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Voices of First Responders

Public Safety Communications Research

Emergency Medical Services

Special Publication 1286pt2



NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
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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 emergency medical services (EMS).

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 EMS 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 EMS.

Communication Center & 9-1-1 Services



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Emergency Medical Services

(this Special Publication)



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Fire Service



NIST SP 1286pt3

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

Law Enforcement



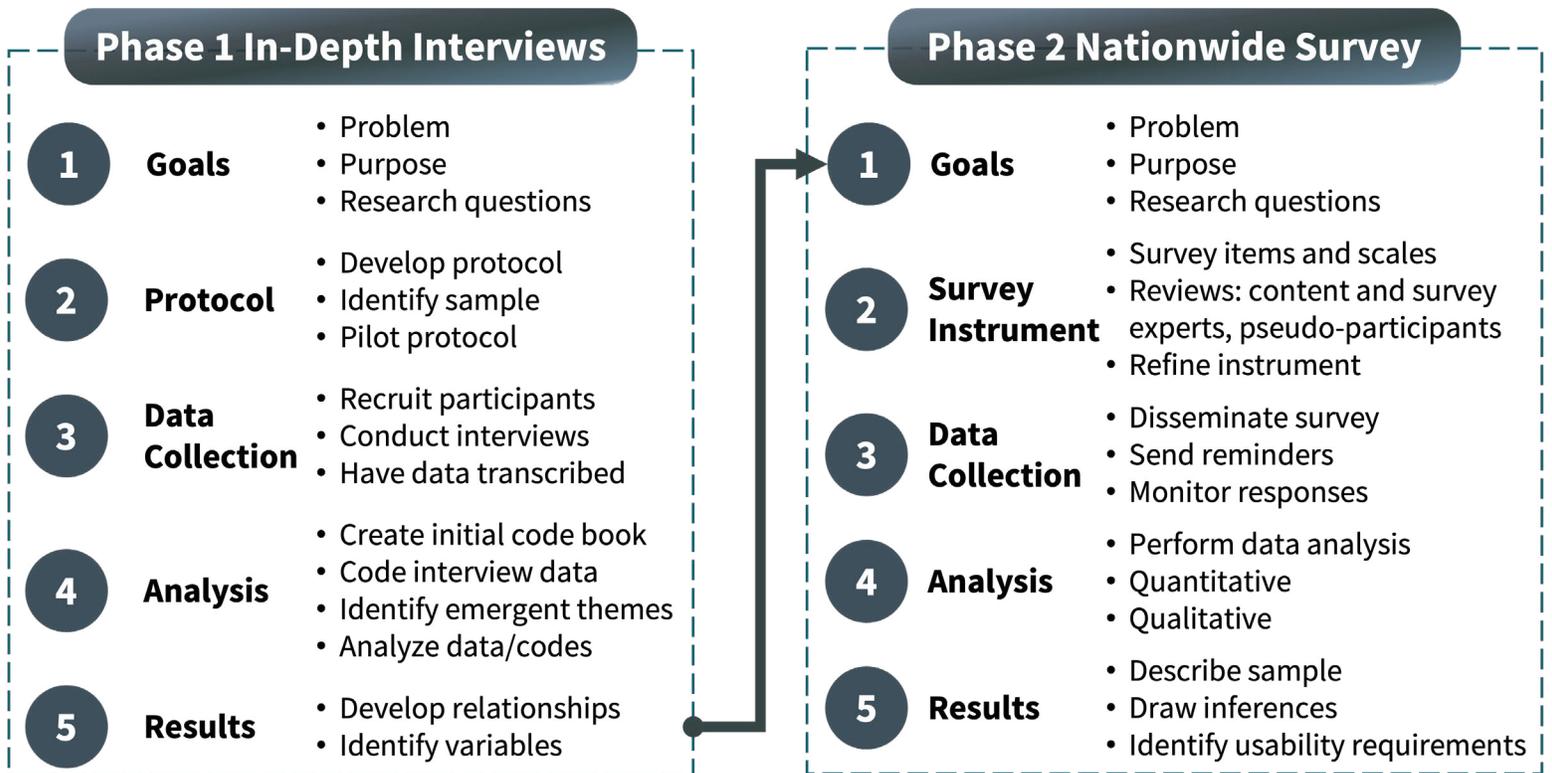
NIST SP 1286pt4

[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-EMS-R-200 refers to interview participant number 200 who was in EMS and worked in a rural area.



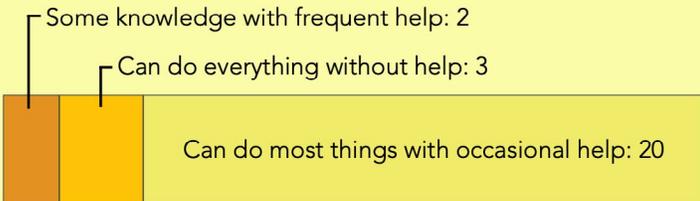
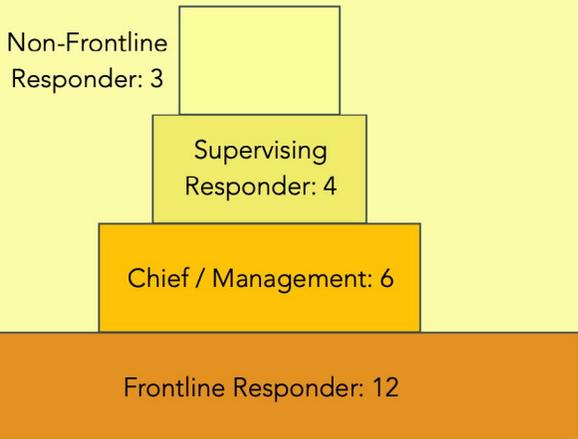
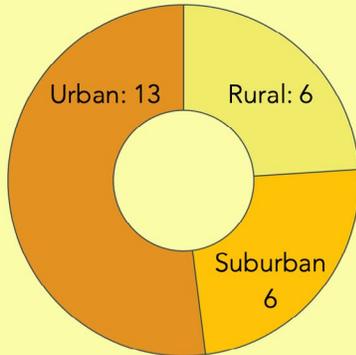
The Voices We Heard

Emergency Medical Services Participants

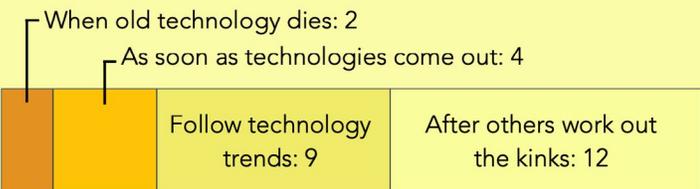
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First responders interviewed

Average
16 years
experience



Experience with Technology

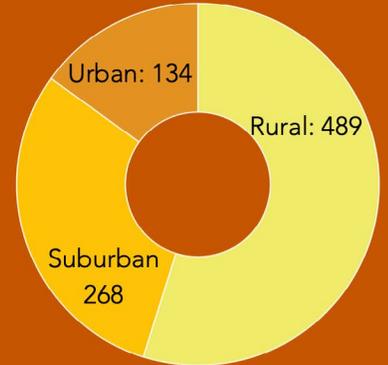


Technology Adoption

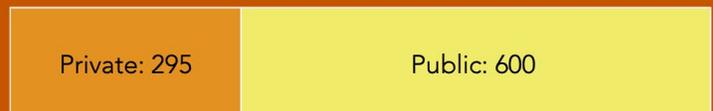
902

Survey respondents

Average
22 years
experience



Jurisdiction



EMS Agency

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.

- Improve the current technologies EMS first responders continue to experience significant problems with, including with the devices they rank as most useful for their day-to-day incident response listed on the right.
- EMS survey responses show that “price: too expensive” is the top problem that EMS first responders “Always” experience with communication technology. Both qualitative and quantitative data show that the top problems across the most used devices for EMS are price, coverage and connectivity, and battery life.
- Improving their current technology is more important to EMS participants than having access to futuristic forms of technology. When asked about futuristic forms of technology on the survey, only two “futuristic” technologies were chosen by more than 50% of EMS survey respondents as technologies they thought would be useful: one login (single sign-on or SSO) and the automatic transmission of patient vitals and information to the hospital, both of which are widely used in other domains and generally not considered advanced technologies.

Devices Ranked Most Useful

1. Portable radio
2. Personal smartphone
3. In-vehicle radio
4. Work-issued smartphone
5. Pager
6. Desktop computer
7. Laptop
8. Mobile Data Terminal
9. Tablet

“The big issues with our communications are the dead zones... holes in our communications.”

(INT-EMS-S-016)

“The one thing that seems to have been lacking on our ambulance for years is a built-in GPS. So we don't have the ability to open CAD computer and sort of GPS ourselves if we're confused of where we're going.”

(INT-EMS-U-011)

“We have a lot of software with connectivity between the patient care records we have on our laptops to our monitors... So I think a lot of times there could be ways to improve the connectivity between that because it's so integrated.”

(INT-EMS-S-006)

Top problems across devices



price



coverage & connectivity



battery life



GUIDELINE 2: Reduce Unintended consequences

In both Phase 1 and Phase 2 data, EMS first responders note that new technology often comes with, or can create, unintended consequences. While a new technology might be designed to aid with primary tasks, it may also come with issues that are difficult to resolve. For example, technology that allows EMS workers to send vital health information to hospitals relies on having the ability to access and connect to wireless networks, or software that identifies drugs and/or drug interactions depends on being able to access the internet.

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.

Case: Coverage and Connectivity

As new EMS technology has developed, more and more of it relies on access to wireless networks and/or the ability to connect to the internet. While this new technology can be helpful for their work, it is useless without coverage and connectivity. This could lead to more manual work, requiring more time and providing more opportunities for error when engaging in primary tasks such as transmitting patient vitals/information to the hospital or writing reports.

"The county topography makes radio coverage a challenge, however, add to that the fact that 1/3 is public land in which no communications towers can be placed- limits your ability to plan for improvements. The government mandates for technology improvements severely limits the small counties ability to keep pace."

(SUR:EMS:R:2434)

"Since we do not have cell phone coverage or mobile internet in our district, most of these [futuristic] items would be useless here."

(SUR:EMS:R:4396)

"Our monitor/defib is probably the most important. Software that would link the field to the hospital would be very helpful. Also a reliable internet connection in the rural areas would be a good benefit."

(SUR:EMS:R:427)

75%

of EMS survey respondents had problems with the coverage of their radios and mobile devices at least "Sometimes"



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.

- Survey responses show that, while similar to FF, EMS first responders use different devices and software/apps than first responders in other disciplines. For example, like FF, EMS used pagers more frequently than COMMS and LE, but used mobile data terminals (MDTs) and corded mics at lower rates than other disciplines.
- The contexts of use, needs, and problems also vary amongst EMS first responders. For example, rural EMS have very different needs than their suburban and urban counterparts, lacking many basic resources and desiring existing technology solutions as shown below.

“So that’s the challenge [for developers]. Whatever you come out with, it’s not going to be one size fits all.”

(INT-EMS-U-001)

Considering EMS Environments

Rural vs. Urban and Suburban Areas

- Rural EMS are *more* likely to:
 - frequently use pagers
 - have problems with the price of desktop computers
- Rural EMS are *less* likely to:
 - have tablets, corded mics, and MDTs
 - have first responder vehicle tracking and traffic apps

Chief/Management vs. Frontline Responders

- EMS chiefs are *more* likely to:
 - frequently use work-issued smartphones and desktop computers
 - use email, emergency response guides, and weather apps
 - view automatic vehicle location (AVL) as a useful futuristic technology
 - have problems with the price of MDTs and radios



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.

- Of all the futuristic technology listed in the survey, only two technologies were selected by more than half of EMS respondents: the automatic transmission of patient vitals and information to the hospital and one login (single sign-on or SSO).
- More than 1 in 5 EMS 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 EMS respondents did not have, but thought would be useful:
 1. Tablet
 2. Mobile Data Terminal
 3. Portable radio
 4. Laptop
 5. Work-issued smartphone
 6. Wireless earpiece (work-issued)
 7. In-vehicle radio

"They keep trying to do these things, and I think they're trying to do it with safety in mind, but they're not really keeping what really your day-to-day job is in mind. So the safety hinders you from doing your job."

(INT-EMS-R-007)

Least selected futuristic technology

Half of the futuristic technologies listed on the survey were selected by less than 20% of EMS. Some of the most futuristic technology in the list, like those shown here, were selected by less than 10% of EMS.



Augmented reality (AR)



Self-driving vehicles



Smart glasses



Robots



Smart buildings



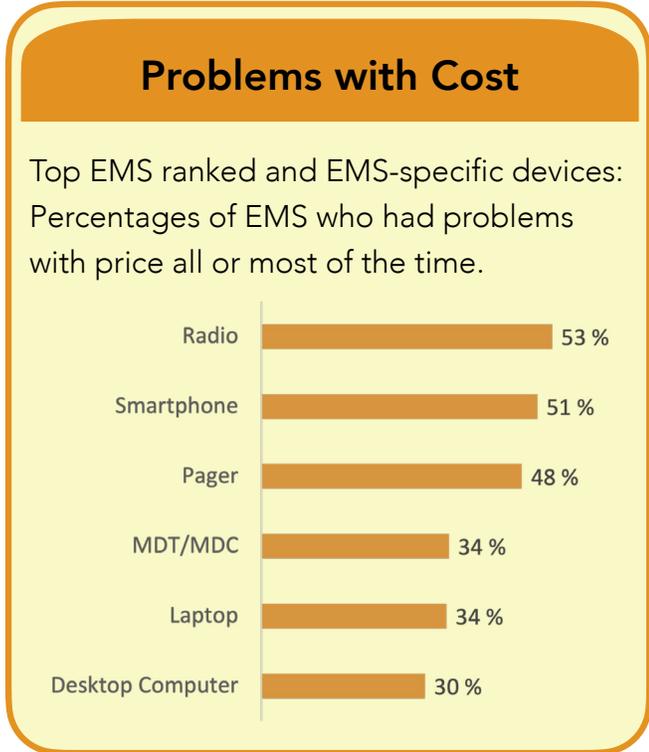
Virtual reality (VR)



GUIDELINE 5: Lower product/service costs

The cost of technology was a major issue identified by EMS participants in the Phase 1 interview data. Likewise, survey data show that “Price: too expensive” was the top problem “Always” experienced by EMS respondents across devices by an average ratio of 3:1 — three times as many EMS survey respondents had problems with price than any other device problem. Cost issues were wide-ranging, and not only refer to the initial cost of purchasing the 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 participants whose funding sources were often woefully inadequate to support their work and the tools they need to accomplish it. EMS 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.



“You’re never going to have enough money to do everything you want to do right now. It’s just not the way emergency services works. It’s all plea to the public for money, you know.”
(INT-EMS-R-018)

“Simply having to use my cell phone for a reliable connection. They work better than our radios. Why should I have to use my data/minutes for work related communications.”
(SUR:EMS:S:3987)

“Technology is very expensive. You don't just buy it and you're good. You've got to maintain it... You've got to upgrade it.”
(INT-EMS-R-008)

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Our survey data show that COST was the top problem 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.

- EMS first responders experience significant problems with their ability to efficiently and effectively access and use the devices they rely on every day for incident response, like radios, smartphones, and pagers.

"I mean, if the regular person running an errand... has to find an address quickly and can do it accurately, then you'd think that it'd be quite important for the ambulances to be able to do that... it seems crazy that the ambulances don't have it yet, but they don't."
(INT-EMS-U-011)

"Carrying a radio that requires 2 hands with all our equipment to carry, trying to do CPR or some other medical thing and try to answer dispatch who never hear you correctly takes away patient care!" (SUR:EMS:R:532)

"[MDT] screen brightness can be a problem at night, needs to be bright enough for me to see but not so bright that it affects the driver's night vision."
(SUR:EMS:U:8395)

Human factors & Ergonomics (HFE)

HFE considerations

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

Usability considerations

- Efficiency
- Effectiveness
- Satisfaction

"Everything we use, I mean, we don't have time to mess with it, or tweak it, or play with it. It has to work the first time, every time, or people will just stop using it. They will just refuse to use it and go back to the old way."

(INT-EMS-U-003)

"Ease of use and usability is a big deal, and we're doing the same things over and over and over again, so we want those to be as efficient as they can be. Sometimes the software needs to be tweaked, sometimes I hit this button and it's supposed to do X, and when it doesn't that creates more work for me... [it] gets frustrating."

(INT-EMS-U-001)

VOICES OF EMERGENCY MEDICAL SERVICES

Urban
15%

Suburban
30%

Rural
54%

902 Respondents



Radio
Portable 93%
Vehicle 87%

Coverage
Audio Quality
Price
Battery Life



Smartphone
Personal 90%

Coverage
Price
Battery Life
Dropped Calls



Desktop Computer
86%

Software Updates
Login/Passwords
Outdated
Price



Laptop
83%

Internet Connection
Battery Life
Login/Passwords
Software Updates



Tablet
60%

Internet Connection
Battery Life
Glare
Durability



Corded Mic
53%

Price
Audio Quality
Placement on Body
Falling off



Email
98%



Electronic patient care records
85%



Mapping
81%



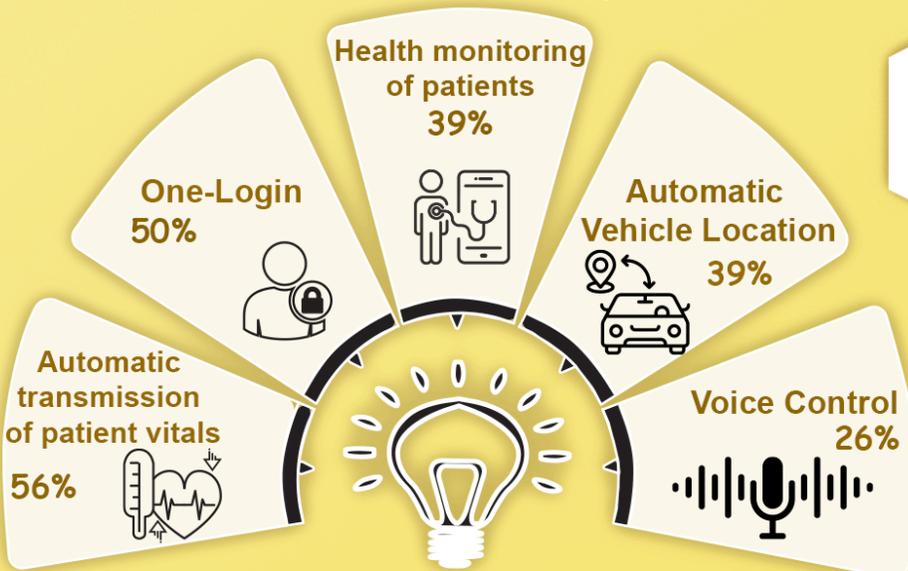
Weather
71%



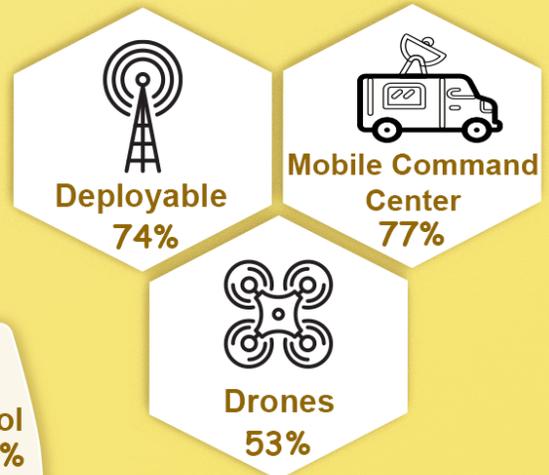
Computer Aided Dispatch
69%

Apps Used

Devices Used & Top 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)

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<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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