



# National Institute of Justice

## Research in Brief

Jeremy Travis, Director

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**Discussed in this Research in Brief:** A 1997 survey designed to provide quantitative data from State and local law enforcement agencies nationwide on their current and planned use of communications equipment and services and their experience with interoperability.

**Key issues:** Routine police work requires effective coordination and communication with other police agencies, fire departments, and emergency medical services to mount a well-coordinated response. Interoperability, the ability of agencies to communicate across jurisdictions, often depends on wireless radio communications systems. This study, based on a mail-in questionnaire, examines telecommunications systems; knowledge and training about their use; and interoperability experience, requirements, and shortfalls.

### Key findings:

- Interoperability is common, with 82 percent of agencies having at least one channel dedicated solely for use with other organizations. Though most agencies are confident of their ability to handle routine situations, many law enforcement agencies experience serious obstacles, particularly when trying to communicate with agencies beyond their local network or operating in different frequency bands.
- Limitations in funding and frequency incompatibility were identified as the biggest interoperability problems.
- Thirty-five percent think State or Federal mandates are needed to ensure interoperability, but the majority believe local planning best meets

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## Wireless Communications and Interoperability Among State and Local Law Enforcement Agencies

by Mary J. Taylor, Robert C. Epper, and Thomas K. Tolman

Routine police work requires effective coordination and communication with other police agencies, fire departments, emergency medical services, and public service organizations. High-profile incidents—such as bombings, plane crashes, and natural disasters—test the ability of public safety and public service organizations to mount a well-coordinated response. Interoperability, the ability of different agencies to communicate across jurisdictions with each other, often

depends on wireless radio communication systems.

This 1997 NIJ-sponsored study, conducted by the National Law Enforcement and Corrections Technology Center, focuses on interoperability issues in the law enforcement community. It is based on a survey of the interoperability experiences and needs of law enforcement agencies across the Nation.<sup>1</sup> (See “Methodology” for a discussion of the sampling and analysis

### Methodology

Starting in February 1997, 10-page questionnaires were mailed to all agencies that employ more than 100 sworn officers and to a stratified random sample of smaller agencies across the country. By the end of the data collection phase in July 1997, a total of 1,334 agencies had responded to the questionnaire, an overall response rate of 48 percent. Agencies were categorized by size (six size categories based on the number of sworn officers) and type (local police, sheriff's departments, special police, and

State police) for analyses. State agencies were not included in the analyses by size.

All data in this report are based on the respondent sample. A bias analysis was conducted, as were analyses based on weighted data to correct for underrepresented or overrepresented groups. The sample is broadly representative of the Nation, although respondents were *more* likely to have problems caused by outdated equipment and to be *less* confident in their ability to handle interoperability situations.

## Issues and Findings

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their needs. Many agencies indicated that funding assistance would make mandates more acceptable.

- Discrepancies in State and local perceptions about the existence of formal State interoperability plans suggest a need for more dialogue between State and local law enforcement agencies.

- Most agencies have conventional analog systems and operate in high VHF bands, but information from agencies planning to replace/upgrade their systems within 10 years, 46 percent of the total, indicated that the number of agencies operating in 800 MHz will about double, as will those using digital systems. The use of trunked systems is also expected to increase.

- Most radio spectrum is used for voice transmissions but the number of agencies devoting channels to data-only transmissions is increasing. Plans for use of new technologies and mobile/portable computers will increase the need for additional spectrum. The use of laptops (projected to double in the next 10 years) is currently replacing mobile data terminals in larger agencies.

- Dead spots and outdated equipment are the most common problems with radio systems. More than half of the agencies that complained of outdated equipment (older than 10 years) had plans to replace/upgrade their radio systems.

- Channel congestion, a serious problem for almost half the agencies, is much less of a problem for agencies with trunked systems. Large and State agencies indicated the greatest need and requested the greatest number of additional channels.

- The use of voice and data security measures is increasing in all agencies, although large and State agencies currently are the most likely to use security measures.

**Target Audience:** Local, State, and Federal policymakers and law enforcement communications officials.

techniques used.) The full report provides detailed information about telecommunications equipment and infrastructure, knowledge and training, interoperability experience and requirements, and interoperability shortfalls.

In September 1996, the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) received a report from the Public Safety Wireless Advisory Committee (PSWAC)<sup>2</sup> that concluded, “Unless immediate measures are taken to alleviate spectrum shortfalls and promote interoperability, Public Safety agencies will not be able to adequately discharge their obligation to protect life and property in a safe, efficient, and cost-effective manner.”<sup>3</sup> As an initial response to PSWAC recommendations, the FCC is considering an allocation of 24 megahertz (MHz), essentially doubling the spectrum currently available.<sup>4</sup> **[Editor’s note 2/23/98. The FCC approved this allocation on January 6, 1998.]**

Integral to both interagency and intra-agency communications are agency-controlled and -operated wireless communications systems; the efficiency of these systems ultimately depends on radio frequency availability and compatibility. Radio spectrum is a limited resource that will become increasingly valuable as public and private use increases and applications proliferate. Allocation of spectrum represents a substantial resource investment for the country. This study resulted from the belief that careful research and public debate should inform decisions of such magnitude. The purpose of this research was to explore issues identified by the Public Safety Wireless Advisory Committee, provide quantitative data from State and local

law enforcement agencies across the Nation, and quantify the nature and extent of current use and anticipated needs for wireless communications, particularly as they relate to interoperability.

## Findings

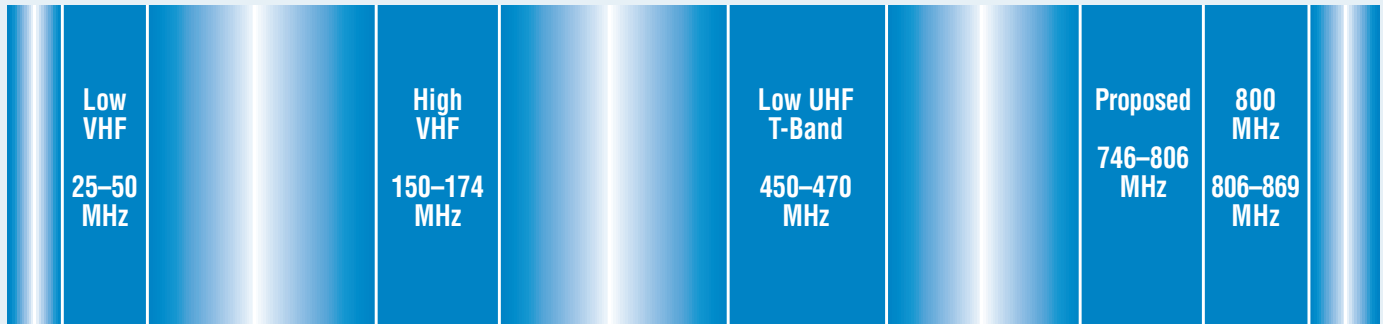
This study confirms and quantifies much of what is already “known” about law enforcement agencies’ use of telecommunications equipment for routine operations and for interoperability, although there are a few surprises. The findings are organized into four categories: telecommunications equipment and infrastructure, knowledge of interoperability standards, interoperability experience and requirements, and interoperability shortfalls.

### Telecommunications equipment and infrastructure

Mobile radios, whether handheld or vehicle-mounted, are basic law enforcement communications equipment. State agencies and sheriff’s departments are more likely to use citizens band and amateur radios, but agencies of all sizes and types use cellular phones and pagers. The sharing of frequencies and/or infrastructure (e.g., transmitters and repeaters) is very common, and most agencies that share radio systems remain involved in making decisions related to their system.

**Land mobile radio (LMR) technology.** Most agencies have conventional analog systems and operate in high VHF bands, but information from agencies that were planning to replace or upgrade their systems within 10 years, 46 percent of the total, indicated several trends: (1) the number of agencies operating in 800 MHz<sup>5</sup> will more than double, growing from 23 to 51 percent; (2) the number of agencies

Exhibit 1: **Radio Spectrum Band Diagram**



using digital systems will increase from 13 to 25 percent; and (3) the number using trunked systems will increase from 24 to 27 percent. Large agencies are most likely to use trunking—the technology that allows more efficient use of spectrum by automatically routing users to an open channel. Agencies with trunked systems (24 percent) reported fewer serious problems with channel congestion than did agencies with conventional systems. Agencies with older equipment were less likely to have trunked systems and more likely to indicate problems with channel congestion.

**Radio frequency preferences.** Most law enforcement agencies (73 percent) currently operate at the high end of the very high frequency (VHF) band (see exhibit 1 for radio spectrum allocations for public safety), although many of them expect to move to 800 MHz when they upgrade or replace their systems within 10 years.<sup>6</sup> There were no significant differences between agencies with 800 MHz systems and those operating in other bands with respect to their confidence in the ability of their radios to handle routine day-to-day local interoperability situations. However, there was a difference in confidence in their ability to establish radio links with State and Federal

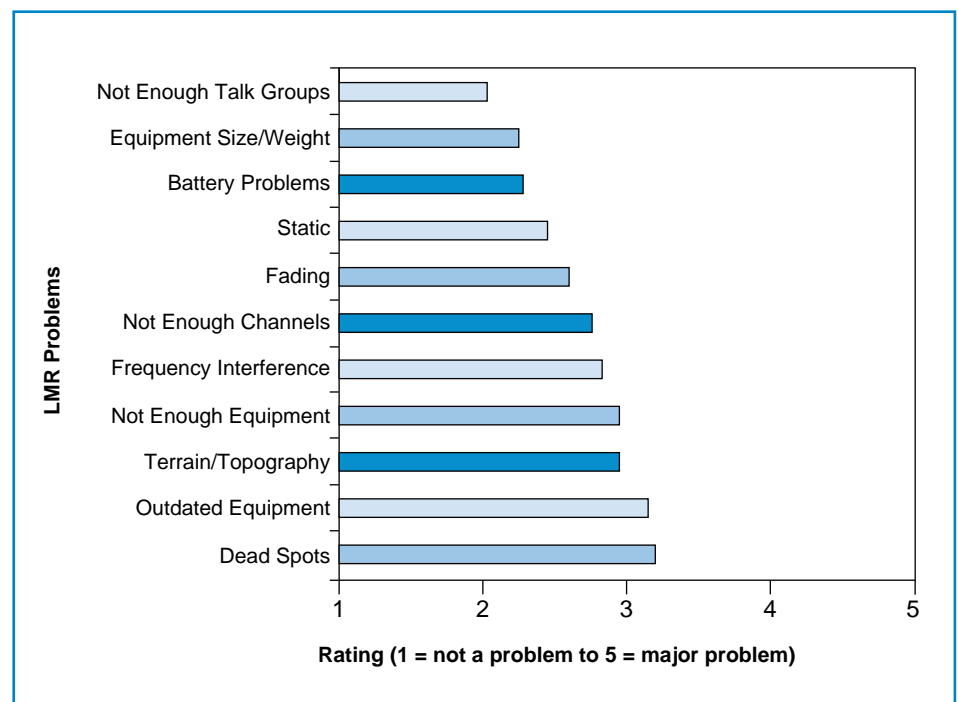
organizations and in their ability to handle mutual aid or task force operations. (Agencies with 800 MHz systems were more confident.)

**LMR problems.** Agencies identified dead spots and outdated equipment as the most common and serious problems with their radio systems (see exhibit 2). Thirty-seven percent of respondents indicated serious problems due to topography/terrain; agen-

cies with mountains or many highrise buildings were the most likely to have problems with dead spots.

Problems with land mobile radio systems do not necessarily translate into problems with interoperability, but given that “limitations in funding” was rated as the most severe obstacle to interoperability (see “Interoperability shortfalls” on page 8), the problem of outdated equipment was selected for

Exhibit 2: **Problems With Land Mobile Radio Systems**

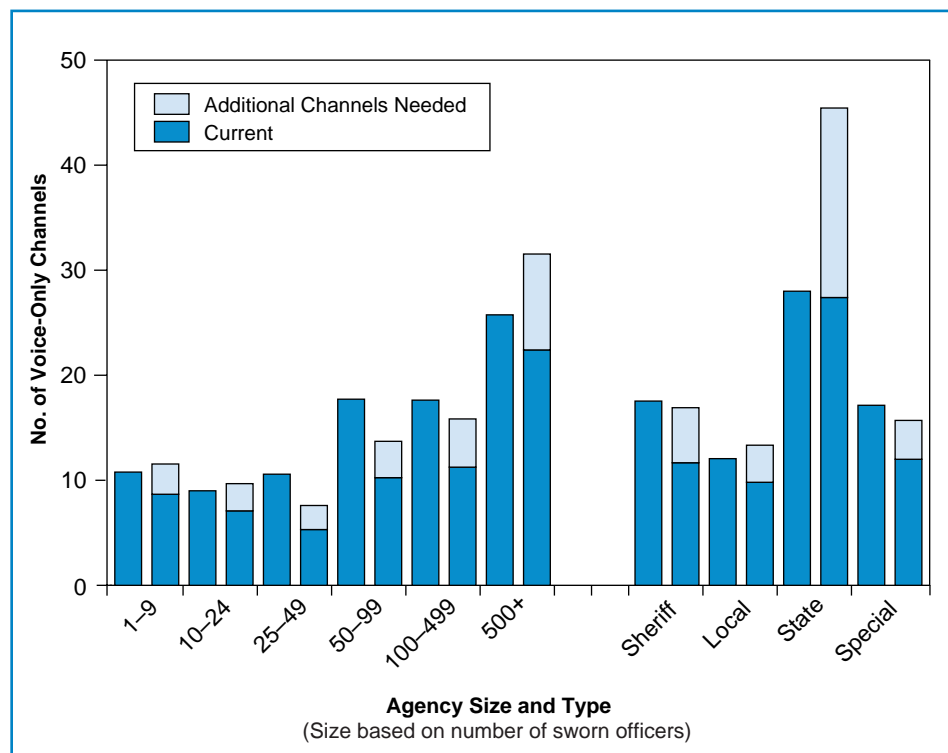


more detailed analysis. The process for systematically replacing aging equipment appears to have somewhat stalled: 43 percent of the agencies reported serious problems due to outdated equipment, compared to 35 percent that reported having only minor problems. Most of the agencies having problems with old equipment reported that they plan to replace or upgrade within 10 years.

**Voice and data channels.** Channel congestion is a significant problem for many agencies, especially for large agencies and for State police, although the problem is alleviated somewhat by trunking. Ninety-one percent of respondents have channels dedicated to voice-only transmissions, 27 percent have some channels dedicated to data-only transmissions, and 19 percent use alternate voice and data channels. As a result of the increasing use of wireless data technology (related to use of mobile data terminals [MDTs] and laptops), the estimated need for additional data-only channels shows the greatest rate of increase, even though the greatest overall need is for more voice-only channels.

The study further analyzed the data from agencies that indicated they did not have enough channels. Agencies' current and preferred uses of voice-only and data-only channels were analyzed to determine the extent of problems with channel congestion. More than half (53 percent) of all respondents indicated they needed additional voice-only channels, and 30 percent indicated they needed additional data-only channels. (Exhibit 3 offers a comparison of agencies with sufficient voice-only channels and agencies with insufficient voice-only channels and the estimated voice-only channel needs, by agency size and type.) Agencies that said they needed

Exhibit 3: **Voice-Only Channel Analysis**



Note: The first bar in each size/type category represents those agencies that reported having enough voice-only channels. The second bar in each size/type category represents agencies that reported having insufficient channels.

more channels (53 percent of the respondents) were asked to estimate the number of additional channels needed; they reported a need for an overall average of 5.1 additional voice channels per agency (a 40-percent increase) and 4.9 data channels (a 70-percent increase).

A comparison of agencies that were satisfied with their current number of channels and those that said they needed additional channels showed considerable agreement across agencies in the number of channels considered optimal for routine operations, including interoperability situations. A similar pattern was not evident for data-only channels, perhaps because agencies are just beginning to dedicate channels for data transmission and are less clear

about how many data channels will be optimal. Agencies are also planning to increase their use of wireless data applications and have yet to determine how those new applications will translate into a need for additional spectrum.

Agencies that reported plans to replace or upgrade their land mobile radio systems (46 percent of all respondents) estimated they would need an average of 13.7 voice-only channels and 4.9 data-only channels in their next system. State agencies and agencies with 500 or more sworn officers indicated the greatest need for additional channels, but overall, those that planned to replace or upgrade were not expecting big differences in the total number of channels

in their next system, perhaps because many of them planned to upgrade to trunked systems that use the available frequencies more efficiently.

**Wireless data transmissions.** According to the results of this study, the number of law enforcement agencies that will be using free text (e.g., reports and queries) and database information on MDTs and laptops will double in the next 2 years. Although few agencies now use wireless transmission of still images, fingerprints, or videos, many agencies plan to use them within 2 years, if budgets permit (see exhibit 4). The use of MDTs and laptops is widespread and increases with agency size. The use of MDTs is increasing in smaller agencies but leveling off or declining in large agencies; however, agency plans for the use of laptop computers show dramatic increases across the board.

**Advanced technology.** Commercially available advanced wireless technology services are also viewed as highly desirable. Most law enforcement agencies already use cellular phones and more plan to begin using them within the next 5 years. About 40 percent of all agencies expect to use global positioning system (GPS) services within 5 years. The use of other advanced technology services remains low, though a significant number of agencies indicated an interest in cellular digital packet data (28 percent) and personal communications systems (26 percent). If budgets allow, planned use of advanced technology will triple.

**Security measures.** Most agencies said they never use voice or data security (e.g., scrambling devices, digital encryption, or digital voice processing). This study revealed a discrepancy between the number of agencies that say security measures are essen-

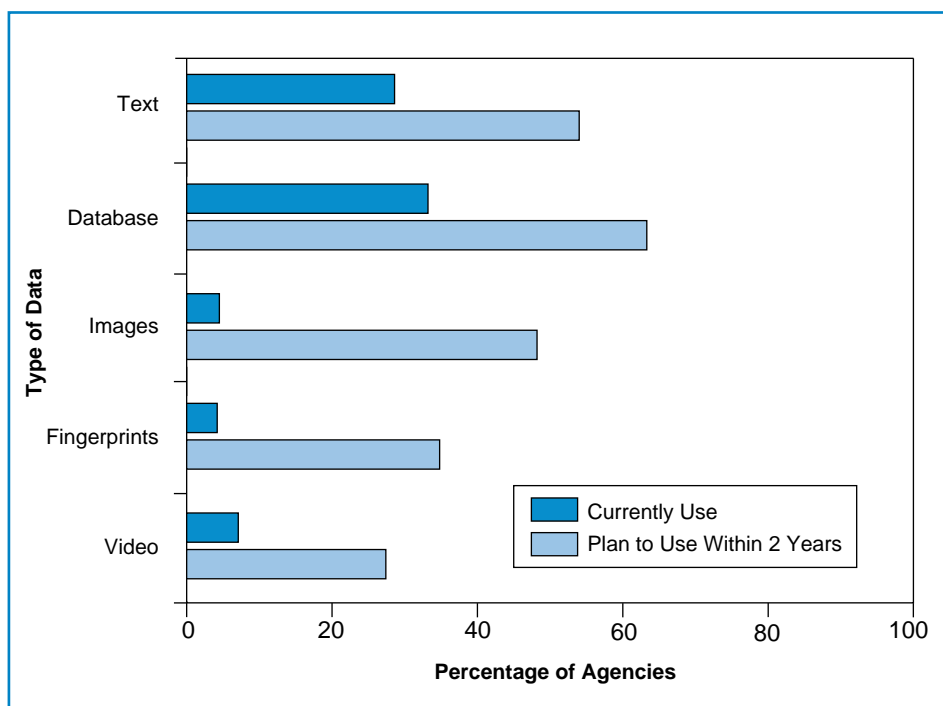
tial to their operations and the number that use them on a regular basis. However, there appears to be a growing awareness of the need, as well as an increasing use of voice and data security measures. Large agencies and State police agencies are the most likely to use security measures of all kinds, with digital encryption being the most common form of security protection for both voice and data.<sup>7</sup>

### Knowledge of interoperability standards

As agency size increases, so does familiarity with initiatives related to interoperability in wireless communications, such as the FCC Frequency Application Process, Project 25 Interoperability Standards (see exhibit 5) and/or National Public Safety Planning Advisory Committee (NPSPAC) guidelines.<sup>8</sup> Agencies of all sizes and types rated manufacturers as the primary source of information when planning the purchase of communication technologies. Other government agencies were ranked as the second most important source.

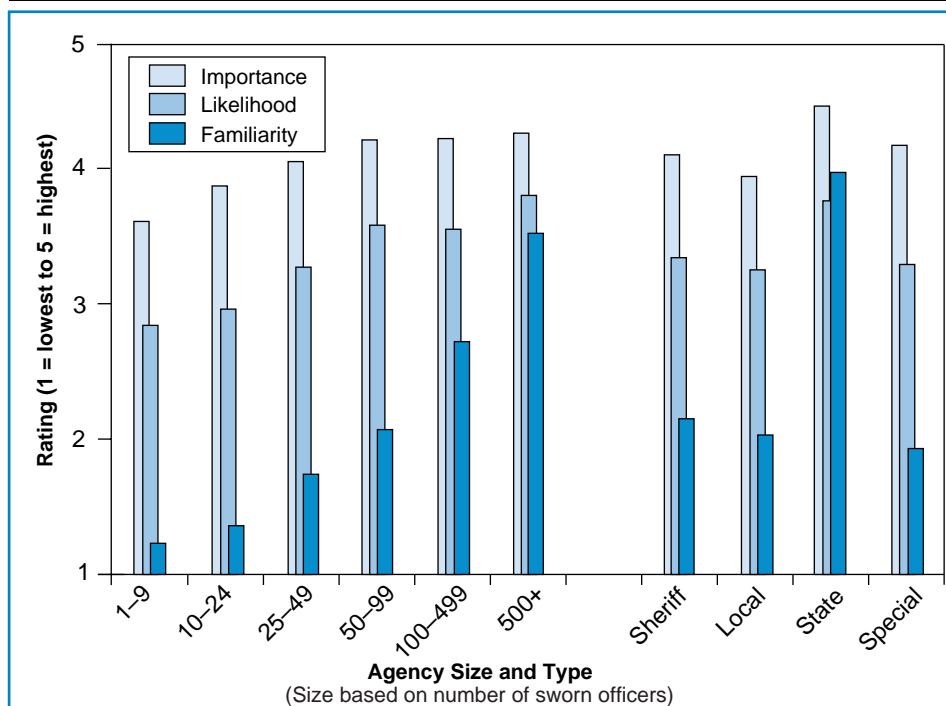
Seventy percent of respondents said consideration of interoperability issues and interoperability standards was important to their agency when planning for the purchase of their next land mobile radio system. About a third (36 percent) of respondents indicated they were very likely to adopt Project 25 Interoperability Standards for their next land mobile radio system, another third (33 percent) were somewhat likely (middle rating of 3 on a 5-point scale), and 19 percent were very unlikely (12 percent did not answer the question). As exhibit 5 shows, the likelihood of adopting Project 25 Standards was not dependent on agency familiarity with the standards.

Exhibit 4: Current and Planned Use of Wireless Data Applications

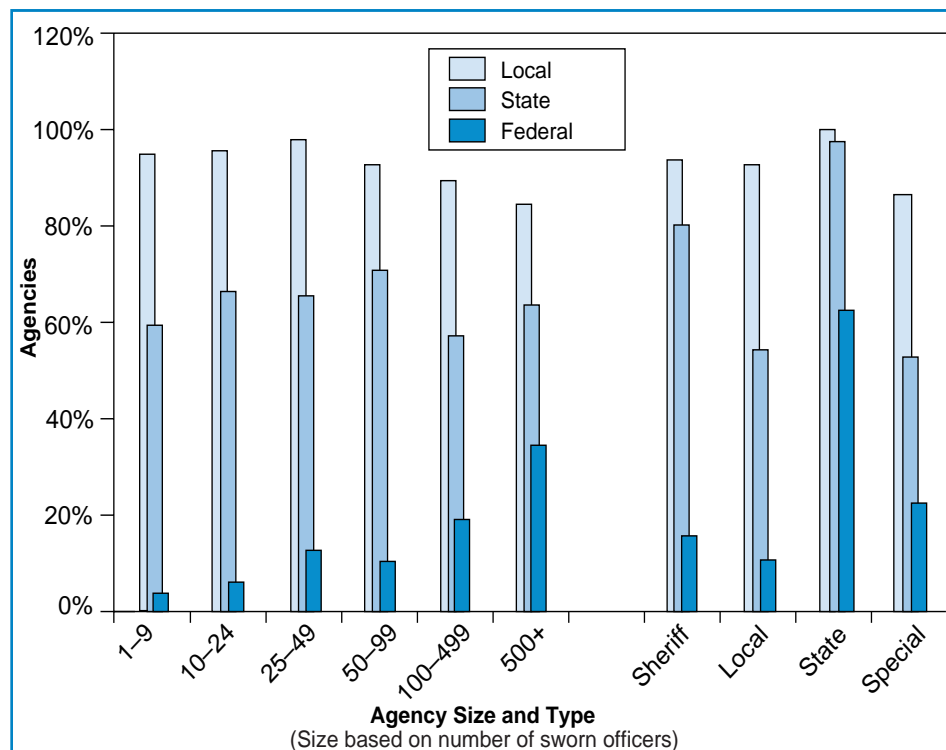




**Exhibit 5: Comparisons of Importance Ratings of Interoperability Standards, Likelihood of Adopting Project 25 Standards, and Agency Familiarity With Project 25 Standards**



**Exhibit 6: Percentage of Agencies Experiencing Daily or Weekly Interoperability Events With Federal, State, and Local Organizations**



### Interoperability experience and requirements

Interoperability is extremely common for law enforcement agencies of all sizes and types, with 93 percent indicating they interoperate on a daily or weekly basis with local organizations, and 63 percent indicating they interoperate with State-level organizations daily or weekly (only 15 percent interoperate with Federal organizations daily or weekly). (See exhibit 6.) Eighty-two percent of respondents have at least one radio channel solely dedicated to communicating with other organizations. Most (59 percent) use plain English, but 37 percent use a code system for communications between agencies (7 percent said using a code resulted in interoperability problems).

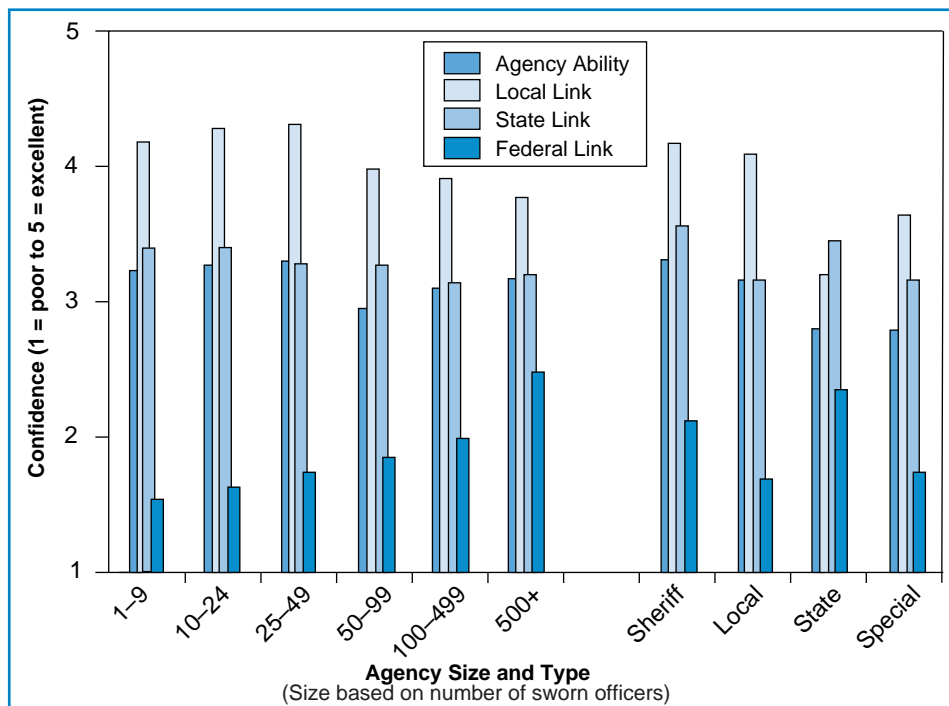
About half of the local and special police agencies participate in joint training activities with other organizations that involve actual use of communications equipment, compared to two-thirds of sheriff's departments and State agencies. Agencies that participate in such hands-on practice are significantly more confident in their preparation and in their agency's overall ability to handle interoperability situations.

**System abilities compared to agencies' abilities.** An agency's overall ability to establish radio communications links includes factors that go beyond the technical capabilities of radio equipment (e.g., people and training). Using reported confidence ratings, agencies' ability as a whole and their radio systems' ability to establish links at different levels were compared. The results are summarized in exhibit 7. Seventy-four percent of respondents expressed a high level of confidence in their agency's ability to

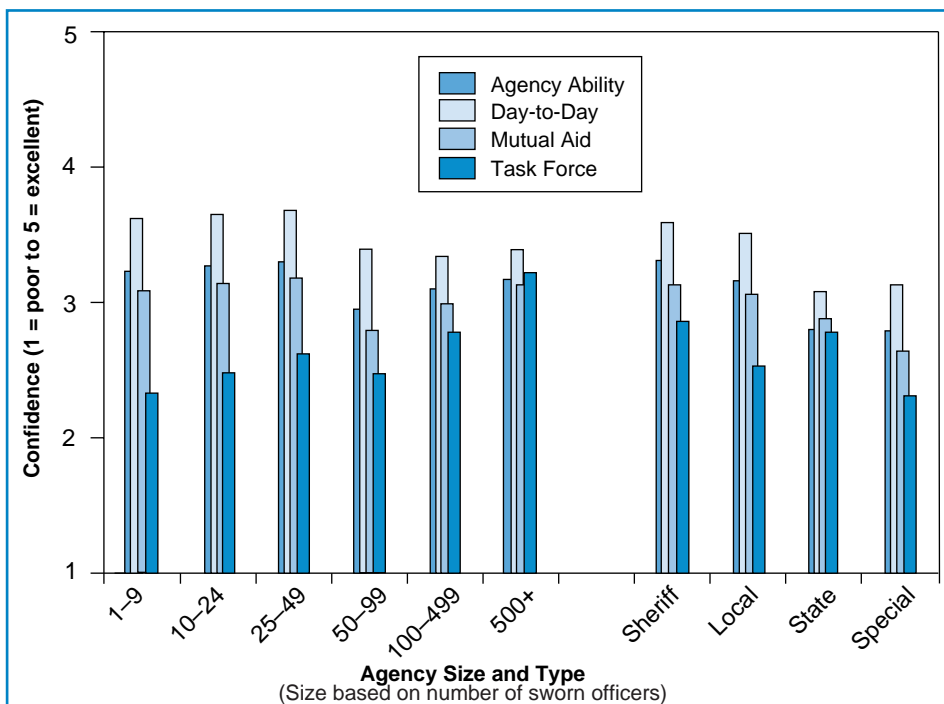
establish radio links at the local level, compared to 50 percent that expressed confidence in their ability to establish links with State organizations, and 15 percent with Federal organizations. (See exhibit 7.) More agencies expressed confidence in the ability of their radio system to handle day-to-day interoperability (57 percent) than to handle mutual aid (33 percent) or task force (32 percent) situations. (See exhibit 8.) Almost half (43 percent) were very confident in their agency's overall ability to handle interoperability situations, but 22 percent rated their agency's overall ability to establish communications links as poor.

**Use of formal interoperability agreements.** Interactions with Federal organizations are relatively uncommon for most local agencies but considerably more common for State agencies and larger agencies. Local agencies are the

*Exhibit 7: Confidence Levels in Agency Ability Compared to Radio System Ability to Establish Links*



*Exhibit 8: Ratings of Agency Ability Compared to System Ability to Handle Different Types of Interoperability Situations*



least likely to use written interoperability agreements, and smaller agencies are consistently less likely to use written agreements than larger agencies. State agencies interact with the greatest number of Federal, State, and local organizations and are most likely to use formal agreements. Most agencies use high band VHF for interoperating with other organizations, although larger agencies are more likely to use 800 MHz systems than smaller agencies.

**Local versus State-level interoperability planning.** Sheriff's departments, local police, and special police indicated a preference for local, regional, or multijurisdictional interoperability planning, while State agencies preferred State-level planning. Only one-quarter of the responding State agencies indicated their State had a formal State interoperability plan, but a few local agencies in almost every

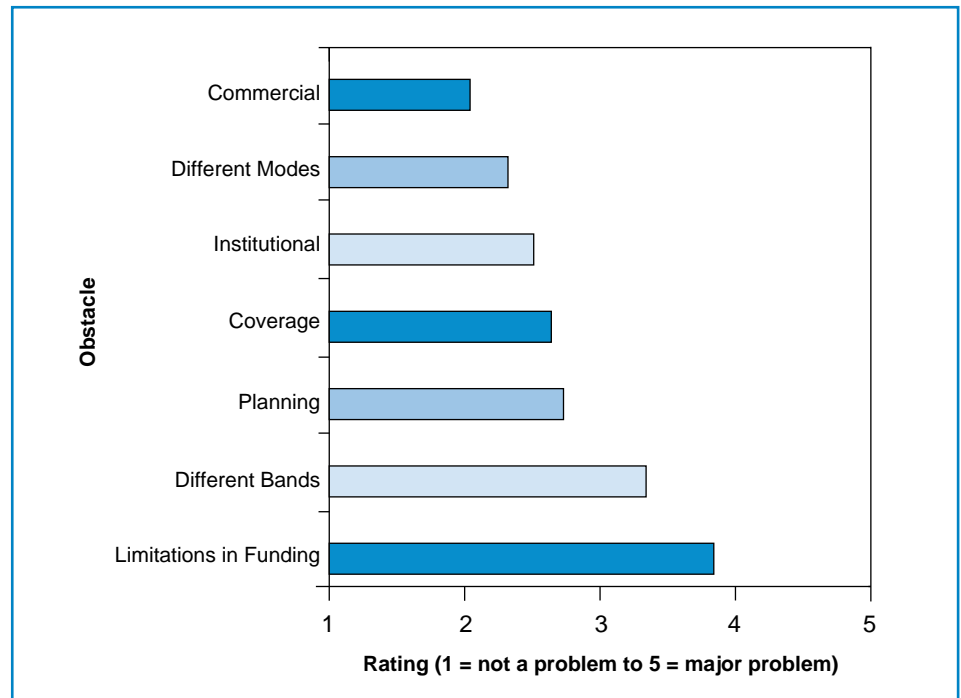
State indicated they thought there was a State plan. The discrepancy between State and local perceptions suggests a need for more dialogue and better information dissemination.

### Interoperability shortfalls

As part of the survey, agencies were asked to rate obstacles to interoperability. Agencies of all sizes and types rated “limitations in funding” and “different bands” as the two biggest obstacles to interoperability. A comparison of the average ratings gives an indication of the extent to which each of the obstacles identified by the PSWAC Interoperability Subcommittee has been experienced by State and local law enforcement agencies (see exhibit 9).

Overall, 69 percent of respondents rated limitations in funding as a severe problem (88 percent of State agencies, 78 percent of special police, 70 percent of sheriff’s departments, and 67 percent of local police). Agencies that rated limitations in funding as a serious problem also rated both their radio system’s ability and their agency’s ability to handle different types of interoperability situations significantly lower than did agencies that believed themselves to be adequately funded. Underfunded agencies were significantly more likely to identify outdated equipment as a serious problem, but they were no more or less likely to be planning to replace or upgrade their radio systems, to share frequencies and/or infrastructure with other organizations, or to have a channel solely dedicated to communicating with other organizations. They were just as likely as their better funded colleagues to participate in joint training activities that involved the use of communications equipment.

Exhibit 9: **Obstacles to Interoperability**



State agencies (68 percent) and special police (60 percent) were the most likely to experience severe interoperability problems because of different frequency bands, although a large number of local police (51 percent) and sheriff’s departments (47 percent) also indicated severe problems. Generally, larger agencies experienced more problems because of different frequency bands than smaller agencies. Larger agencies were also more likely to have 800 MHz systems. To work around frequency incompatibilities, agencies have developed a variety of “low tech” methods, which include using walkie-talkies and scanners, posting representatives in dispatch centers to relay information, and issuing mobile radios to other agencies. Nearly half of the respondents (47 percent) reported being able to patch across channels if necessary.

Three out of ten agencies indicated severe obstacles to interoperability

because of a lack of adequate planning. Differences in coverage areas, human and institutional limitations (such as agency concerns about maintaining communications links and reluctance to allow agency personnel to join other systems), and different communication modes (analog versus digital) have an adverse effect on approximately one in four agencies. Limitations in commercial services (e.g., telephones, fax machines, and cellular phones) were viewed as a minor problem.

When agencies were asked if they thought there should be “date certain” timelines to ensure implementation of interoperability standards, they were slightly more likely to say “yes” (35 percent) than “no” (28 percent). However, it is difficult to draw a firm conclusion because 37 percent of them did not answer the question (it was the last item on the questionnaire). Written



responses suggested linking Federal or State dollars to mandates, but many agencies noted that an external requirement could help them free up the funds needed to update their equipment. One respondent wrote in, “The only way we will update our system is if it is mandated. If not, the council will not spend the money.” Another respondent wrote, “no money, no mandate.” Many of the written responses raised issues related to cost and local control.

All sizes and types of agencies expect their agency’s overall ability to handle interoperability situations to improve over the next 5 years. This generally optimistic outlook may be related to the fact that more than half of them plan to replace or upgrade their radio systems within the next 10 years, and many plan to adopt new technologies that can improve interoperability by increasing efficiency and effectiveness.

## Discussion and conclusions

This study confirms and quantifies much of what was already “known” or suspected. It may also hold a few surprises for some readers. The data support the Public Safety Wireless Advisory Committee (PSWAC) conclusion that many agencies are experiencing serious problems with interoperability. The data also support contentions that there is a need for additional spectrum, and that larger agencies and State agencies have greater needs for additional spectrum than smaller agencies. The actual number of additional channels that agencies say they need is not large, and requests for additional channels appear to be reasonable when one compares the total number being requested to the number of channels now being used by agencies of different sizes that say they already have sufficient channels.

There is widespread use of channels dedicated solely to communicating with other organizations (i.e., to interoperability) and a high level of confidence in interoperability with other local organizations. Written comments revealed a variety of “solutions” that have been patched together by agencies. The creativity that has gone into solving local interoperability problems may be one of the factors involved in the decline in confidence when agencies rate their ability to interoperate with State agencies and the still further decline when they are asked to rate their ability to interoperate with Federal agencies. The question becomes “whose problem is it?”

Specific obstacles to interoperability have been rated and ranked by the number and extent of agencies that experience them as a problem. Each community and each law enforcement agency is working with a unique combination of interrelated factors. As a result, the data presented here may allow them to assess their own experience against the national profile, but decisions must still be made locally. The finding that most agencies prefer local (rather than State or national) planning for interoperability appears to contradict the PSWAC conclusion that a common, nationwide mutual aid plan and incident command system is necessary for interoperability.<sup>9</sup>

Some of the problems agencies are experiencing with their radio systems are undoubtedly related to the issues they identified as obstacles to interoperability. Limitations in funding contribute to problems with outdated equipment, insufficient equipment, channel congestion, and insufficient infrastructure to compensate for dead spots. But funding cannot solve all of the problems agencies are experienc-

ing. Topography/terrain may make it difficult or impossible to totally eliminate dead spots, particularly in mountainous regions and areas with many highrise buildings.

The general knowledge level among smaller agencies should be a concern for State and national policymakers, as should the resentment smaller agencies feel toward the influence exerted by large agencies and their perceived loss of control over their local budgeting. On the other hand, these data support the observation that external mandates can serve as either a threat or opportunity, depending on the agency. Even though the FCC has made a special effort to move allocation decisions for some of the 800 MHz spectrum to the State and local level (using the NPSAC guidelines and process), agencies with 800 MHz systems were no more likely to give favorable ratings to the FCC application process than were their colleagues operating under the existing process.

## Policy implications

Attorney General Janet Reno, in her recent address to the International Association of Chiefs of Police (IACP), referred to radio spectrum as a “precious commodity” subject to “fierce competition” and “among the most pressing issues faced at every level of law enforcement.” She encouraged IACP to begin thinking about the cost of upgrading and how to pay for it.<sup>10</sup>

Law enforcement agencies *are* concerned about the cost of communications equipment and are already working to systematically replace aging equipment, but a disproportionate number of agencies are still working with old equipment. Because of the rapidly changing nature of radio

technology, some agencies, especially larger agencies for which a complete overhaul of their communications system is a major investment, may be holding off until the bugs get worked out of the technology.

Most of the agencies that complained of outdated equipment already have plans to replace or upgrade their systems within the next 10 years. At a time when technology is changing rapidly, 10 years can be a long time. This study found an average equipment lifecycle of about 8 to 15 years (depending on the size of the agency and the cost of the system to be replaced).

Agencies are generally willing to adopt Project 25 Interoperability Standards when they upgrade but would clearly appreciate Federal or State funds to help defray or absorb the costs. The policy question is whether to allow the replacement process to happen naturally as a result of agency need and market forces, or to use incentives and sanctions to speed the process.

The extent to which channel congestion is a threat to an agency's effectiveness and ability to carry out its mandate is ultimately a local determination, although this study suggests that many communities would have to depend on marginal communications equipment should a disaster strike. Agencies are making plans to increase the use of available spectrum by expanding the use of wireless data applications and accessing commercially available services, such as cellular voice, global positioning system, cellular digital packet data, specialized mobile radio, and satellite systems.

Even if funding were unlimited, spectrum is not. New technologies (e.g.,

trunking) can increase efficiency in the use of spectrum, but the demand for advanced technology services and the increasing use of mobile computers by agencies of all sizes and types will require additional spectrum. An FCC decision to allocate additional spectrum for public safety is consistent with the needs identified in this study. Wise decisions about the actual amount of additional spectrum needed will require further analysis of both quantitative data and political realities. The allocation of additional public safety spectrum, narrow-banding, increased use of trunking across all bands, digital technology, and other innovations may make it possible to absorb continued expansion of applications with limited spectrum.

The fragmentation of public safety spectrum is a complex problem. The migration to 800 MHz and the allocation of adjoining spectrum for public safety could greatly facilitate interoperability, and the national negotiation and adoption of interoperability standards may serve as an impetus to hasten the shift to higher frequencies. On the other hand, this study also identified problems related to the shift to greater use of 800 MHz by the larger agencies—a shift that facilitates interoperability for those that are on the system but may isolate them from smaller colleagues and neighbors that are not using 800 MHz. Also, the needs of some agencies are best served by operating in VHF or ultra high frequency (UHF) bands.

This study found surprisingly little support for national interoperability planning, and it revealed some of the reasons the vast majority of agencies prefer local planning. Agencies

interoperate primarily with other local organizations. They have more confidence in their ability to handle all kinds of interoperability events with the organizations they interact with on a regular basis. The data suggest that interoperability problems may be more of a State and/or Federal issue than a local issue—it was in the interactions with these more distant colleagues that agencies expressed the least confidence in their ability to establish radio communications links.

Agencies that participate in joint training activities that involve use of communications equipment have more confidence in their ability to respond to interoperability situations. Written comments confirmed that critical incidents often spur communities into action and release funds for upgrading wireless communications systems. The cost of communications equipment appears to be contributing to the increasing use of regional communications centers that cross jurisdictions and facilitate interoperability.

The intent of this study was to provide data that could be used by policymakers at all levels, by agencies of all sizes and types. Aggregate data such as those presented by this study are useful for developing a broadbrush portrait of nationwide practice and even for assessing national trends. A national portrait can provide important information for comparisons, and data such as those presented here can inform the decisionmaking process, but ultimately local decisionmakers must weigh many factors and assess the value of the data for the decisions they have to make.

Notes

1. A follow-on study, due to be completed in 1998, is currently underway to collect similar information from the fire, emergency medical, and emergency management communities.
2. The Public Safety Wireless Advisory Committee was established to advise the FCC and NTIA on public safety needs and concerns related to spectrum allocations.
3. Irving, Larry, *Final Report of the Public Safety Wireless Advisory Committee (PSWAC) to the Federal Communications Commission and the National Telecommunications and Information Administration*, September 11, 1996, page 2.
4. Clark, John F., "Public Safety Communications in the Years Ahead: A Time of Crisis and Opportunity," Remarks to the annual business meeting of the Major Cities Chiefs of Police, Orlando, Florida, October 25, 1997.

5. The term "800 MHz" is used throughout this report as shorthand for all public safety frequencies between 806 and 869 MHz.
6. Of the 46 percent of surveyed agencies who plan to replace/upgrade their systems in the next 10 years, 61 percent (28 percent of all agencies surveyed) expect to purchase 800 MHz systems.
7. Agencies that use laptops and/or MDTs are significantly more likely to view security measures as essential and use such measures on a daily or weekly basis compared to agencies that do not use MDTs or laptops.
8. For more information about the FCC Frequency Application Process or NPSPAC Guidelines, contact: Joy Alford, Federal Communications Commission, Public Safety and Private Wireless Division, 2025 M Street N.W., Room 8010, Washington, DC 20554 (202-418-0680 or e-mail jalford@fcc.gov).

For information about the Project 25 Interoperability Standards, contact: Ali Shunami, APCO International, 2040 South Ridgewood Avenue, South Daytona, FL 32119-8437 (800-272-6911 or e-mail apco@apcoind.org).

9. This conclusion is based on the statements made in the final PSWAC report. Although there is no nationwide plan or incident command system, there are radio channels that have been dedicated nationwide for mutual aid.
10. Reno, Janet. October 27, 1997. Remarks on Public Safety Radio Communications excerpted from her address to the International Association of Chiefs of Police, Orlando, Florida, October 27, 1997.

Glossary

**Analog Modulation Technique—** Process whereby a message signal, which is the analog of some physical quantity, is impressed on a carrier signal for transmission through a channel (e.g., FM).

**Cellular Digital Packet Data (CDPD)—**an open transmission control protocol/Internet protocol (TCP/IP) standard for cellular data communications.

**Conventional Radio System—** Nontrunked, similar to telephone party line in that the user determines availability by listening for an open channel.

**Digital Modulation Technique—** Technique for placing a digital data sequence on a carrier signal for subsequent transmission through a channel.

**Global Positioning System—** Based on 24 satellites orbiting earth at 11,000 miles.

**Interoperability Standards—** Established protocols that provide common interface between different communication systems.

**Mobile Data Terminal (MDT)—** Small computer-like system, usually installed in a patrol car, which allows the officer to receive and transmit a limited range of information between the officer and communications center.

**NPSPAC Guidelines—**National Public Safety Planning Advisory Committee's nationwide public safety plan for the 821-824 MHz and 866-869 MHz bands.

**Project 25 Standards—**A joint government/industry effort to develop technical standards for the next generation of public safety radios, both voice and data.

**Spectrum—**The usable radio frequencies in the electromagnetic distribution. Specific frequencies have been

allocated to the public safety community. They include:

Low VHF	25-50 MHz
High VHF	150-174 MHz
Low UHF	450-470 MHz
UHF TV Sharing	470-512 MHz
800 MHz	806-869 MHz

**Talk Group—**A subgroup of radio users who share a common functional responsibility and usually only coordinate actions among themselves and therefore do not require radio interface with other subgroups.

**Trunked Radio System—**A system that integrates multiple channel pairs into a single system. When a user wants to transmit a message, the trunked system automatically selects a currently unused channel pair and assigns it to the user, decreasing the probability of having to wait for a free channel for a given channel loading.

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Findings and conclusions of the research reported here are those of the authors and do not necessarily reflect the official position or policies of the U.S. Department of Justice.

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