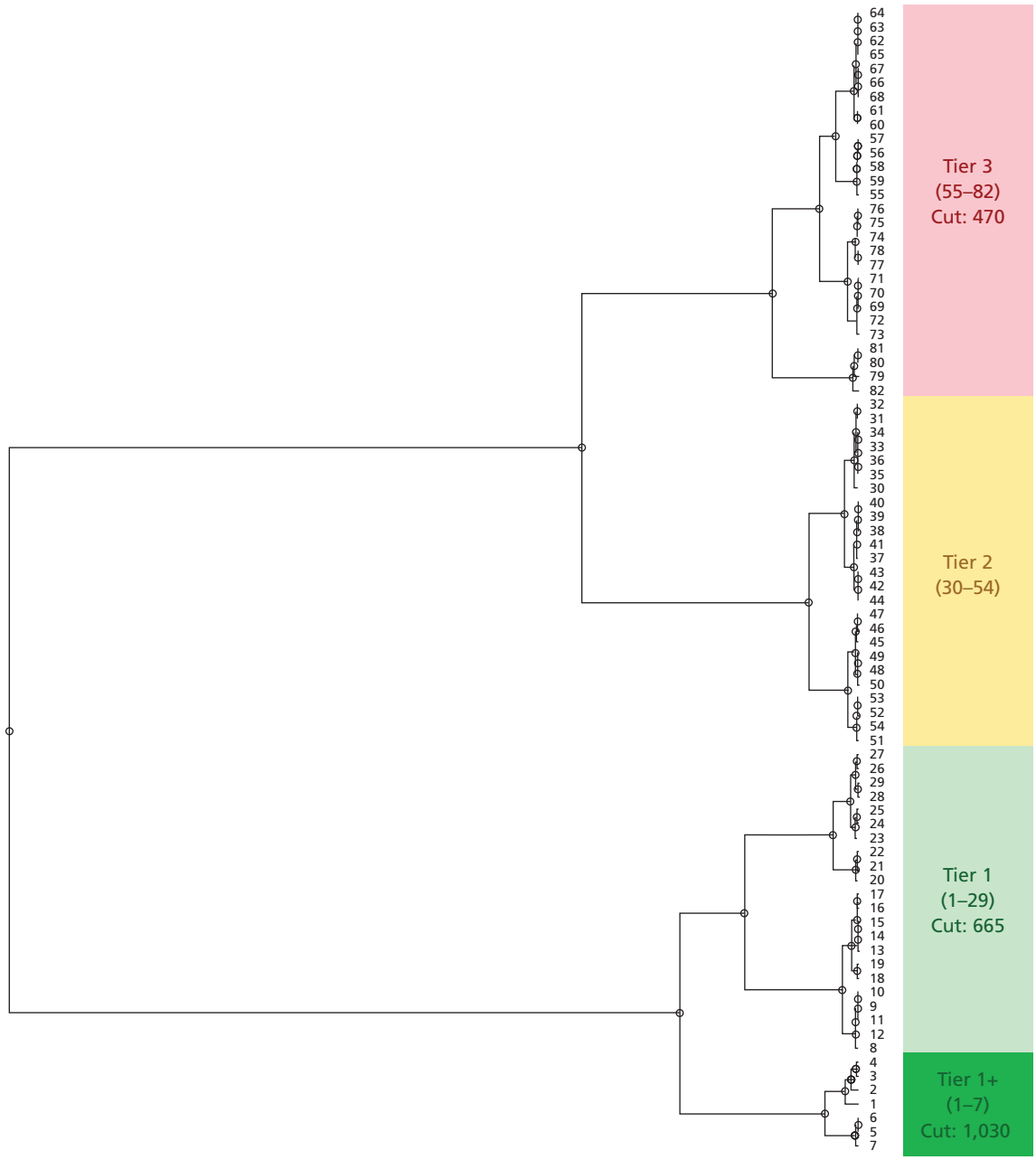
Figure D.2 shows a similar dendrogram for the strategic and administrative needs. Here, the breakpoint between Tier 2 and 3 needs was a score of 430; between Tiers 1 and 2, a score of 560; and to get into Tier 1+, a score of 760. Note that these cutoff scores are systematically lower than those for operational needs; RAND's prior experience is that it is common for scores to differ across different groups of experts. Thus, in our analyses, we just treat all needs labeled as being in the same tiers from different groups the same way, rather than, say, treat operational needs as usually being higher priority than strategic/administrative needs because of the higher numerical scores. This nonparametric approach avoids the problem of how different groups score needs differently.

Chapter Four introduced special priority needs, which are needs that have the highest "reduced" EV with respect to any single objective. These are needs that have the highest scores when just using the importance and feasibility ratings from the panelists, ignoring objective assignments and objective weights, which mathematically is ($M_{ij}X_{Tij}\,X_{Oij}$). Figure D.3 shows the results of applying hierarchical clustering on the reduced EV scores for operational needs; Figure D.4 shows the results for strategic and administrative needs. As shown, special priority needs are those in the upper branch of the top-tier cluster, equivalent to Tier 1+.

Similarly, low-hanging fruit needs are needs that would be in Tier 1+ when considering only their median risk score (technical feasibility score × operational feasibility score, which

mathematically is ($X_{Tij}\ X_{Oij}$). Figure D.5 highlights the results for operational needs, and Figure D.6 highlights the results for strategic and administrative needs.

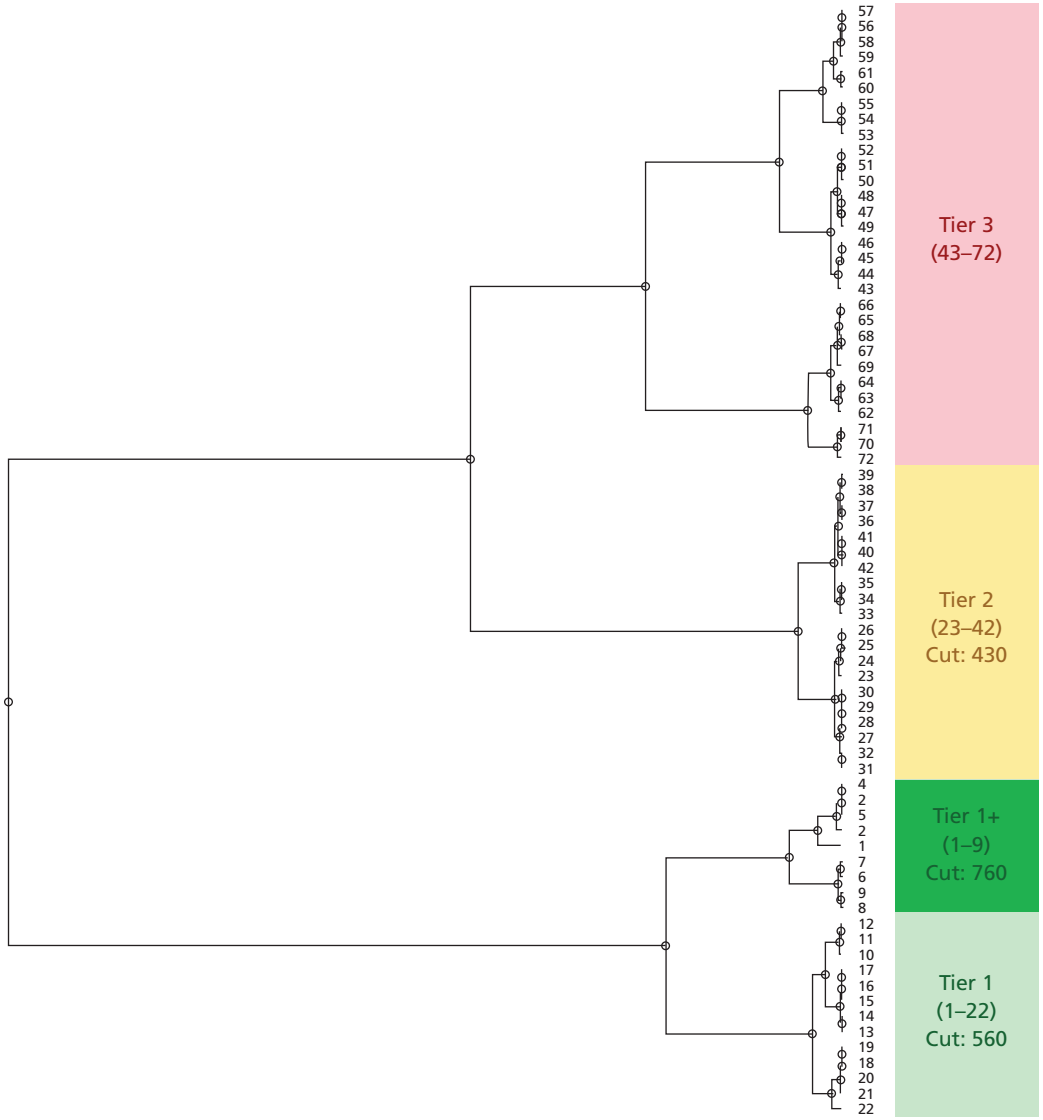
Figure D.1
Dendrogram of Operational Needs' Scores



NOTE: "Score" defined as median objective-weighted expected value score for each need. Dendrogram generated using Wessa (2016).

RAND *RR1814-D.1*

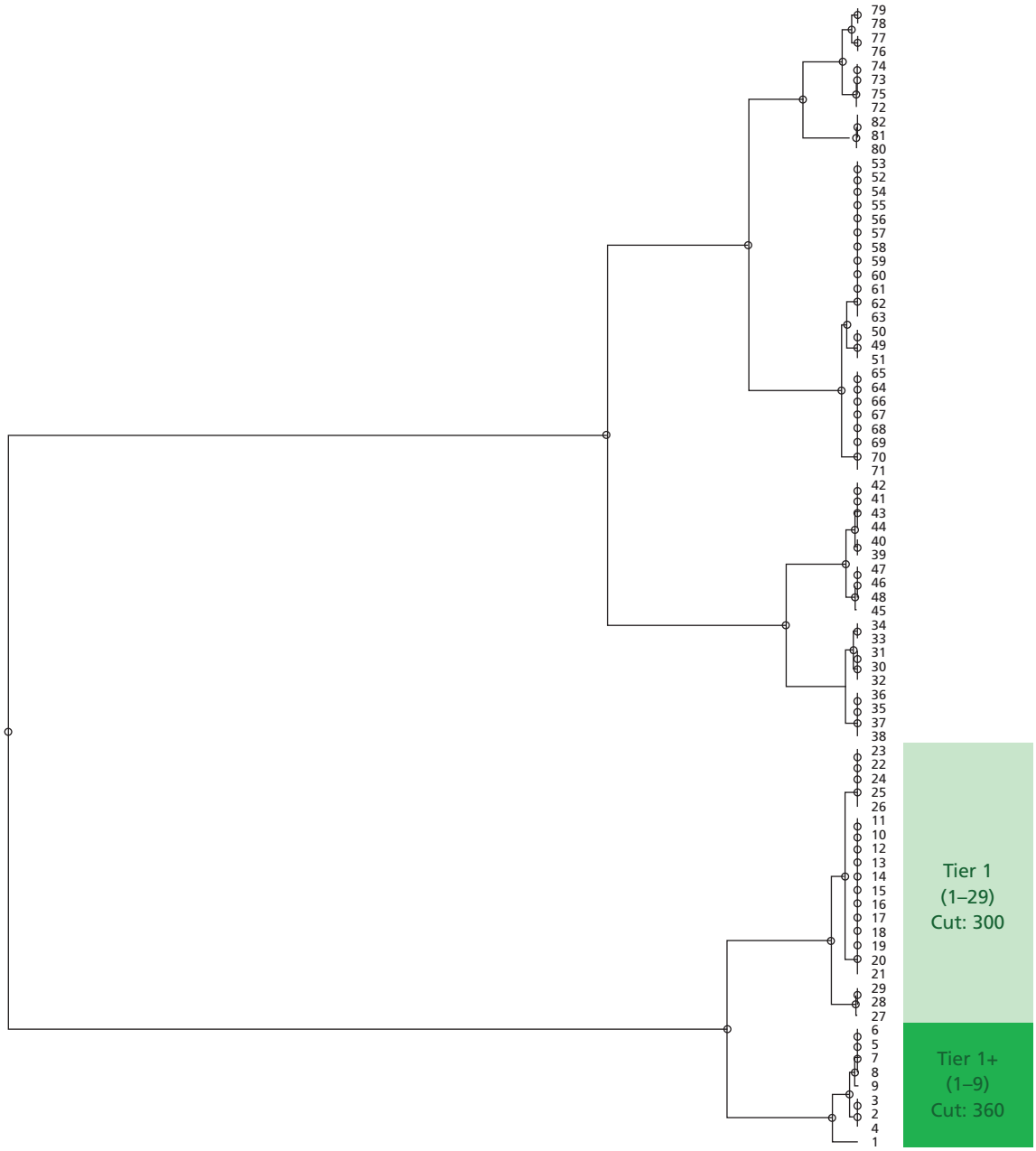
Figure D.2
Dendrogram of Strategic and Administrative Needs' Scores



NOTE: "Score" defined as median objective-weighted expected value score for each need. Dendrogram generated using Wessa (2016).

RAND *RR1814-D.2*

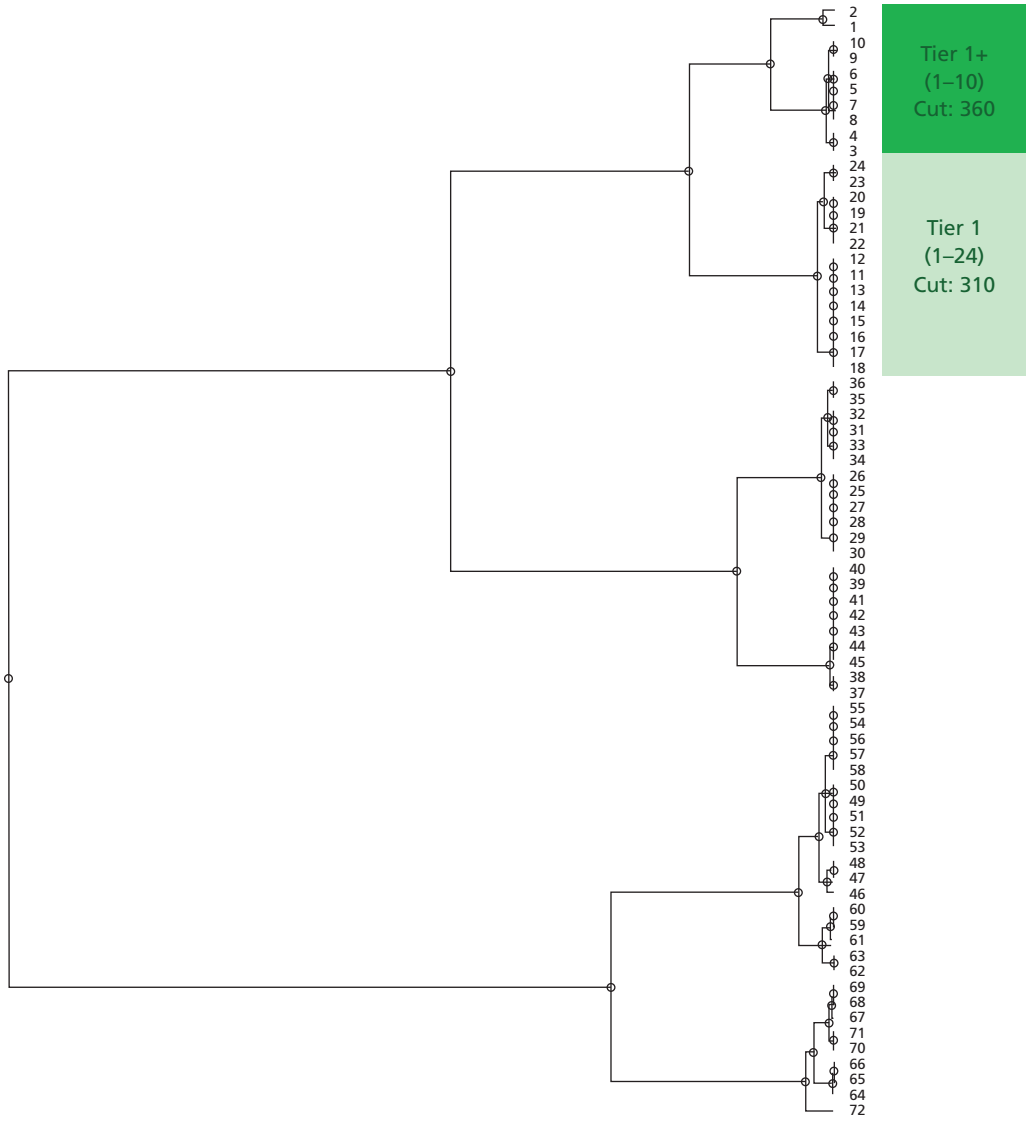
Figure D.3
Identifying Special Priority Needs—Operational



NOTE: Metric used for special priorities is the median unweighted EV score. Dendrogram generated using Wessa (2016).

RAND *RR1814-D.3*

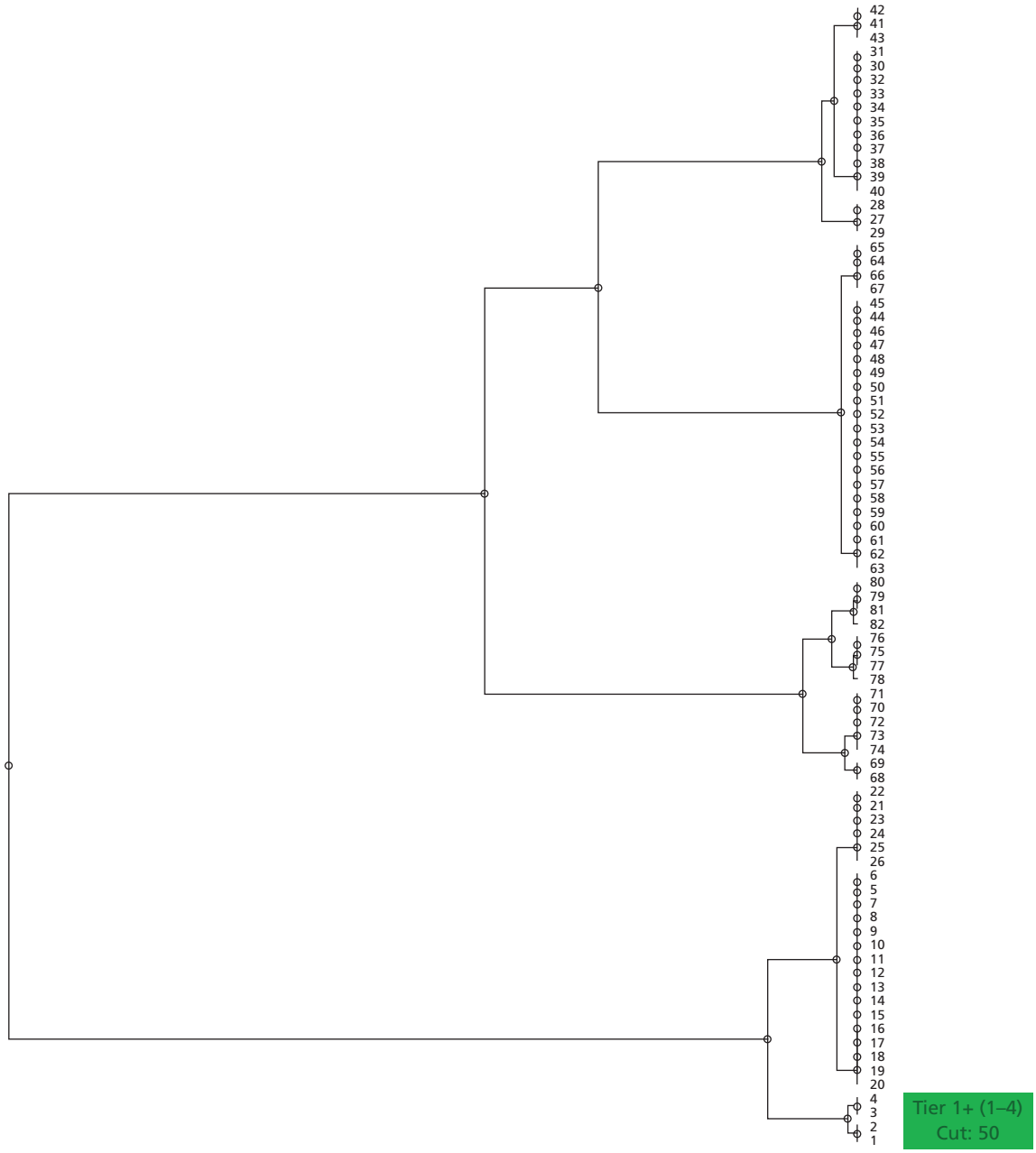
Figure D.4
Identifying Special Priority Needs—Strategic and Administrative



NOTE: Metric used for special priorities is the median unweighted EV score. Dendrogram generated using Wessa (2016).

RAND *RR1814-D.4*

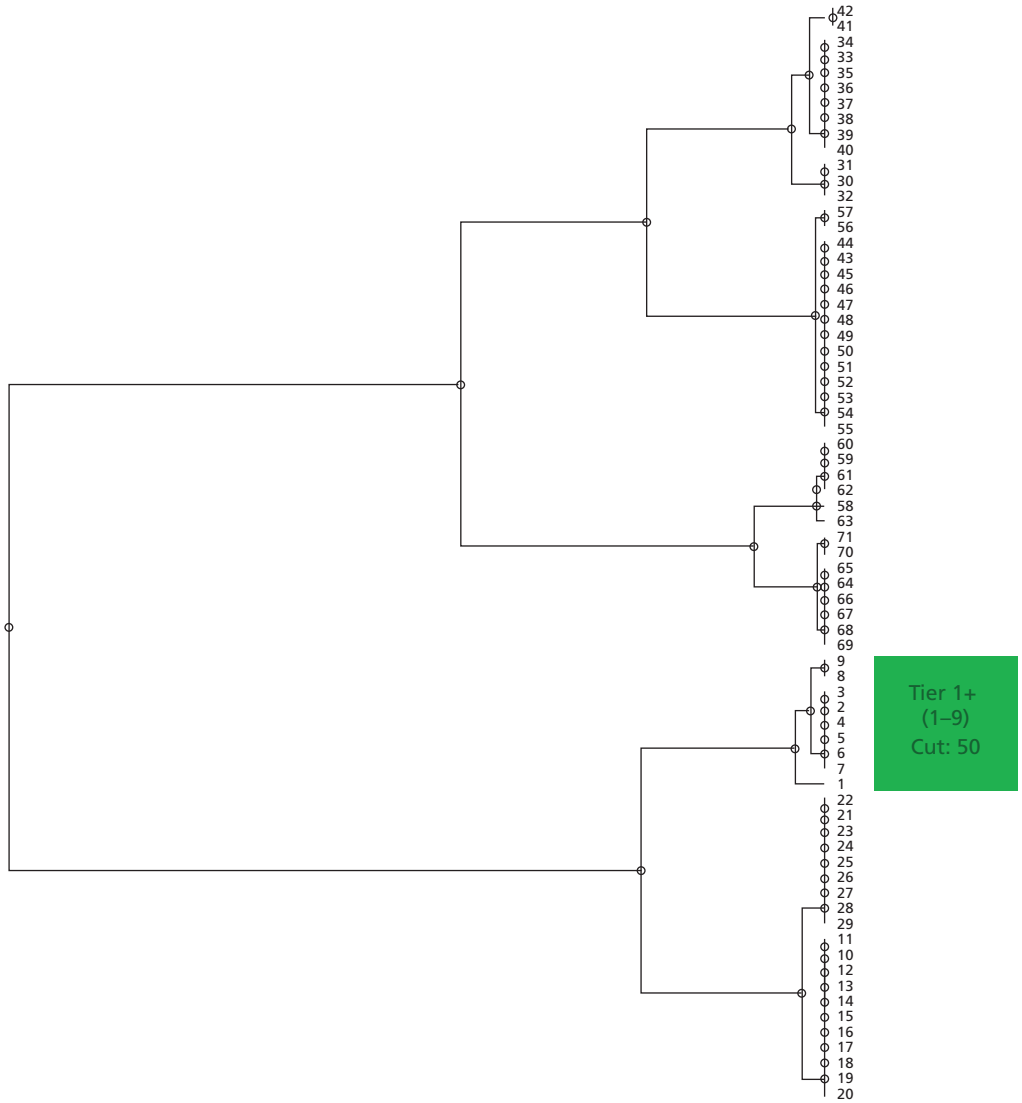
Figure D.5
Low-Hanging Fruit Needs—Operational



NOTE: Dendrogram generated using Wessa (2016).

RAND *RR1814-D.5*

Figure D.6
Low-Hanging Fruit Needs—Strategic and Administrative



NOTE: Dendrogram generated using Wessa (2016).

RAND *RR1814-D.6*

APPENDIX E

Full Law Enforcement Technology Taxonomy

Below is the outline version of the full law enforcement technology taxonomy. The graphical version of the taxonomy is available from www.rand.org/t/RR1814 as a standalone poster.

1. Information and communications
    a. Information technology—basic systems
        i. Infrastructure
            1. Information technology hardware, networks/capacity, connectivity
        ii. Information security
            1. Authentication, access management
    b. Information collection
        i. Community interaction tools
            1. Website crime report filing
            2. Social media strategies and tools for interacting with the public
        ii. Field analytic tools or test technologies
            1. Drug and alcohol screens and tests
        iii. Laboratory tools and techniques for evidence analysis (forensics technologies)
            1. Chromatographic techniques
            2. Spectroscopic techniques
            3. Microscopy
            4. DNA analysis
            5. Forensic entomology
            6. Forensic anthropology and pathology
            7. Document analysis
            8. Crime scene reconstruction tools
            9. Ballistics and tool marks analysis
            10. Hair and fiber analysis
            11. Fingerprint analysis
            12. Forensic tools for electronic devices
        iv. Surveillance/monitoring
            1. Mobile surveillance and detection
            2. Fixed surveillance and detection
            3. Specialized task information collection tools
        v. Internal data collection
            1. Organizational performance monitoring tools
            2. Personnel management and performance monitoring tools

        3. Primary record keeping methods and tools
c. Information analysis
    i. Individual analytical methods
        1. Offender risk analysis
        2. Prehiring personnel screening methods
        3. Predictive policing models
        4. Decision support tools
        5. Strategic planning and process improvement tools
        6. Best practices/research results repositories
    ii. Computational tools
        1. Officer performance prediction models
        2. Geographic information systems
        3. Link analysis software
        4. Language translation technologies
        5. Video surveillance analytic tools (intelligent video)
    iii. Organizational analytic structures
        1. Real time crime centers (see "Facility operations and population services" category for architectural design of these centers)
        2. Fusion centers, analytical task forces, centralized analytic cells
d. Information management (including sharing)
    i. IT systems for managing organizational resources
        1. Computer-aided dispatch system (CAD)
        2. Scheduling tools
        3. Human resources management tools
    ii. IT systems for managing mission-related data
        1. Record management systems (RMS)
        2. Computer-aided dispatch system (CAD)
        3. Laboratory management systems
        4. Evidence management systems
    iii. System integration and information sharing
        1. Cross-sector information-sharing tools and standards
        2. Local, regional, state, and national data systems
        3. Systems for law enforcement access to private surveillance systems
e. Information delivery (including communications)
    i. Fixed location communications
        1. Voice
        2. Video
        3. Data
    ii. Mobile communications
        1. Vehicle-based communications
        2. Personnel communications
        3. Mobile infrastructure
    iii. External communications
        1. Public alert and notification
        2. Public information functions

        3. Public Information provision and training for criminal justice system roles
    iv. Information presentation tools and dashboards
        1. Command-level decision dashboards (e.g., COMPSTAT)
        2. Tablet or mobile applications for presentation of data to officers
2. Vehicles
    a. Ground
        i. Automobiles
            1. Patrol cars
            2. Patrol SUVs
        ii. Motorcycles
            1. Patrol motorcycles
            2. Patrol tricycles
        iii. Bicycles
        iv. Unmanned ground vehicles
            1. Explosive ordnance disposal (EOD) unmanned ground vehicles/bomb disposal units
        v. Specialized Ground Vehicles
            1. SWAT vehicles
            2. Vans and larger transport vehicles
            3. Mobile incident command post vehicles
            4. Scooters and small electric ground vehicles
            5. Armored vehicles
            6. Deployable DUI checkpoint vehicles
        vi. High-durability or ruggedized components
        vii. Fuel efficiency/anti-idling systems
    b. Aircraft
        i. Fixed wing
            1. Small planes
        ii. Rotorcraft
            1. Helicopters
            2. Gyrocopters
        iii. Unmanned aerial vehicles
            1. UAV surveillance platforms
            2. Armed UAV systems
            3. Lighter-than-air vehicles/blimps
    c. Watercraft
        i. Patrol/enforcement watercraft
        ii. Water rescue craft
        iii. Inflatable watercraft
    d. Associated Technologies
        i. Sirens, markings, and warning indicators
            1. Rotating warning lights
            2. Strobe warning lights
            3. Steady warning lights
            4. Exterior mount lights

        5. Interior mount lights
        6. Public address systems
        7. Siren systems
    ii. Vehicle-embedded sensors
        1. Night vision
        2. Vehicle location systems
        3. License plate readers
        4. Driving behavior monitoring systems
        5. Launchers for deployable GPS tags/pursuit reduction
        6. Dash and other vehicle mounted cameras
        7. Environmental sensors (e.g., radiation, chemical threats)
        8. Radar units
        9. See also "Information collection and information management" for other sensors and systems that could be vehicle integrated
    iii. Vehicle armor
        1. Ballistic protection
        2. Push bumpers
    iv. Pursuit management
        1. Deployable physical vehicle stopping technologies
        2. Remote vehicle stopping technologies
    v. Internal modifications
        1. Weapon security/storage
        2. Offender restraints/security
        3. K9-friendly vehicle modifications
        4. Distraction-minimizing control systems
        5. Secure equipment storage
        6. Supplementary power systems
        7. Antenna and connectivity for on-board IT
        8. See also, Information and Communications, Information Delivery for in-car computer systems and other information presentation tools

3. Facility operations and population services
    a. internal access control
        i. Access control technologies
            1. Proximity card/radio frequency identification (RFID) access systems
        ii. Locks/locking systems
        iii. Biometrics and other sensors (see also "Information collection")
    b. Internal environment control
    c. Internal physical infrastructure
        i. Architectural design and systems
            1. Green technologies
            2. Technology infrastructure support
            3. Maintenance and support facilities
            4. Ranges and training facilities
            5. Public safety access point/call center design
            6. Real-time crime centers

        7. For jail design and related technologies, see "Fostering innovation in community and institutional corrections"
    ii. Furnishings and contents
        1. Visitor interface design and furnishing
        2. Officer workstation and offices
d. External/perimeter physical infrastructure
    i. Walls and fences
        1. Gate systems
    ii. Lighting
    iii. Guard stations
    iv. Visitor management
    v. Design approaches for public accessibility
    vi. See "Information collection" for sensors and biometrics for perimeter control and visitor management
e. Delivering services to population
    i. Health care delivery
    ii. Education delivery
        1. Systems for delivering information to citizens at station locations
    ii. Product delivery
f. Organizational logistics
    i. Staff equipment storage and maintenance
        1. General staff storage systems
        2. Weapon storage and maintenance/armory
        3. Evidence storage
    ii. Physical materiel tracking
        1. Asset tracking systems
        2. RFID for material tracking

4. Person-worn equipment and weapons/force
    a. Personnel clothing, protection, or augmentation
        i. Clothing/uniforms
            1. Standard clothing
            2. Instrumented clothing (e.g., physiological monitoring)
        ii. Armor and helmets
            1. Worn
            2. Shields
        iii. Respiratory protection
            1. Self-contained breathing apparatus
            2. Evacuation/escape hoods
            3. Gas masks
        iv. Eyewear
            1. Protective
            2. Augmenting
        v. Credentials/identification
            1. Badges
            2. ID credentials
        vi. Duty technology (person-carried basic tools)

        1. Belts, holsters, and related
        2. Flashlights
        3. Knives
    b. Weapons and force
        i. Lethal weapons
            1. Firearms
            2. Associated technologies
        ii. Less-than-lethal weapons
            1. Blunt or kinetic firearm-based technologies
            2. Batons
            3. Water
            4. Irritants
            5. Odorants
            6. Foam
            7. Directed energy
        iii. Restraint technologies
            1. Fixed restraints
            2. Durable mobile restraints (e.g., handcuffs)
            3. Disposable mobile restraints (e.g., zip ties)
        iv. Specialized task technologies
5. Doctrine, tactics, management, and behavioral knowledge development and training
    a. For analytics techniques supporting decisionmaking in each of these areas, see "Information analysis"
    b. Tools to assist live training
        i. Firearms range technologies
        ii. Simulated training munitions
    c. Technology-mediated Training Tools
        i. Instructional simulations
        ii. Remote learning tools
        iii. Firearm simulators
        iv. Use-of-force simulators
        v. Incident command simulations
        vi. Computer-based training (CBT)
    d. Officer/practitioner knowledge development and training
        i. Practices and tactics
            1. Incident command training
            2. Use-of-force training
            3. Hostage negotiation
            4. Personal combat/martial arts
            5. Riot and crowd control
        ii. Technology use and application
            1. Technology-specific resources and training
        iii. Policies and knowledge for carrying out roles
            1. Standard operating procedures and department specific policies
            2. Special operations plan templates and tools
    e. Specialist/technologist knowledge development and training

    i. Technology use and application
        1. Guides and training for tools and their use
    ii. Tactics and practices
        1. Laboratory accreditation processes
    iii. Policies and knowledge for carrying out roles
        1. Forensic and investigation best practices and standards
f. Management/Leadership Knowledge Development and Training
    i. Acquisition and Technology Decisionmaking
        1. Facility planning guidelines
        2. Technology standards for justice information systems (e.g., National Information Exchange Model [NIEM], Global Justice XML Data Model [GJXDM])
        3. Model policies, guidelines, and plans for acquisition management
    ii. Organizational and human resources policy and practices
        1. Recruiting and retention best practices and tools
        2. Staff wellness and support best practices
        3. Training and capability maintenance best practices
        4. Early warning and supervision best practices and tools
    iii. Doctrine and strategy for carrying out agency missions
        1. Lower-level crime prevention strategies
        2. Model policies and policy templates
        3. Overall policing strategies (e.g., order maintenance policing, community policing)
g. Societal/legal knowledge development and training

APPENDIX F

Full List of Needs from LEAP 2

The following table contains the complete list of needs from LEAP 2. For each need, the table provides

- ID number of the need. The need begins with "O" if it is from the operational group and "S" if is from the strategic and administrative group.
- priority tier
- whether the need is a top-rated need, overall (in the top part of Tier 1)
- law enforcement technology taxonomy category.
- title of the need
- description of the need, including both the issue being addressed and the means (opportunity for innovation) to address the issue
- which law enforcement objectives are addressed by the need.

Needs are sorted by taxonomy category, then by overall score (highest score first).

Table F.1
Full List of Needs from LEAP 2

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O83	1	*	Organizational and Human Resources Policy and Practices	Assess adequacy of mental health services, for both officers and the community	Issue: Lack of adequate mental health/crisis/social services—both offered by law enforcement and external to law enforcement. Need: Assess adequacy of resources for mental health response and treatment at the regional or lower level, and implications on law enforcement of current situation.			*	*	*			
O75	1	*	Doctrine and Strategy for Carrying Out Agency Missions	Best practices on sectoral policing with community engagement elements	Issue: Overcoming "us versus them" mentalities between departments and communities. Need: Develop and disseminate best practices on sectoral policing and/or community relations.	*	*			*		*	
S45	1	*	Doctrine and Strategy for Carrying Out Agency Missions	Short paper defining and explaining "evidence-based management"	Issue: There is not a common understanding of the definition of what it means to use "evidence-based management." Need: Develop a very short document/publication that discusses the various definitions and how common they are.	*				*		*	
S51	1	*	Organizational and Human Resources Policy and Practices	Guidance on change management for law enforcement agencies	Issue: Change management within law enforcement agencies is often insufficient or inadequate. Younger generations may have a greater desire to know "why" things are changing. Need: Develop easy-to-use, law enforcement–specific guidance on change management.	*				*		*	
O77	1		Doctrine and Strategy for Carrying Out Agency Missions	Best practices on using and sharing existing resources across community relations and other functions	Issue: Overcoming "us versus them" mentalities between departments and communities. Need: Disseminate and share best practices with respect to using existing resources across multiple priority areas.					*	*	*	
O73	1		Doctrine and Strategy for Carrying Out Agency Missions	Best practices for restorative justice programs between the police and community	Issue: Overcoming "us versus them" mentalities between departments and communities. Need: Best practices for implementing restorative justice programs to mediate between the police and the community.		*			*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S13	1		Doctrine and Strategy for Carrying Out Agency Missions	Assess which types of community-policing interventions are most successful	Issue: There are a lot of misconceptions of what community policing is and how it should be implemented. Need: Assessments of community-policing implementations to determine which ones are more successful.	*				*		*	
S111	1		Doctrine and Strategy for Carrying Out Agency Missions	Study how to better present uncertainties to decisionmakers	Issue: Evidence-based management practices are often not generalizable across different agency sizes and environments. Need: Examine ways to better present to decisionmakers assessments of what is known and what the "most promising" options are, given uncertainty in the specific situation and prior evidence.	*				*		*	
S73	1		Doctrine and Strategy for Carrying Out Agency Missions	Have evidence-based studies include information on when and where interventions are effective	Issue: Evidence-based management practices are often not generalizable across different agency sizes and environments. Need: Evaluation reports need to show information about when and where interventions/technologies are more are less effective—notably including qualitative.	*				*		*	
S15	1		Acquisition and Technology Decisionmaking	Case studies on free/low-cost crime analysis tools and support	Issue: Agencies often do not have sufficient analytic support (or tools). Need: Collect and disseminate "best practice" case studies on how to leverage existing free tools or free/part-time analysts.	*	*				*		
S81	1		Doctrine and Strategy for Carrying Out Agency Missions	Assess law enforcement–initiated alternatives to criminal justice court proceedings	Issue: The pipeline from law enforcement to the court system is extremely slow and time intensive and may not always contribute to the best outcomes. Need: Explore law enforcement alternatives to the court system (alternative dispute resolution, restorative justice, arbitration/mediation, diversionary programs). In particular, assessments of cost and efficiency can have the greatest impact.	*				*	*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O59	2		Acquisition and Technology Decisionmaking	Educate agencies on using bulk procurement vehicles	Issue: Could adapt purchasing cooperatives for law enforcement. Need: Ways to educate agencies on how to use bulk procurement vehicles to acquire equipment.						*	*	
O101	2		Acquisition and Technology Decisionmaking	General policy on considerations when transferring DoD technologies to law enforcement	Issue: Varying and limited perspectives on the conditions under which DoD technology is appropriate to port to law enforcement—raises concerns both about "militarization" and law enforcement not having access to key technologies. Need: Develop general policy on considerations when transferring DoD technologies to law enforcement.				*	*			
O61	2		Acquisition and Technology Decisionmaking	Forums/clearinghouses to share pricing and reviews for large purchases	Issue: Market pricing for new technologies is difficult to obtain/understand. Need: Information exchange forums/clearinghouse to better understand "market" pricing, reviews, etc. for large purchases such as software, hardware, and more.					*	*	*	
S123	2		Organizational and Human Resources Policy and Practices	Model language on caring for staff's families during major incidents	Issue: Contingency plans do not often consider the needs of agency employee families. Need: Publish model language that can be readily dropped into contingency plans for ensuring that agency employee families are taken care of.			*					*
S17	2		Acquisition and Technology Decisionmaking	Use cases for portable fingerprint scanners	Issue: It is difficult to verify identities when individuals lie about who they are. Need: Collect and disseminate agency use cases and experience with portable fingerprint scanners.		*		*				
S115	2		Doctrine and Strategy for Carrying Out Agency Missions	Identify the most appropriate interventions for persons flagged as high-risk	Issue: There are insufficient appropriate practices and interventions for individuals flagged on risk assessments. Need: Identify the most appropriate interventions are for individuals who are flagged as high-risk.	*				*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S103	2		Organizational and Human Resources Policy and Practices	Create middle level of agency certifications that is easier to attain	Issue: National agency certification standards are unaffordable. Need: A middle "layer" of standards for equipment and certifications that simplifies compliance with policy standards.					*	*	*	
O71	3		Doctrine and Strategy for Carrying Out Agency Missions	Measures for evaluating success of initiatives to improve public trust	Issue: Overcoming "us versus them" mentalities between departments and communities. Need: Develop measures for evaluating the success of activities for improving the relationship between law enforcement and the community.					*			
O63	3		Doctrine and Strategy for Carrying Out Agency Missions	Research on new technologies' effects on public-police trust	Issue: Insufficient research exists on the effects of technology on police-community relations. Need: Conduct new research on the effects of new technologies on trust between law enforcement and the public.					*			
O57	3		Acquisition and Technology Decisionmaking	Cooperatives for bulk purchases of IT, equipment, and capital	Issue: Could adapt purchasing cooperatives for law enforcement. Need: New ways (such as cooperatives and state purchasing instruments) to facilitate bulk purchases of IT, equipment, and other capital costs.						*		
S71	3		Acquisition and Technology Decisionmaking	Model contracts that include multiyear sustainment costs	Issue: After products and services are acquired, sustainment funding is often difficult to identify. Need: Ensure that model acquisition contracts consider or include multi-year sustainment costs at the time of acquisition.						*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S27	3		Organizational and Human Resources Policy and Practices	National study on approaches to retaining skilled law enforcement personnel	Issue: Law enforcement agencies are often "training grounds" for individuals who leave for larger agencies/ salaries (especially in highly technical fields). As a result, law enforcement agencies have difficulty retaining experienced personnel. Need: Conduct a survey or an assessment of the size and scope of the problem, and develop ideas for solutions going beyond standard approaches of "hire sworn" or "hire civilians."						*	*	
S121	3		Acquisition and Technology Decisionmaking	Media articles highlighting how agencies might use new technologies	Issue: Law enforcement agencies are generally unaware of emerging technologies and their potential uses for law enforcement. Need: Periodically assess emerging technologies and disseminate articles that highlight potential law enforcement uses.							*	
S53	3		Acquisition and Technology Decisionmaking	GSA-type schedules for agencies to buy equipment and services	Issue: "Market prices" faced by agencies for similar products and services are significantly different among similar products or between agencies. Need: Develop GSA-type schedules with fixed costs for products and services that agencies can shop from.						*		
S113	3		Doctrine and Strategy for Carrying Out Agency Missions	Holistic approaches for community policing that include monitoring technologies	Issue: There are a lot of misconceptions of what community policing is and how it should be implemented. Need: Highlight holistic approaches to implementing community policing that could potentially be assessed by monitoring technologies (e.g., GPS tracking of officer locations).	*				*		*	
S59	3		Acquisition and Technology Decisionmaking	Regional requirements allowing smaller agencies to help set technology standards	Issue: Small agencies lack economy of scale in setting standards, acquiring, implementing, and training on new technologies. Need: Develop regional or national "requirements" for significant purchases to allow smaller agencies to have greater market influence.						*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S85	3		Doctrine and Strategy for Carrying Out Agency Missions	Review appropriateness of agency and forensic accreditation standards for different types and sizes of agencies	Issue: National certification standards are often "one size fits all" and can present barriers that are too difficult for some agencies to meet (large vs. small, urban vs. rural, etc.). Need: For key standards (law enforcement agency/ Commission on Accreditation for Law Enforcement, forensic labs, digital forensics), work with standards groups to (1) review standards to ensure all provisions serve an operational purpose and (2) tailor provisions for agencies with different focuses and sizes.					*		*	
S97	3		Doctrine and Strategy for Carrying Out Agency Missions	Identify sources of assistance for agencies to measure their effectiveness	Issue: There is not a common understanding of the definition of what it means for agencies to be effective. Need: Identify sources of assistance for agencies to better measure their effectiveness.							*	
S109	3		Doctrine and Strategy for Carrying Out Agency Missions	Study how to combine experimental results and human judgments	Issue: Evidence-based management practices are often not generalizable across different agency sizes and environments. Need: Examine how experimental results and human judgments can be combined to develop better-fit solutions.	*				*		*	
O33	1	*	Practices and Tactics	Research repository with both search and dissemination capabilities	Issue: Important research results are not widely known by the practitioner community. Need: A research repository that (1) makes it easy for law enforcement to find and understand research results relevant to a problem and (2) pushes out pressing results that law enforcement needs to know.	*				*		*	
O93	1	*	Practices and Tactics	Research on integrating different types of training	Issue: Training is often stovepiped into categories, such as "firearms" or "tactical," and is rarely tied together until it is used in the field. Need: Research and measures to assess the effectiveness of different modes, methods, quality, and types of training integration.				*	*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O95	1	*	Practices and Tactics	Develop and evaluate curricula on how to handle problem encounters comprehensively	Issue: Lack of integrated training on problematic engagements. Need: Develop and evaluate training curricula on how to handle problematic encounters, specifically covering and integrating persuasion, crisis intervention, physical, and weapon elements.				*	*		*	
O97	1		Practices and Tactics	Research and evaluation of de-escalation training	Issue: Training often concludes with repetitive use of force, but often does not repetitively train on de-escalation. Need: Research and measures to assess the importance and effectiveness of additional deescalation training.				*	*		*	
O89	1		Practices and Tactics	Taxonomy to evaluate individual trainings on compliance with promising practices	Issue: Training best (and worst) practices and instructional design are either not well known or not implemented widely. Need: A taxonomy or set of categories and supporting information that can be used to evaluate individual trainings on their compliance with promising practices (approaches and content).				*	*		*	
O31	1		Practices and Tactics	Research results documents that can be read and understood quickly	Issue: Reduce information overload and lack of accessibility of academic/technical papers. Need: Academics need to work with practitioners to create documents and training that can be read and understood quickly.	*				*		*	
O91	1		Practices and Tactics	Taxonomy to design individual trainings to comply with promising practices	Issue: Training best (and worst) practices and instructional design are either not well known or not implemented widely. Need: A taxonomy or set of categories and supporting information that can be used to design individual trainings on their compliance with promising practices (approaches and content).				*	*		*	
O87	1		Practices and Tactics	Research on procedural justice training methods and their effectiveness	Issue: Lack of training on procedural justice methods. Need: Research and measures to assess the effectiveness of different modes, methods, quality, and types of procedural justice training tools.				*	*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O37	1		Practices and Tactics	R&D on getting research results out, and understood, in the field	Issue: Even "known" research results tend to be known at top levels of an organization, not by officers in the field who need to implement them. Need: Research and dissemination on materials and practices that can push results—that can be easily understood—out to the field.	*				*		*	
O125	1		Technology Use and Application	Research on best practices for selecting and carrying operational gear	Issue: Size and amount of personally carried equipment can be burdensome/uncomfortable. Need: Research and dissemination on effective practices for selecting and carrying gear. Needs to account for officer health, mission flexibility, and citizens' perception of appearance, to include informing the public of why gear is carried in certain ways.			*	*	*			
O85	2		Practices and Tactics	Research on instructional design to reduce burden and improve engagement of training	Issue: Lack of focus and resources for training in general, despite the fact that many issues seen on news could be mitigated with better training. Need: Research on improved instructional design to reduce the burden and improve the engagement level of training and retraining tools.						*	*	
O127	2		Policies and Knowledge for Carrying Out Roles	Research on how officers' appearance actually impacts public perceptions	Issue: Officer appearance can result in both public perception and morale issues. Need: Research and dissemination of how officers' appearance actually impacts public perception of police and risk to officers.				*	*			
O121	2		Policies and Knowledge for Carrying Out Roles	Identify current and promising policies and laws around body-worn cameras and other surveillance data	Issue: There is a disconnect between standards for recording and standards for public disclosure, which is having a de facto affect on cases. Need: Set up a collaborative effort to identify promising legal provisions and policies around video footage and other law enforcement surveillance data, and serve as a clearinghouse for current laws and policies. Should leverage both commercial and governmental research to date.		*			*			

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O99	2		Practices and Tactics	National model curricula and standards for field training	Issue: There are wide variations among agencies in the use and tracking of "field training." Need: Develop national model curricula, standards, and measurements for implementing field training.				*	*		*	
O35	2		Practices and Tactics	Processes for prioritizing and disseminating research findings	Issue: Given the large volume of results, it is hard to know what practitioners should focus on. Need: Processes/group who can nominate and prioritize research results, taking into account the maturity of the results.	*				*		*	
O123	3		Policies and Knowledge for Carrying Out Roles	Policies and standards for sharing body-worn camera data with researchers	Issue: Body-worn camera footage could be used as data for research. Need: Develop policies and standards for sharing body-worn camera data with researchers (policies could be modeled on historical use of dashboard cameras).							*	
S43	3		Policies and Knowledge for Carrying Out Roles	National training and expertise certifications that follow officers across agencies	Issue: National law enforcement certifications are not sufficient to allow officers to easily transfer from one agency to another (e.g., across state lines). Need: Develop a national training and expertise standard for law enforcement officers to allow more comparability among officers trained in different locations.						*	*	
S11	1		Policies and Knowledge for Carrying Out Roles	Assess training materials on handling digital evidence	Issue: There are varying levels of experience that are required to effectively handle digital evidence. Need: Assess training materials for all levels of responding and investigating and make recommendations for improvements.		*					*	
S145	2		Tactics and Practices	Examine how to fill gaps in law enforcement standards that were adapted from other areas	Issue: There is a gap in some sets of standards for law enforcement laboratories and technologies (e.g., ISO standards), especially those adapted from other areas. Need: Work with standards development organizations to fill the gaps with new standards or with "handbooks" that describe how to implement the standards in particular settings.		*					*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S127	3		Firearm Range Technologies	Study costs and benefits of using portable facilities for training and labs	Issue: Portable facilities for training (including shooting) and labs are underutilized. Need: Study the costs and benefits of portable facilities to fill the gaps in facility needs.						*	*	
O7	2		Architectural Design and Systems	R&D on facility space and designs associated with high performance	Issue: Lack of data/guidelines to explain/justify why specific facility features are needed. Need: Research and dissemination on square footage/space design associated with high performance.			*			*	*	
S21	2		Architectural Design and Systems	Best practices on long-range facility construction	Issue: Long-range planning for facility needs is difficult. Need: Collect and share best practices for long-range facility planning. Should include collecting and disseminating data that can be used to identify and justify locations and capacities for stations.	*	*				*		
O3	3		Architectural Design and Systems	Partner with schools and companies to provide computerized training	Issue: Lack of computerized facilities for training. Need: Consider and disseminate alternatives, including partnering with local schools and private companies to provide low-cost/free computerized training facilities as well as improving remote connections.						*	*	
O9	3		Architectural Design and Systems	R&D on designing facilities for both community access and security	Issue: Trade-off between security and public accessibility is a challenge. Need: Research and dissemination on environmental design of stations to make them both welcoming and secure.				*	*			
O5	3		Architectural Design and Systems	R&D on facility services to improve officer and community morale	Issue: Few services offered at facilities to make them more hospitable/improve morale for both officers and community. Need: Research and dissemination on what sorts of specialized services and facilities would be most useful to officers/most improve morale.			*		*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S19	3		Architectural Design and Systems	Best practices on getting public support for facility construction	Issue: Getting community and political support for new stations and renovations is difficult. Need: Collect and share best practices for getting community, private-sector, and political support for new construction and renovations. Should include considering the kinds of facilities in police stations (community centers, etc.) that are most likely to get support.					*	*		
S129	2		Staff Equipment Storage and Maintenance	Study costs of storing excess evidence	Issue: Significant amounts of excess evidence are being retained well beyond retention standards. Need: Study the costs of storing evidence (and excess evidence).		*				*		
S61	2		Staff Equipment Storage and Maintenance	Case studies on getting rid of no-longer-needed evidence	Issue: Significant amounts of excess evidence are being retained well beyond retention standards. Need: Disseminate case study vignettes that describe the successes that agencies have had with getting rid of no-longer-needed evidence.		*				*		
S37	2		Physical Materiel Tracking	Research on inventory tracking systems	Issue: Existing inventory tracking systems are not sufficiently robust or flexible to support tracking the age or condition of equipment held by law enforcement agencies. Need: Conduct research to assess the state of the problem and recommend potential solutions.				*		*		
S133	2		Physical Materiel Tracking	Study law enforcement–court data exchanges to help identify when evidence is no longer needed	Issue: Significant amounts of excess evidence are being retained well beyond retention standards. Need: Study the state of evidence-prosecutor-court data interchange to facilitate helping agencies to decide when evidence is no longer needed. Potentially examine the effect of adding "expiration dates" to evidence records to trigger the discussion about whether evidence should be retained.		*				*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S25	2		Staff Equipment Storage and Maintenance	National study on the state of evidence storage facilities	Issue: The level of compliance with evidence preservation standards is low, but the extent data about the overall level of compliance is unknown. Need: Collect and share data about the state of evidence storage facilities nationally.		*			*			
S107	3		Staff Equipment Storage and Maintenance	Solutions for addressing a lack of space and maintenance in evidence rooms	Issue: Property room facility management is becoming an issue. Need: Assess and disseminate solutions for dealing with a lack of space and maintenance for evidence rooms, to include procedures for setting up and securing flexible warehouse space.		*				*		
O15	1		Organizational Analytic Structures	R&D on having crime analysis capabilities in all agencies	Issue: Many agencies do not have crime analysis capabilities. Need: Research and dissemination on how to have crime analysis capabilities embedded in all agencies, including small/low-resource agencies.	*	*					*	
O21	2		Individual Analytical Methods	R&D on integration of multiple types of crime analysis and forensic data	Issue: Could integrate crime linking, crime-to-suspect linking, forensic evidence, and tracking tools to solve more crimes. Need: Research and dissemination on integration and filtering of crime analysis and forensic analysis data to collectively solve crimes.		*					*	
O17	2		Computational Tools	R&D on improving quality of collected data, including automated tools	Issue: Collected law enforcement data are often inaccurate and incomplete. Need: Research and dissemination on mechanisms for improving the quality of data collection, including automated collection tools and agents to take the burden off of officers.		*			*	*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S89	2		Computational Tools	Case studies on using smartphone translation services	Issue: Agencies are increasingly relying on smartphone translation services to fill communication gaps. However, there are problems with presenting those statements in courts. Need: Gather and disseminate positive use cases (e.g., taking a written statement and using the smartphone to photograph and translate).		*			*		*	
O19	3		Individual Analytical Methods	Core definitions of crime and analysis concepts	Issue: Lack of standardization in crime and law enforcement data analysis, starting with how to define different types of crimes. Need: Core references for definitions of crime and crime analysis concepts.	*	*					*	
S75	1	*	Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Assess impacts of forensic backlogs on the criminal justice system	Issue: Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources. Need: Examine and highlight the impacts of forensic backlogs on justice system processes and efficiencies.		*			*	*		
S141	1	*	Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Develop forensic backlog reduction grants beyond those for DNA	Issue: Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources. Need: Work to develop forensic backlog reduction grants beyond what already exists for DNA backlogs.		*			*	*		
S117	1	*	Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Expand DNA backlog grants to cover other types of forensic equipment	Issue: Crime labs often need major updates. Need: Widen grants for DNA backlogs to include updates of other types of forensic equipment (physical and digital).		*			*	*		
S79	1	*	Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Assess sharing forensic analysis capabilities across states and regions	Issue: Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources. Need: Examine the potential effects of "sharing arrangements" to optimize forensic analyst labor across state and local demands.		*			*	*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O49	1		Surveillance/Monitoring	Partner with colleges and federal training programs on social media investigations training	Issue: Police use of social media for investigative purposes needs to be improved. Need: Explore and disseminate partnerships with universities, community colleges, and federal training programs (enrollment limited) that already provide training and support on Internet investigations, to make it a routine part of training and operations. Training must be free/very low cost and scalable.	*	*					*	
O111	1		Internal Data Collection	Best practices for cataloging, redaction, and deletion of body-worn camera video	Issue: There is a high cost for storage, cataloging, redaction, and deletion of body-worn camera video. Need: Develop best practices and best practice business rules for body-worn camera video.					*	*	*	
O117	1		Internal Data Collection	Best practices for body-worn camera on/off business rules	Issue: There are significant business rules considerations in coordinating when cameras are turned on manually, automatically, and in a coordinated fashion. Need: Develop best practices for camera on/off business rules.		*		*	*	*		
S65	2		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Collect data on the impact of forensic backlogs on the criminal justice system	Issue: Insufficient data exist to adequately measure the impact of forensic backlogs and other bottlenecks on criminal justice system efficiency and throughput. Need: Do a study to measure the impact of forensic backlogs on case solution and justice outcomes.		*				*		
O55	3		Surveillance/Monitoring	R&D on the amounts of time subsets of license plate recognition (LPR) data should be retained	Issue: Privacy concerns vs. ability to solve cases in what and how long LPR data are stored. Need: Research and dissemination on guidance on what amounts and lengths of time LPR data should be stored to support solving crimes/improving public safety. The research should explicitly assess age of LPR hits used to solve crimes. Should explicitly consider different policies for different subsets of data ("all data" vs. LPR hits around specific crime locations and times).		*			*			

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O27	3		Surveillance/Monitoring	R&D on "going dark" and workarounds	Issue: End-to-end encryption supports both improved protection of law enforcement and the public and concealment of criminal activity. Need: Research and dissemination on data on the nature and extent of the "going dark" problem, as well as promising workarounds.		*		*	*			
O47	3		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	R&D on digital forensic tools that can suggest relevant evidence	Issue: Forensics investigators often have to manually sort through large numbers of documents and other files to get to relevant evidence. Need: Research and dissemination of digital forensic tools that can filter/suggest evidence relevant to a particular case.		*				*		
O143	3		Surveillance/Monitoring	Assess options for triaging digital evidence in the field	Issue: Lack of ability to triage evidence in the field (such as digital device evidence). Need: Consider and disseminate existing triage options, legal constraints, and existing technical options for doing triage in the field.		*					*	
O53	3		Field Analytic Tools or Test Technologies	Sensors or chemical tests for detecting DUIs from drugs besides alcohol	Issue: It is difficult to assess impaired driving when someone is under the influence of marijuana or other drugs. Need: Accurate and usable field-grade sensors or a chemical test for detecting driving under the influence of marijuana or other drugs.	*	*				*		
O113	3		Internal Data Collection	System for consolidating evidence from multiple sources into single "records"	Issue: Data and evidence are on disparate systems in disparate formats and are difficult to collate into a single "record" that can be shared, viewed, redacted, and deleted as a set. Need: A system for collective record management.		*			*	*	*	
S105	3		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	System to triage digital devices at crime scenes	Issue: The number of digital devices found at scenes continues to grow. Additionally, some information needs to be extracted before the device is powered off. Need: A system to triage digital devices at crime scenes (mobile lab, etc.).		*						

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S39	3		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Research on integrating case history data and forensic data	Issue: It is difficult to integrate forensic and case information in an automated fashion (which can include or exclude suspects across a large set of cases). Need: Conduct research to assess the state of the problem and recommend potential solutions. Some solutions might include adapting and integrating existing solutions for real-time analysis (e.g., CrimePad, Visionaire, OSSI).		*				*		
S119	3		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Partner with universities on studying forensic backlogs	Issue: Forensics backlogs at labs (especially state and federal) are resulting in delayed justice and wasting other law enforcement resources. Need: Partner with universities to analyze existing data, highlight shortcomings, and provide insight.		*					*	
S67	3		Surveillance/Monitoring	Encourage use of scanners to create 3D-walkthroughs for first responders	Issue: The internal layout of structures is not sufficiently available when responding to incidents in buildings where the public frequently gather (building drawings are often not available or are insufficient). Need: Encourage owners of facilities that frequently host public gatherings to leverage 3D scanning technologies and make the data available to first responders (law enforcement, fire, etc.).				*				*
S57	3		Surveillance/Monitoring	Model procedures to investigate spoofing and SWAT-ing	Issue: Concerns about capabilities to spoof phone numbers for both prank and SWATing/criminal purposes. Need: Develop model policies and procedures to track and investigate spoofing.		*			*			
S35	3		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Research on using DoD surplus equipment to stock mobile crime labs	Issue: Mobile crime laboratories are not as available as they could be. In some cases, excess DoD equipment is available to fill the gap. Need: Conduct research to assess the gaps and identify potential solutions to fill the gaps.		*				*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S143	3		Laboratory Tools and Techniques for Evidence Analysis (Forensics Technologies)	Examine expanding NIBRS to include fields on digital evidence use	Issue: NIBRS and Uniform Crime Reporting processes do not result in a sufficient level of resolution to measure and assess the justice system throughput and potential problems resulting from digital forensics-intensive cases (and, to a lesser degree, for other forensic disciplines). Need: Work with NIBRS to collect data on the use and processing of digital evidence in criminal justice cases.		*				*		
S101	1	*	External Communications	Create public education materials on how frequent police misconduct actually is	Issue: Insufficient public and political recognition of just how endemic (or not) police misconduct situations are. Need: Invite researchers and "industry" organizations (e.g., IACP) to produce materials that raise the level of public information and increase the amount of context that the public and politicians have access to.					*		*	
O39	1		Information Presentation Tools and Dashboards	Assist software vendors with identifying information needed by officers at different points on a call	Issue: Many information displays result in information overload for responding officers. Need: Assist software vendors with identifying the pieces of information that are relevant to officers at particular stages in a response or an investigation.		*		*				*
O69	1		External Communications	Tools and processes for getting and acting on community feedback	Issue: Overcoming "us versus them" mentalities between departments and communities. Need: Tools and online environments to facilitate the level of feedback and two-way information exchange expected by the public. ("Bring the police department to the people" and "real listening.")					*		*	
O65	1		External Communications	Best practices for educating the public on how law enforcement operates and responds to events	Issue: Law enforcement officers do not have much control over how they are portrayed in popular culture (the military does a better job in this regard). Need: Develop strategies and best practices for ensuring that the community has sufficient information about law enforcement activities and events.					*		*	*

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O81	1		External Communications	Research on IT systems for capturing and sharing information from community engagements	Issue: Overcoming "us versus them" mentalities between departments and communities. Need: Research on IT databases and systems that can support police-community engagement, providing officers with the ability to capture and share information they learn from the community.	*	*			*			
O79	1		External Communications	Best practices for integrating law enforcement and community data to evaluate operational success	Issue: Existing "business intelligence" systems do not capture and make best use of the data that are already being collected. Need: Develop best practices for integrating and using existing internal and community data for evaluating operational success.	*	*			*		*	
O115	1		Information Presentation Tools and Dashboards	Methods for assessing whether technologies provide enough value to be worth the risk of information overload	Issue: Many officers are experiencing data overload and information overload. Need: Measures and methodologies for deciding whether new technologies are sufficiently mature and truly value added.				*	*			*
S23	1		External Communications	Best practices on using social media to correct mass media errors	Issue: Mass media stories are often riddled with inaccuracies. Need: Collect and share best practices where social media can be used to correct inaccuracies disseminated by mass media.					*		*	
S47	1		External Communications	Best practices to ensure the public correctly interprets open law enforcement data	Issue: Open data/transparency may give the public the incorrect impression of what is actually going on ("shots fired" ended up being firecrackers, "dangerous area" is a busy shopping mall). Need: Develop best practices for ensuring that the appropriate levels of context are available to consumers of "open" data (less frequent events, e.g., officer-involved shootings provide an opportunity to include narrative context).					*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S7	1		External Communications	Assess public education materials on why law enforcement carries different types of equipment	Issue: The public is generally unaware of the benefits of certain technologies carried by officers (pistols versus rifles), which often results with only inferior technologies being authorized for use. Need: Assess the state of existing public education materials for these situations.				*	*			
S9	1		External Communications	Assess public education materials on responding to active shooters	Issue: The public is generally unaware of the appropriate tactics and techniques for responding to active shooter situations in group settings. Need: Assess the state of existing public education materials for these situations.				*	*			
O13	2		Mobile Communications	Ways to improve adoption of existing radio interoperability solutions	Issue: Ongoing non-interoperability of radio networks—cost of upgrades is a major factor. Need: Explore ways to improve adoption of existing technological solutions for radio interoperability by agencies and their funders.						*		*
O119	2		External Communications	Materials to educate the public about law enforcement technologies actually in use and their capabilities	Issue: There is a significant disconnect between public perceptions of the types of technologies that are actually in use and their capabilities and limits. Need: DOJ (and law enforcement agencies) should produce materials that can be used to educate the public.					*	*		*
O25	2		External Communications	R&D on which law enforcement information should lbe posted versus what should be kept private	Issue: Concerns about some exploiting data/using it against police. Need: Research and dissemination on guidelines of what is most useful to publish for transparency/crime fighting vs. what can be most readily exploited by criminals.	*			*	*			
O23	2		Mobile Communications	Demo radios with both legacy voice and cellular communications	Issue: Could integrate cell phones with legacy radio communications. Need: Work with other DHS science and technology, DoD (DARPA, etc.), and other agencies to identify potentially suitable prototypes.			*	*				*

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O29	2		Information Presentation Tools and Dashboards	R&D on interfaces for preparing reports	Issue: Human factors design of reporting and displays need to be improved, especially on mobile devices. Autofill (but concerns about data accuracy), display/order of prompts, and eliminating retyping are common requests. Need: Research and development on reporting interfaces (broadly defined) that are easier to use—and can be readily and easily customized to how people actually work—while ensuring data accuracy.		*		*		*		*
O67	2		External Communications	Facilitate connections between patrols and community social networks using mapping and social media tools	Issue: Law enforcement officers do not have much control over how they are portrayed in popular culture (the military does a better job in this regard). Need: Systems to facilitate connections between patrol-accessible mapping systems and community social networks and liaisons.	*				*		*	
S29	2		External Communications	Research on best practices for public information officers	Issue: Insufficient research exists on best practices for modern public information practices for law enforcement. Need: Conduct additional research on the effectiveness of public information officer best practices.					*		*	
S83	3		Mobile Communications	Assess using social media platforms to communicate during incidents	Issue: Communication during incidents continues to be a problem. ICS discipline helps, but is not a solution. Need: Explore using social media platforms (e.g., Twitter) to facilitate communication.								*
S31	3		Mobile Communications	Research on using commercial recording pens during incident response	Issue: Commercial recording pens and recording devices are inexpensive and becoming ubiquitous. Need: Conduct and disseminate research on using recording pens to track and share written plans during and after incident response.						*		*
S131	1	*	IT Systems for Managing Organizational Resources	Study the risks and benefits of dispatch center consolidation	Issue: Consolidation efforts for dispatch centers often focus on the personnel and cost benefits, but not on other risks, such as lack of familiarity with the local area. Need: Study the risks and benefits of dispatch center consolidation.				*		*		*

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S93	1	*	System Integration and Information Sharing	Model interoperability language for RMS requests for proposals	Issue: Data systems are often not compliant with data interchange standards (and vendors are resistant to facilitating data interchange). Need: Have DOJ publish model interoperability language that can be readily dropped into requests for proposals for new RMSs. Language will need to support being configured for different sizes and types of agencies.		*		*		*		
O45	1		System Integration and Information Sharing	Explore use of entity resolution and federated search tools across multiple databases	Issue: Could use entity resolution/federated search tools to pull together related information across multiple government databases. Need: Explore the application of entity resolution technologies from the private sector to criminal justice applications, to include assessing effectiveness and long-term costs of existing commercial tools.	*	*		*		*		
S125	1		IT Systems for Managing Organizational Resources	Study how to improve question trees used by PSAP operators	Issue: Some PSAP operators are confined to a fixed script that makes it difficult to get the full set of information in a way that is the most useful for law enforcement (sometimes it is optimized for fire and EMS). Need: Research the locally optimal sets of questions (with branching) to gather the critical information and be able to dispatch law enforcement, firefighters, and EMS.				*			*	*
S87	1		System Integration and Information Sharing	Case studies that show the benefits of agencies' sharing data	Issue: Agencies unwilling to share data. Need: Gather and disseminate positive use cases (e.g., LInX program).		*				*	*	
S137	1		System Integration and Information Sharing	Study improvements to weapon-related suspicious activity reports.	Issue: Lack of capability for firearm dealers to digitally and rapidly transmit suspicious activity reports and have those reports evaluated and shared. Need: Study the state of the problem and provide recommendations for potential data-sharing solutions.		*		*		*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O43	2		System Integration and Information Sharing	Explore how NIEM and Global Justice Information Sharing Initiative standards could enable automated workflows	Issue: Support information integration that eliminates data reentry and automates workflows throughout criminal justice life cycles. Need: Explore how application of such standards as NIEM and Global Justice Information Sharing Initiative in information systems could facilitate automated workflows in IT systems.		*		*		*		*
S69	2		System Integration and Information Sharing	Ensure that federal grants require compliance with data standards	Issue: Data systems are often not compliant with data interchange standards (and vendors are resistant to facilitating data interchange). Need: Ensure that federal grants supporting the purchase of data systems require compliance with data interchange standards.		*				*		
S55	2		System Integration and Information Sharing	Model records and evidence laws	Issue: Records and evidence laws are out of date—many were written in the paper records era. Need: Develop model laws that can be easily adapted to the state and local level.		*				*		
S135	2		System Integration and Information Sharing	Study improvements to the information used in weapon background checks	Issue: The information needed to perform background checks for weapon purchases is often inaccurate or out of date. Need: Study the state of the problem and provide recommendations for potential data-sharing solutions.		*		*		*		
S91	2		IT Systems for Managing Mission-Related Data	Federally supported capability for real-time crime and threat data about persons	Issue: Data systems are often not compliant with data interchange standards (and vendors are resistant to facilitating data interchange). Need: A federally supported capability for capturing, storing, and securing updated crime and threat information about individuals.		*		*		*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S139	2		System Integration and Information Sharing	Study approaches to generating a complete background check on a person	Issue: It is extremely difficult to get a complete background information on an individual (mental health, convictions, sentencing, etc.). Need: Study the state of the problem and provide recommendations for potential solutions. Should include policy, data integration, federated search, and entity resolution elements.		*		*		*		
O41	3		System Integration and Information Sharing	Approaches to limit use of proprietary software standards	Issue: Proprietary data installations can result in vendor lock-in and inability to share data across systems. Need: Examine approaches to limit use and mitigate effects of proprietary standards. Examples include changing grant requirements and standard contract language to require open standards (or at least make data accessible if standards are not mature).						*	*	
S77	3		IT Systems for Managing Organizational Resources	Assess workforce scheduling systems to identify scheduling solutions for law enforcement	Issue: Existing scheduling systems are not sufficiently robust or flexible to support the "business" needs of law enforcement agencies. Need: Examine the entire "scheduling system" industry (hospitals, law offices, etc.) to see if these problems have been adequately addressed elsewhere.						*		
S49	3		System Integration and Information Sharing	Data standards to connect law enforcement case records with court records	Issue: It is extremely difficult to monitor and track the progress and disposition of court cases. Need: Develop data interchange standards (including business rules) to facilitate making the connection between law enforcement records and court records.		*				*		
S99	3		IT Systems for Managing Mission-Related Data	Standards for RMS/CAD systems to include built-in analytics	Issue: Existing RMS/CAD systems do a poor job of supporting analysis. Need: Identify standards for RMS/CAD systems to include analytic capabilities.	*					*		

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S3	3		System Integration and Information Sharing	Assess solutions for sharing new types of evidence data with courts	Issue: Modern technologies result in new kinds of evidence that are difficult to transmit to follow-on portions of the justice system (district attorneys, etc.). Need: A variety of existing solutions and approaches exist (or are being tried). Those that are more successful should be identified and highlighted.		*				*		
S5	3		System Integration and Information Sharing	Assess barriers to sharing new types of evidence data with courts	Issue: Modern technologies provide new opportunities to transmit to follow-on portions of the justice system (district attorneys, etc.). However, some systems are not being used to their fullest potential (after installation and implementation). Need: Assess barriers to adoption or realization of the potential of such systems to inform implementation		*				*		
S95	3		IT Systems for Managing Organizational Resources	Conference with users and vendors to improve law enforcement scheduling systems	Issue: Existing scheduling systems are not sufficiently robust or flexible to support the "business" needs of law enforcement agencies. Need: Hold a "conference" with users and vendors to discuss shortcomings and engineer potential solutions.						*		
S41	2		Information Security	"Red team" services to test law enforcement agencies' cyber defenses	Issue: Law enforcement agencies are increasingly using IT to conduct business and, as a result, are increasingly vulnerable to cyber attacks (much as other U.S. offices are). Need: Develop "red team" services that are available to law enforcement agencies to test their personnel behavior and other defenses.						*	*	
O51	3		Infrastructure	Best practices on monitoring analytic tools' audit trails	Issue: Analytic tools often provide audit trails, but they are not often audited to ensure that the tools are being used in compliance with departmental policies. Need: Develop best practices for monitoring audit trails for misuse.					*		*	

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
S63	3		Information Security	Case studies on how agencies have implemented cyber protections	Issue: Law enforcement agencies are still susceptible to cyber attacks. Need: Disseminate case study vignettes that describe the successes that agencies have had with implementing cyber protections.						*	*	
O103	1		Armor and Helmets	Examine use of ceramics and other advances in body armor	Issue: Body armor needs to be lighter and cooler, with coverage expanded and effectiveness improved. Need: Examine ceramic/advanced technology effectiveness and cost in body armor.			*	*				*
O11	2		Credentials/Identification	R&D on reliable means for identifying a police officer	Issue: Lack of reliable means for identifying a police officer—existing IDs may not have any security/anti-copyright features; no connections to databases of who actually is an officer. Need: Research and development on means for positively identifying an officer.				*				*
O105	2		Armor and Helmets	Research on making shields lighter	Issue: Ballistic shields are still too heavy to carry. Need: Additional research into making lighter shields.			*	*				*
O107	2		Armor and Helmets	Partner with DoD to harmonize body armor standards	Issue: Defense and law enforcement have historically pursued independent tracks when developing body armor standards. Need: NIJ (and law enforcement standard developers) should engage with DoD standard developers to attempt to harmonize body armor standards.			*	*				*
O109	2		Armor and Helmets	R&E on the operational value of shields	Issue: Ballistic shields are not universally available to, nor standard equipment for, all officers. Need: Additional R&E on the operational value of shields.			*	*				*

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O129	3		Clothing/Uniforms	Assess options for gloves vs. operational needs	Issue: Need gloves that keep hands warm while allowing effective use of weapons. Also need gloves that protect officers from needle pricks/sharp objects and that are thin enough to use weapons and tools. Need: Assess range of current options for gloves vs. operational needs for officers.			*	*				
O131	3		Clothing/Uniforms	Research on load-bearing clothing and gear	Issue: Need personal equipment and safety storage gear that promotes the health of officers. Need: Research and dissemination on load-bearing clothing and gear that reduce injuries and allow more freedom of movement.			*	*				
O137	2		Less-than-Lethal Weapons	Sponsored research on nonkinetic less-lethal weapons	Issue: Could develop portable active denial systems. Need: Research on nonkinetic less-lethal weapons, such as sound, radio frequency, foam, and other mechanisms not yet developed.				*				*
O135	3		Less-than-Lethal Weapons	Research on less-lethal weapons and practices with more consistent incapacitation effects	Issue: Need more-reliable and safer incapacitation weapons than the status quo (conducted energy weapons, beanbags, pepperballs). Need: Research to develop weapons and practices that have consistent effects in stopping suspects.				*				
O141	3		Lethal Weapons	Research on ballistic effectiveness and outcomes	Issue: Lack research on guns (type, power) and police outcomes. Need: Review and disseminate research on ballistic effectiveness and outcomes; identify areas where more research is needed.				*				*
O139	3		Less-than-Lethal Weapons	Research competitions on nonkinetic less-lethal weapons	Issue: Could leverage X-prize concept to develop better less-lethal weapons. Need: Research competitions on nonkinetic less-lethal weapons, such as sound, radio frequency, foam, and other mechanisms not yet developed.				*				*

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O133	3		Less-than-Lethal Weapons	Research on less-lethal weapons that can get through heavy clothing	Issue: Conducted energy weapons often cannot get through heavy clothing. Need: Research on less-lethal weapons that can get through heavy clothing.				*				
O155	1	*	Unmanned Aerial Vehicles	Model policy for base law enforcement use of UAVs	Issue: There are concerns from the community/local governments about using UAVs. Need: A model policy for basic law enforcement use of UAV technologies.		*		*	*			*
O153	1	*	Unmanned Aerial Vehicles	Identify use cases for UAVs that have high utility and low privacy concerns	Issue: There are concerns from the community/local governments about using UAVs. Need: Identify and publicize specific use cases for UAV (barricaded subjects, crime scene investigations) that have high utility and no privacy concerns.		*		*	*			*
O157	1		Unmanned Aerial Vehicles	Research on risks and benefits of UASs in law enforcement	Issue: Insufficient research and policies exist on how to limit collateral property or privacy damage from law enforcement use of UAVs. Need: Conduct research on the risks and benefits of UAV use in law enforcement.		*			*	*		*
O159	2		Unmanned Aerial Vehicles	Research on risks and benefits of using UAVs specifically for payload delivery	Issue: Insufficient research on the use of automated vehicles to deliver sensors, or other materials to areas where they are needed (ongoing cases, etc.). Need: Conduct research on the risks and benefits of automated payload delivery for use in law enforcement.		*			*	*		*
O163	3		Sirens, Markings, and Warning Indicators	Assess scene lighting options to improve safety of road stops	Issue: Could leverage lighting improvements to make stops safer. Need: Assess and disseminate concepts and options for scene lighting.				*				*
O151	3		Pursuit Management	Research on remote vehicle immobilization technologies	Issue: Insufficient pursuit mitigation/vehicle immobilization technologies to address changes in pursuit policies. Need: Research on remote immobilization technologies.				*				

Table F.1—continued

ID	Tier	Top	Category	Title	Description	Reduce Crime	Solve Cases	Improve Health	Reduce Casualties	Improve Trust	Lower Costs	Reduce Competencies	Improve Responses
O161	3		Vehicle Armor	Assess cost and performance impact of adding side panel armor to law enforcement vehicles	Issue: Could place armor panels on side of police vehicles. Need: Assess the cost and performance impact of adding side panel armor to police vehicles.				*				
O165	2		Automobiles	Standards for law enforcement vehicle safety equipment	Issue: No uniform standards exist for law enforcement vehicles. Need: Develop standards for vehicle safety equipment (anti-lock brakes, stability, frame reinforcement, etc.).			*	*		*		
O147	3		Automobiles	Collaborative forums to discuss law enforcement vehicle design issues	Issue: Vehicles contain too much equipment in a cramped area—a hazard during crashes. Need: Collaborative forums to discuss design issues between manufacturers and potential buyers.			*	*				
O145	3		Automobiles	Explore possibility of practitioners and manufacturers jointly designing law enforcement vehicle	Issue: Inadequate ergonomics in car design. Need: Explore the possibility of jointly designing a purpose-built law enforcement vehicle.			*	*				
O149	3		Automobiles	Research on ergonomic cabin layouts	Issue: Insufficient information exists on the most efficient/safest cabin layouts. Need: Additional research into ergonomic cabin layouts.			*	*				
S33	3		Unmanned Ground Vehicles	Research on impacts of autonomous vehicles on law enforcement	Issue: Future autonomous vehicles (airborne and road) may have impacts on the facility, equipment, and communication needs of law enforcement agencies. Need: Conduct research on the potential effects and future needs of law enforcement agencies.				*		*		*

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The National Institute of Justice tasked RAND to host a panel of law enforcement experts to identify high-priority needs for innovation in law enforcement, covering advances in technology, policy, and practice. The needs discussed in this report can help prioritize research, development, and dissemination efforts in ways that will provide the greatest value to law enforcement practitioners.

The panel identified four top findings. First, there is a need to improve practitioners' knowledge of available research and technology, starting with a central knowledge repository and research on how to improve dissemination and training methods. Second, there is a need for practices and technologies to improve police-community relations, both to improve encounters with the public and to improve community relations more broadly. Third, there is a need to improve the sharing and use of information in a range of ways. These include means to get crime analysis capabilities to all agencies (including small and disadvantaged agencies), software development to reduce information overload, and model proposal and contract language to make systems interoperable. Fourth, there is a need to reduce backlogs in forensic processing; panelists suggested broadening U.S. Department of Justice forensic grants outside of DNA to help address the backlogs.

Additional high-priority needs included further development of policies and use cases for unmanned aerial vehicles, best practices for selecting and using personal gear, and improving defenses against active shooters. The latter included improving both suspicious activity reporting processes and efforts to educate the public on responding to an active shooter. There is also a need for a review of technologies that might improve officers' health.

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