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Voices of First Responders

Public Safety Communications Research

Communication Center & 9-1-1 Services

Special Publication 1286pt1



U.S. Department of Commerce
Gina M. Raimondo, Secretary

NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
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Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

PSCR Usability Team
Information Technology Laboratory

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Introduction

The goal of the National Institute of Standards and Technology's (NIST) Public Safety Communications Research (PSCR) program's Usability Team was to provide guidance on the usability of public safety communication technology. Toward that end, the PSCR Usability Team collected and analyzed data related to the contexts in which first responders work and their experiences with communication technology.

Data analysis of first responder needs for, and problems with, communication technology resulted in the development of six user-centered design guidelines. These guidelines serve as a set of best practices for technology developers working to develop and improve communication technology in the public safety domain.

This Special Publication is primarily intended for designers, developers, vendors, and researchers of public safety communication technology, as well as for public safety administrators and decision-makers. It is one of four in a special Voices of First Responders mini-series highlighting the experiences of first responders with communication technology, including their needs for, and problems with, communication technology. The special mini-series focuses on four first responder disciplines: Communication Center & 9-1-1 Services (COMMS); Emergency Medical Services (EMS); Fire Service (FF); and Law Enforcement (LE). Each presents discipline-specific data supporting the six user-centered design guidelines. This publication in the special mini-series focuses specifically on first responders in Communication Center & 9-1-1 Services (COMMS).

In this publication, each of the six user-centered guidelines are discussed, along with supporting data, to provide a succinct view for how to optimize the COMMS user experience with communication technology. The results presented here are not exhaustive or comprehensive but provide a high-level summary of findings. Additional information can be found in the previous nine volumes of the Voices of First Responders Series which are cited on the final page of this publication. Ultimately, the goal is to provide guidance for ensuring an optimal user experience with communication technology for first responders in COMMS.

Communication Center & 9-1-1 Services *(this Special Publication)*

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Emergency Medical Services

NIST SP 1286pt2

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NIST.SP.1286pt2](https://doi.org/10.6028/NIST.SP.1286pt2)



Fire Service

NIST SP 1286pt3

[https://doi.org/10.6028/
NIST.SP.1286pt3](https://doi.org/10.6028/NIST.SP.1286pt3)



Law Enforcement

NIST SP 1286pt4

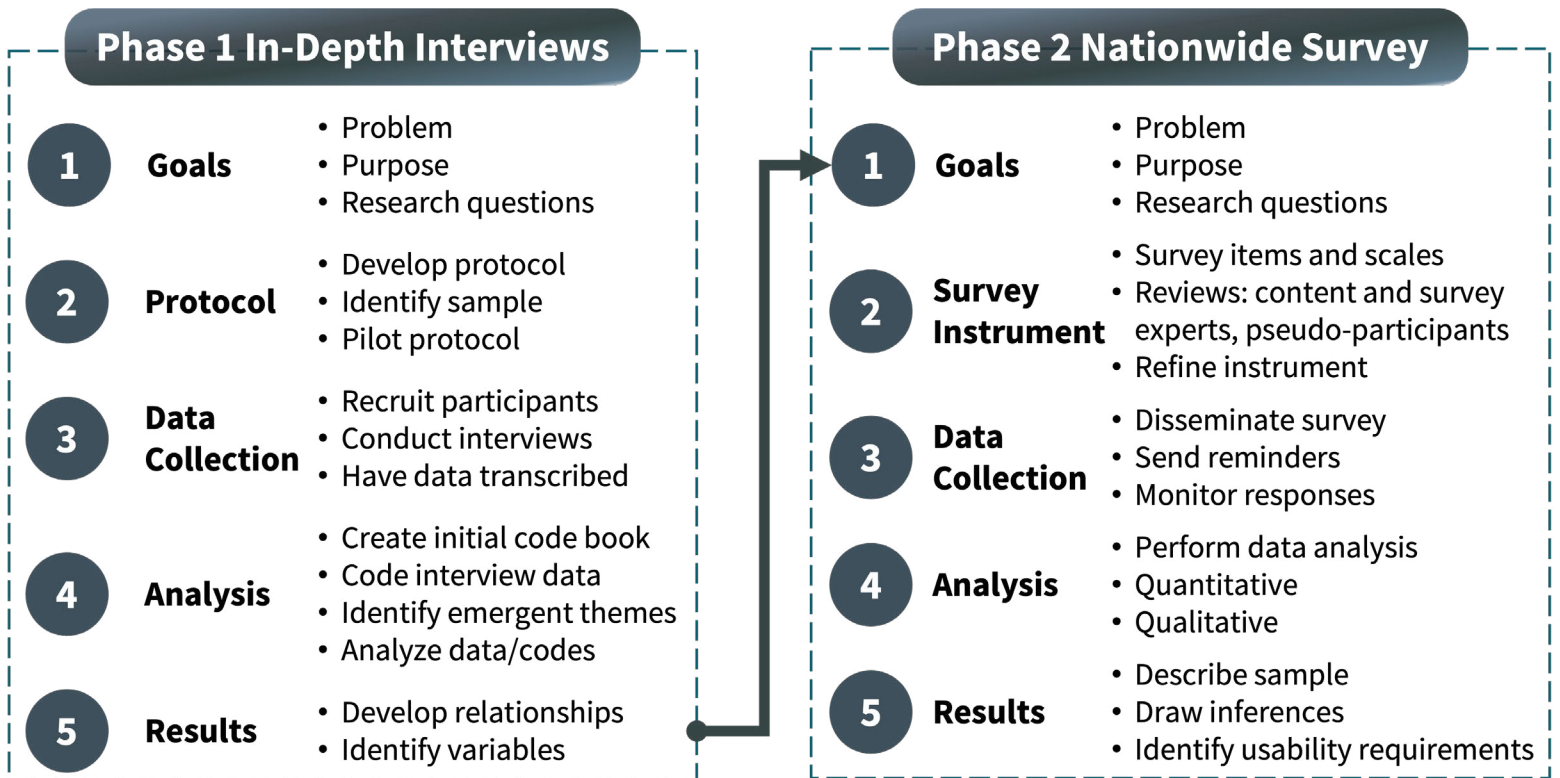
[https://doi.org/10.6028/
NIST.SP.1286pt4](https://doi.org/10.6028/NIST.SP.1286pt4)



What We Did

The NIST PSCR Usability Team conducted an exploratory, sequential, mixed-methods study to gather data about the experiences of first responders in four public safety disciplines – COMMS, EMS, FF, LE. This multi-phase study consisted of in-depth interviews with 193 first responders about their views on communication technology (Phase 1). The results of these interviews informed a large-scale, nationwide survey completed by 7,182 first responders from across the United States (Phase 2). Respondents included first responders from all four disciplines and came from rural, suburban, and urban areas. The results of the study are reported across nine volumes in the Voices of First Responders series.

When quotes from the data are used in this publication, they are followed by a notation that shows where they are from in the data. Notations that begin with INT come from Phase 1 interviews, while those that begin with SUR come from Phase 2 open-ended survey responses. This is followed by the first responder discipline: COMMS; EMS; FF; and LE. Next is an indicator of whether the participant worked in a rural (R), suburban (S), or urban (Urban) area. The notation ends with a participant number. For example, INT-COMMS-R-200 refers to interview participant number 200 who was in COMMS and worked in a rural area.

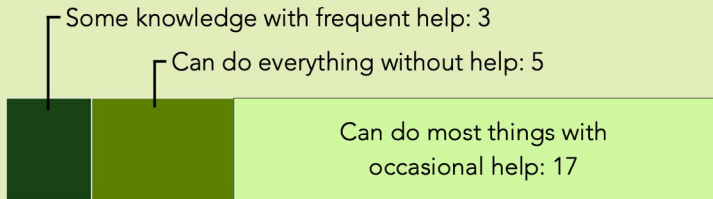
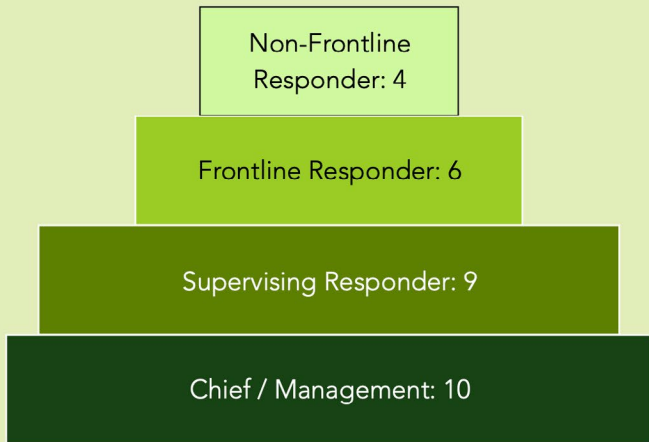
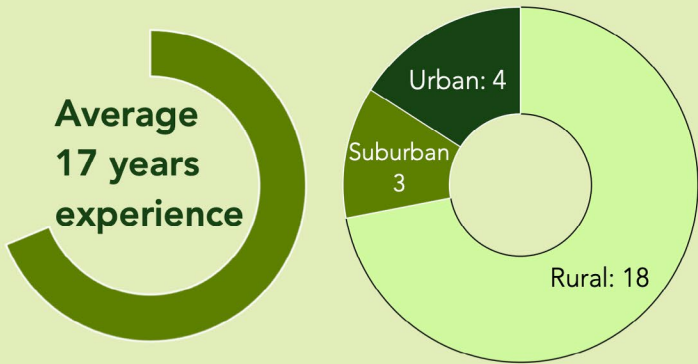


The Voices We Heard

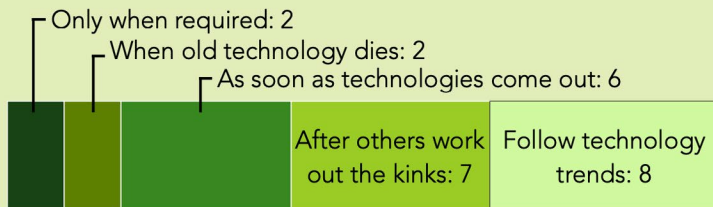
Communication Center & 9-1-1 Services Participants

25

First responders interviewed



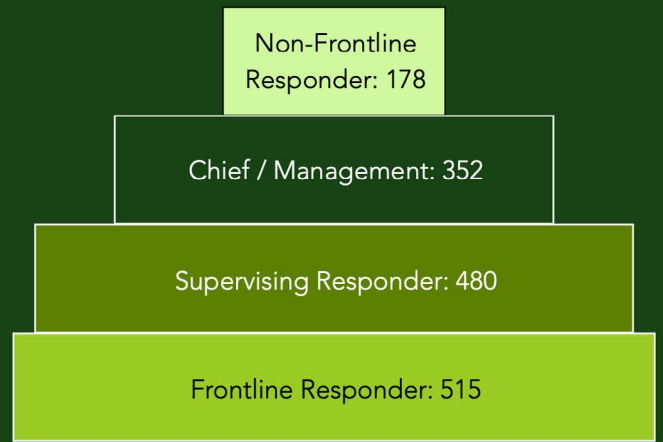
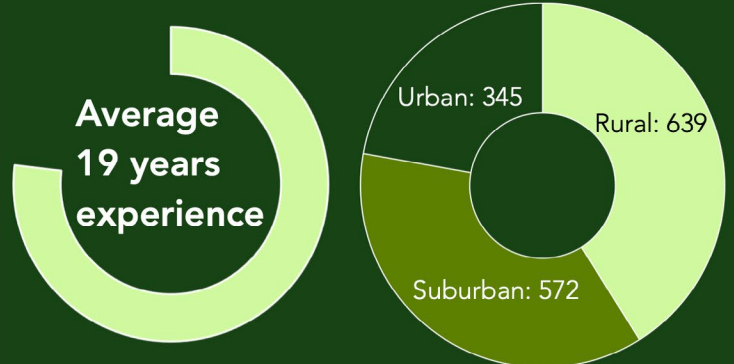
Experience with Technology



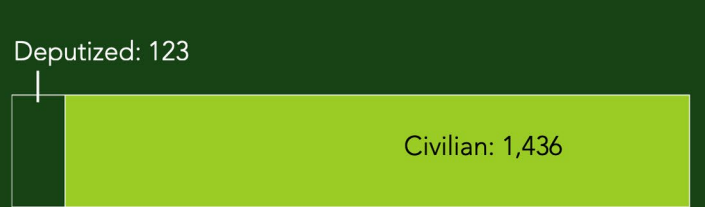
Technology Adoption

1,564

Survey respondents



Jurisdiction



9-1-1 / Dispatch Appointment

What We Recommend

User-Centered Design Guidelines



Guideline #1: Improve current technology

Improve functionality of what first responders currently have, make technology more affordable and more reliable. It is not necessarily new technology that first responders want, but the improvement of current technology that they believe is most important.



Guideline #2: Reduce unintended consequences

Develop technology that does not interfere with first responders' attention to their primary tasks. Technology interference can cause distraction, loss of situational awareness, cognitive overload, and over-reliance on technology.



Guideline #3: Recognize "one size does not fit all"

While there are similarities across the first responder disciplines and standardization is important for consistency, compatibility, and quality, technology must accommodate the wide variety of public safety needs—across disciplines, personnel, departments, districts, and contexts of use. All are different, requiring easy adaptability and configurability.



Guideline #4: Minimize "technology for technology's sake"

Develop technology with and for first responders driven by their user characteristics, needs, requirements, and contexts of use.



Guideline #5: Lower product/service costs

Develop technology at price points that departments can afford, lowering costs for technology. The goal should not only be to design the tool, but to design it at a price-point that makes it feasible and scalable for use.



Guideline #6: Require usable technology

Know thy user and develop 'Fisher-Price' solutions – simple, easy to use, light, fast, and not disruptive. Technology should make it easy for the user to do the right thing, hard to do the wrong thing, and easy to recover when the wrong thing happens.



GUIDELINE 1: Improve Current Technology

Designers, developers, vendors, and researchers of public safety communication technology need to focus their efforts on addressing the issues, including price, that first responders continue to face with the devices they use the most for day-to-day incident response.

COMMS first responders want:

- Improved functionality of technologies they currently use, especially those that continue to present significant problems for their primary tasks. Improvement of their current technology is more important to COMMS participants than having access to futuristic or more advanced forms of technology.
- Better location information, for both callers and first responders. On the survey, COMMS participants noted inaccurate or missing location information and the inability of cell phones to locate and track callers as the main information problems they experience.
- Futuristic technology that provides better location information. COMMS survey respondents identified location technologies as being what they would find useful in futuristic technology. Most of these are generally not considered advanced forms of technology in other domains.

Most used devices

1. Desktop computer
2. Monitor at personal workstation
3. Radio
4. Landline phone
5. Headset

“The biggest improvement that all 9-1-1 public safety dispatchers would like to see is the location accuracy of wireless cell phone devices....It is literally costing lives whenever a dispatcher cannot locate a caller who is calling in from a wireless device and the location accuracy is poor or non-existent. Wireless calls account for over 80% of our inbound emergency calls.”




(SUR:COMMS:S:2333)

“Location is number one. We can dispatch. We can do anything else in the world with that call if we have the location. But getting that location is just paramount. We can't do anything if we don't get a location.”

(INT-COMMS-R-016)

Top problems with information

More than 3 in 4 COMMS first responders frequently had problems with these forms of information.

| | | |
|---|---|---|
|  |  |  |
| Inaccurate or missing caller location | Inability of cell phones to track callers | Information overload (too many calls at once) |



GUIDELINE 2: Reduce Unintended consequences

Designers, developers, vendors, and researchers of public safety communication technology need to make sure that there are no unintended consequences with the technologies they develop for first responders that might interfere with their attention to their primary tasks.

In both Phase 1 and Phase 2 data, COMMS first responders note that new technology often comes with or can create unintended consequences, as with the reception of text and video calls in their public safety answering points (PSAPs) as noted on the right. While a new technology might bring some benefits, it may also create additional problems or burdens for first responders, and make it more difficult to accomplish their primary tasks.

Case: Text and Video Reception

Text calls: potential unintended consequences

- Missing verbal cues/background noise
- Lack of or inaccurate location information
- More time to process calls
- Staffing/training issues
- Additional equipment needed
- Increased costs for staff, equipment, training, etc.

Video calls: potential unintended consequences

- Post-traumatic stress disorder (PTSD) issues
- Missing or poor quality images
- Information overload
- Staffing/training issues
- Data storage, retrieval, or chain of evidence issues
- Additional equipment needed
- Increased costs for staff, equipment, training, etc.

“Based on our experience, text to 911 messages take three times as long to process. Therefore they drag down our 911 answering capacity. Furthermore, the location information is still lacking....there is no guarantee the text will be delivered, or when. It would be unwise to bet your life on a text that may not be delivered timely...if ever. Texts prevent the 911 Operator from gathering unspoken contextual clues to the emergency, such as heavy breathing, background noises, screams, gunshots, etc.”

(SUR:COMMS:U:1855)

“[RE: cons of video] Stressors of seeing incidents live. Liability of making Dispatchers photo or video analysts. We're already held to a standard of interpreting both primary and subliminal messaging from telephone sources, now they're adding photo/video interpretation requirements in a fast moving, high pressure, very stressful environment. We will be held to account for the smallest indicator that we might have missed from photo/video.”

(SUR:COMMS:R:8705)

55%

of COMMS survey participants say their PSAP can receive texts.

10%

of COMMS survey participants say their PSAP can receive videos.



GUIDELINE 3:

Recognize "one size does not fit all"

Communication technology is paramount to all first responder disciplines, however, the contexts of use, needs, and problems vary across disciplines. Designers, developers, vendors, and researchers of public safety communication technology need to make sure that technology they develop attends to the specific contexts of use and needs of first responders, rather than providing "generic" technology that may or may not address their needs and problems.

- The unique work environment for COMMS first responders requires different technologies than the other three disciplines, shown in the survey responses for devices and software/apps use. For example, more COMMS workers use desktop computers and headsets than in other disciplines, but fewer COMMS workers have and use personal or work-issued smartphones.
- The contexts of use, needs, and problems also vary amongst COMMS first responders. For example, rural COMMS personnel have very different needs than their suburban and urban counterparts, they lack many basic resources, and desire existing technology solutions below.
- COMMS Supervisors and Chiefs/Management also use different devices and software/apps than frontline COMMS responders.

"Well it's, as you know, kind of a tourist community in a rural area, so the calls vary widely depending on the time of the year. In the winter we handle a number of ski calls injuries, motor vehicle accidents just because of slick roads and that sort of thing, some avalanche calls... and then the typical, you know, vacationers and that can be at any time either summer or winter with the bar fights or the things like that so, during when summer is more outdoor we have a lot of tech rescues that happen in remote areas of the county that often have to have extra different types of apparatus to get to the location and sometimes swift water rescues, so a variety. Many people don't know where they are so our interest in technology that helps us to find people is important."

(INT-COMMS-R-008)

Considering COMMS Environments

Rural vs. Urban and Suburban Areas

- Rural COMMS are *less* likely to:
 - frequently use language apps
 - have first responder vehicle tracking

Chief/Management vs. Frontline Responders

- COMMS chiefs are *more* likely to:
 - frequently use personal and work-issued smartphones
 - frequently use email
 - think receiving texts would be beneficial
 - have heard of Next Generation 9-1-1 (NG 911)



GUIDELINE 4: Minimize "technology for technology's sake"

Designers, developers, vendors, and researchers of public safety communication technology need to recognize that just because we can, doesn't mean we should—just because technology exists, does not mean it will be helpful for first responders. Focusing on what they see as useful is a better strategy for optimizing the user experience and encouraging adoption and usage.

Both qualitative and quantitative data show that first responders did not see most forms of futuristic technology as something they would find "useful for [their] day-to-day work." On the survey, respondents were asked which futuristic technologies they thought would be "useful for your day-to-day work." Participants could select from a technology list, which consisted of futuristic technology as well as more current devices that participants did not already have.

- Only two items from the list of futuristic technology on the survey were chosen by more than 50% of COMMS respondents: automatic caller location and one login (single sign-on or SSO).
- 1 in 5 COMMS survey respondents did not already have the technologies shown on the right, but thought they would be most useful for their work.

Make "Good, Basic Technology"

- Existing technology many COMMS survey respondents did not have, but thought would be useful:
 1. Desktop computer
 2. Headset
 3. Monitor at personal workstation
 4. Work-issued smartphone
 5. Monitor for shared viewing

"It is hard for any communications center to keep up with all the new and changing technology. It is also difficult to determine which technology is necessary and which will be a passing fad or outdated by technology coming next week, month or year."

(SUR:COMMS:S:1075)

"None of these sound particularly useful and some could be disruptive to our normal work processes in dispatch. If one of the items listed was increased staffing then I would've happily checked that box."

(SUR:COMMS:S:1545)

Least selected futuristic technology

Half of the futuristic technologies listed on the survey were selected by less than 20% of COMMS, including some of the most futuristic technology in the list shown here.



Augmented reality (AR)



Facial recognition



Smart watch



Virtual reality (VR)



Voice controls



GUIDELINE 5: Lower product/service costs

The cost of technology was a major issue identified by COMMS participants in interview and survey data. Cost issues were wide-ranging, and not only refer to the initial cost of purchasing technology, but also auxiliary costs such as maintenance, upgrades, IT support, training, and data plans. Participants reiterated time and time again that technology must be developed at price points they can afford. This was especially true for rural COMMS participants whose funding sources were often woefully inadequate to support their work and the tools they need to accomplish it. COMMS first responders also see changes with technology as happening so quickly that they find it difficult to keep up, financially and technologically.

Designers, developers, vendors, and researchers of public safety communication technology need to address this major pain point for first responders, recognizing the important role that budgets and finances play in the usage and adoption of new technology. When designing new or improving current technology, it needs to be affordable, with scalability for widespread distribution whenever possible.

Problems with Cost

Types of problems associated with costs of technology for COMMS first responders

- Overall cost to purchase new technology
- Maintenance/upkeep of technology
- Pace of technological change and ability to keep up
- Training for/with new technology
- Staffing to use additional technology
- IT to aid with implementation and usage of new technology
- Lack of policies and procedures

"Technology is great, but, the cost is out of hand a lot of times and small centers like mine cannot buy the latest and greatest. Needs to be more affordable."

(SUR:COMMS:R:231)

"We are behind the technological advances that occur in the private sector nor do we have the budget necessary to upgrade to the systems and equipment that are becoming increasingly necessary to perform our duties... We are short-staffed, working on antiquated systems created when only landlines existed... Now, everyone calls [9-1-1] on their cell phones, overloading the system, to report emergencies that we 'should be able to find' with technology we do not have?"

(SUR:COMMS:U:6340)

\$\$\$

Our data show that COST is a major issue across devices and public safety disciplines



GUIDELINE 6: Require Usable Technology

Many problems with communication technology faced by first responders are in some way usability issues. Both interview and survey data show that participants repeatedly identify usability issues with their communication devices as major problems they face during incident response. First responders are not opposed to technology, but they want technology that makes sense to them within their contexts of use. The goal is for technology to make it easier for them to accomplish their primary tasks. Ultimately, first responders require technology that is easy to use, easy to learn, and easy to integrate into their contexts of use.

Designers, developers, vendors, and researchers of public safety communication technology need to recognize that usability and usefulness figure heavily into decisions about adoption and usage. Listening to and taking into consideration the voices of first responders could go a long way in helping them trust (and thus be willing to use) improved and newly developed technology.

- COMMS first responders identified usability issues with new and existing technology.
- Because COMMS first responders interact with both the public and with first responders in the field—the usability of their technology has a major impact on the public safety community.

Human factors & Ergonomics (HFE)

HFE considerations

- Perceptual
- Cognitive
- Physical
- Environmental
- Social & Organizational

Usability considerations

- Efficiency
- Effectiveness
- Satisfaction

“We have a new CAD system that's slower than the one we had before... You think newer technology is going to be better... More user-friendly and it's just not-- It's not the case.”

(INT-COMMS-S-004)

“So, you've got 10 new radio channels but you've got one dispatcher. Are you expecting that one person to handle 10 channels? So, what is the limit? I mean, what is the cut-off in that -- right? Because there is no specific... and there is no defined number, you should be responsible for your primary channel and two side channels or three side channels.”

(INT-COMMS-R-019)

“With all the things that everybody wants to integrate. They want you to have apps, they want you to be able to bring in apps, they want you to be able to bring in photos and videos and texting and this and that. The more stuff we add-- the more computer screens, the more keyboards, the more mice. It just keeps adding, and it's the more burden.”

(INT-COMMS-U-007)

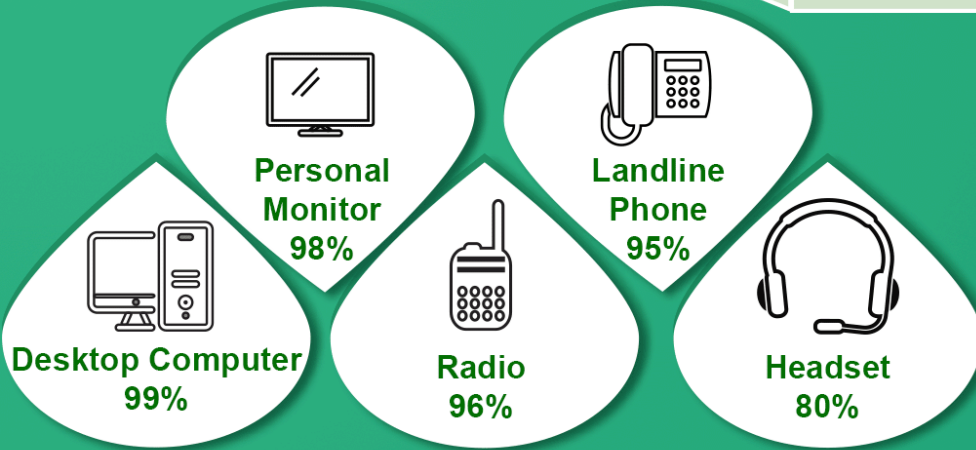
VOICES OF COMM CENTER & 9-1-1 SERVICES

Suburban
30%

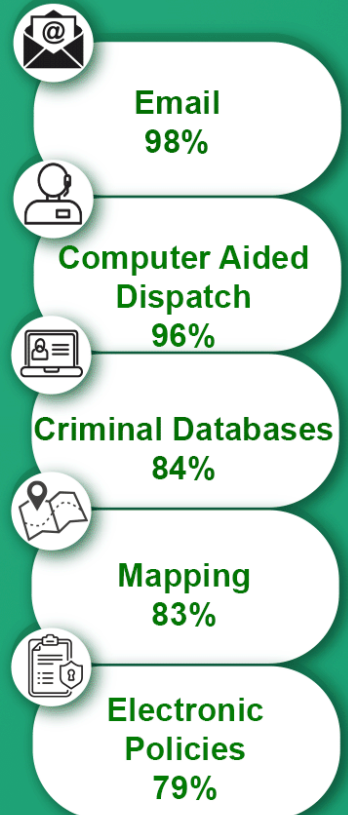
Rural
54%

Urban
15%

1,564 Participants



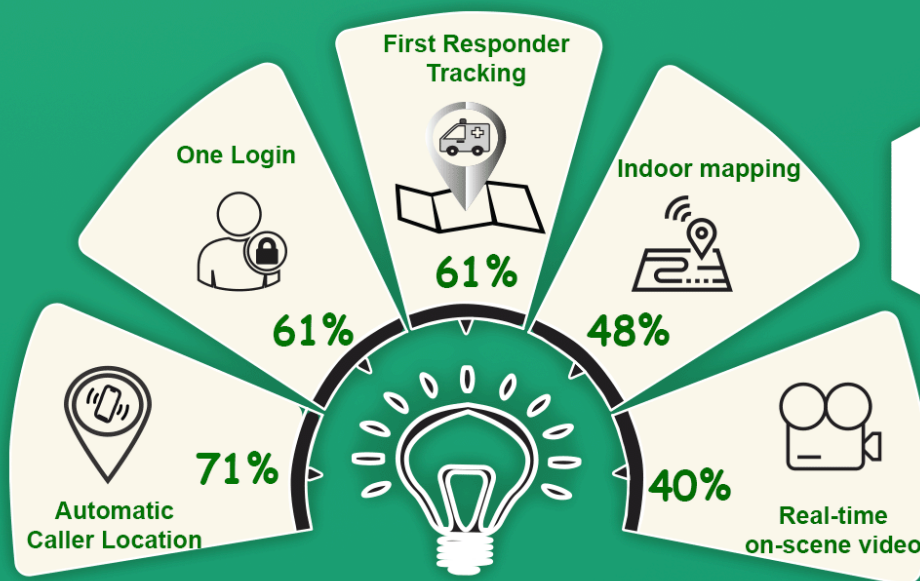
Devices Used



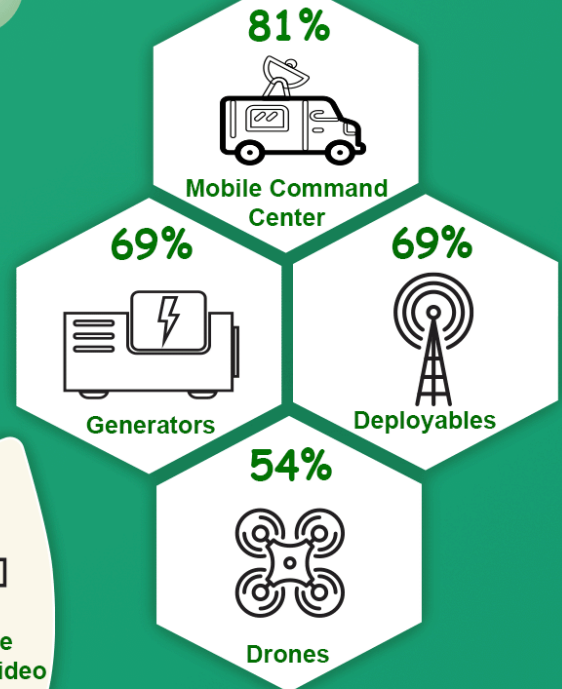
Apps Used



Information Problems



Futuristic Technology Needs



Tech. Needs for Major Disasters

Voices of First Responders Publications

Voices of First Responders, Phase 1: Findings from User-Centered Interviews

- Volume 1 - Identifying Public Safety Communication Problems (NISTIR 8216)
- Volume 2 - Examining Public Safety Communication Problems and Requested Functionality (NISTIR 8245)
- Volume 3 - Examining Public Safety Communication from the Rural Perspective (NISTIR 8277)
- Volume 4 - Examining Public Safety Communication from the Perspective of 9-1-1 Call Takers and Dispatchers (NISTIR 8295)
- Volume 5 - Applying Human Factors and Ergonomics Knowledge to Improve the Usability of Public Safety Communications Technology (NISTIR 8340)

Voices of First Responders, Phase 2: Nationwide Survey

- Volume 1 - Methodology: Development, Dissemination, and Demographics (NISTIR 8288)
- Volume 2 - Mobile Devices, Applications, and Futuristic Technology (NISTIR 8314)
- Volume 3 - Day-to-Day Technology (NISTIR 8400)
- Volume 4 - Statistical Analysis Results (NISTIR 8444)

- How to Facilitate Adoption and Usage of Communication Technology: *An Integrated Analysis of Qualitative and Quantitative Findings* (NISTIR 8443)
- PSCR Usability Results Tool: <https://publicsafety.nist.gov/>

Other relevant publications from NIST's PSCR Usability Team

- Incident Scenarios Collection for Public Safety Communications Research: Framing the Context of Use (NISTIR 8181)
- Usability Handbook for Public Safety Communications - Ensuring Successful Systems for First Responders (NIST Handbook 161)

Special Publication Authors: Shanée Dawkins, Yee-Yin Choong, Kerriane Buchanan, Sandra Spickard-Prettyman

Contact Us: usability@nist.gov

<https://www.nist.gov/ctl/pscr/user-interface-user-experience-publications>

<https://www.nist.gov/programs-projects/usability-and-public-safety-communications-research>



NIST Research Protections Office reviewed the protocol for this project and determined it meets the criteria for "exempt human subjects research" as defined in 15 CFR 27, the Common Rule for the Protection of Human Subjects.

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