Kevin Sofen - September 28, 2023

NIST Special Publication 1191

Research Roadmap for Smart Fire Fighting

Summary Report

NIST National Institute of Standards and Technology U.S. Department of Commerce

THE FIRE PROTECTION RESEARCH FOUNDATION

First Responder Network Authority

ROADMAP

FirstNet Authority

Dr. Lori Moore Merrell

ONE VOICE

U.S. Fire Administration

National Emergency Response Information System (NERIS)

The goal of NERIS is to **empower** the local fire and emergency services community by equipping them with **near real-time** information and **analytic tools** that support **data informed decision-making** for enhanced preparedness and response to incidents involving **all hazards.**

Firefighting → "All Hazards"

Figure 1.3 Key concepts of the Smart Fire Fighting framework.

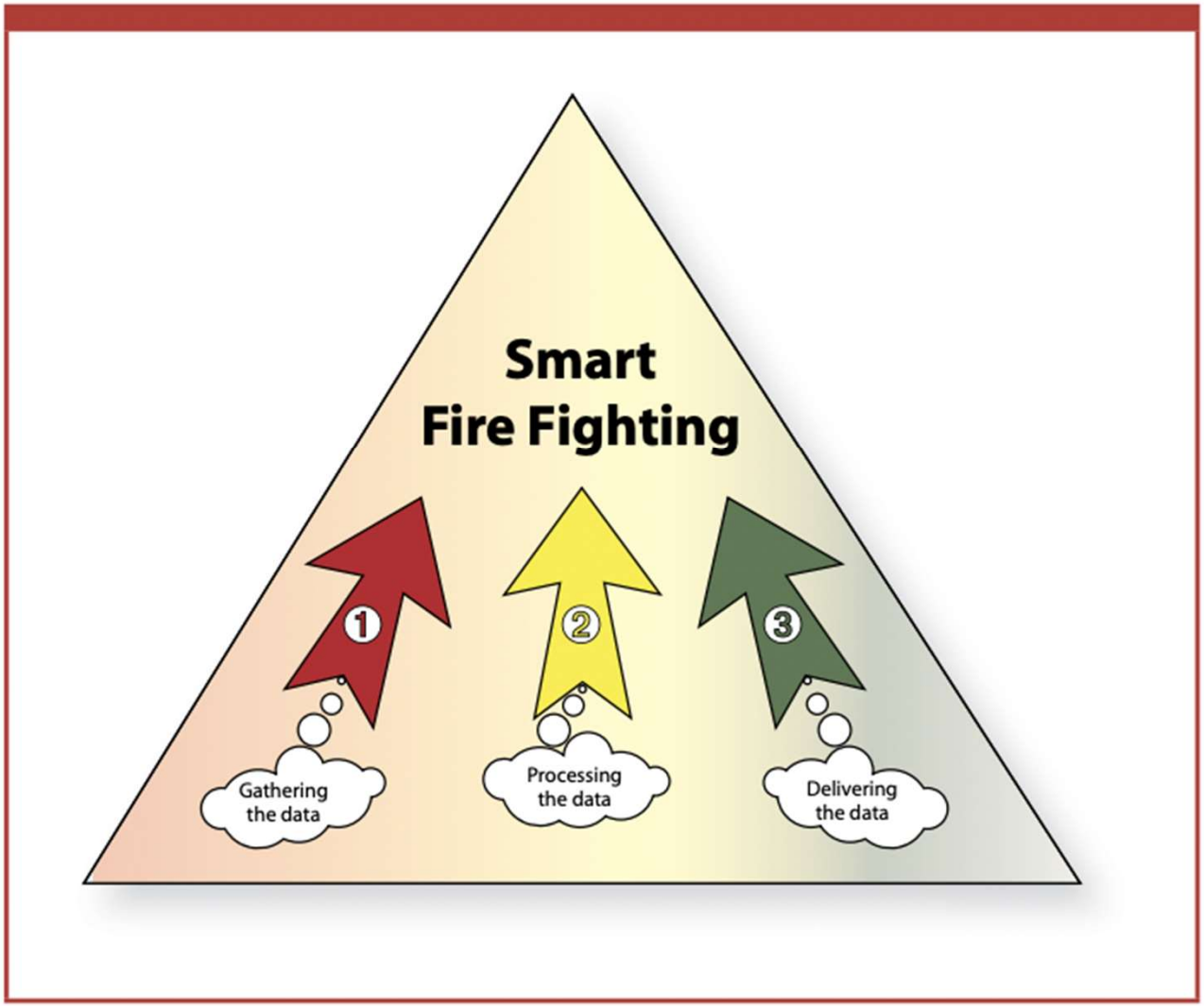
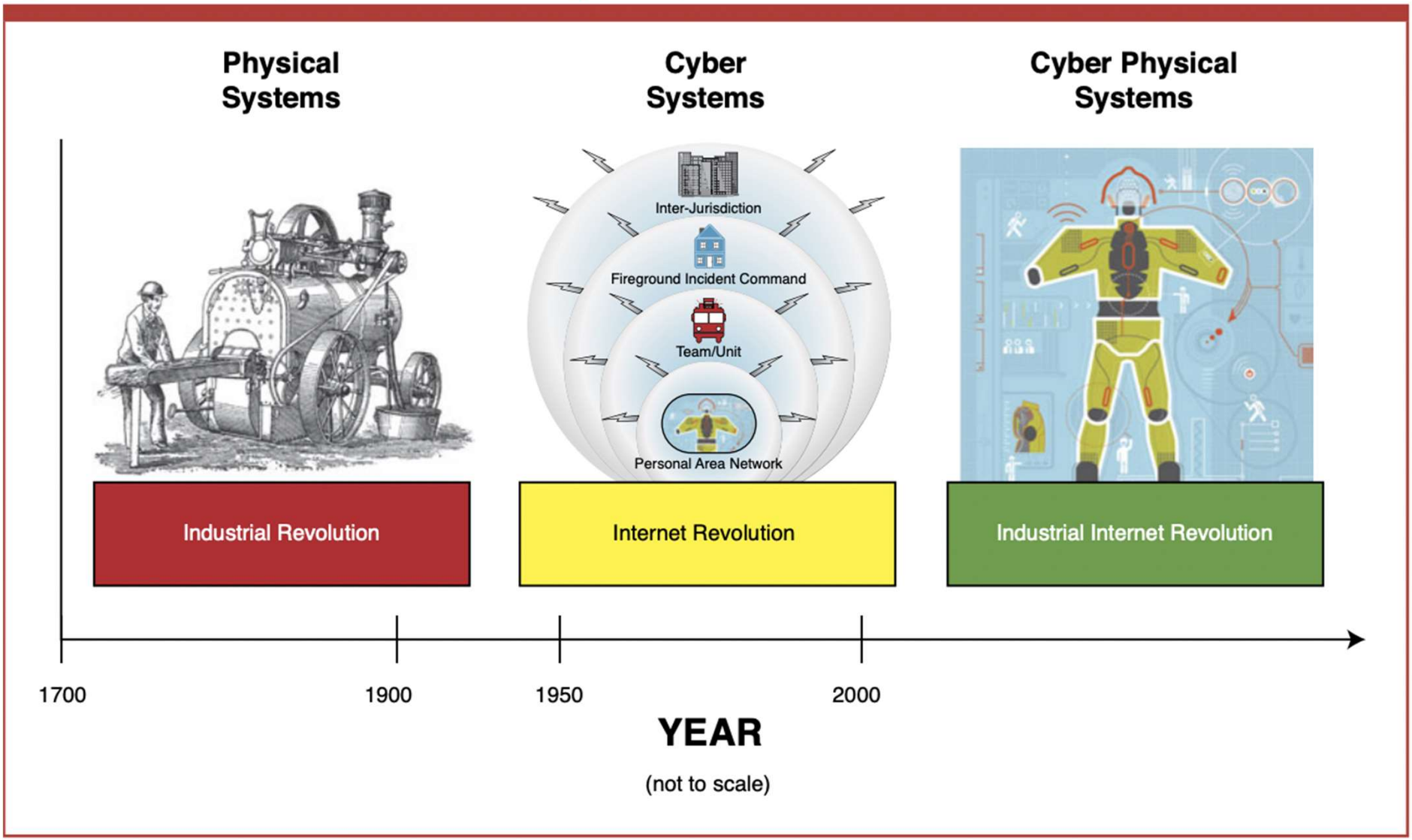


Figure 1.2 Historical perspective on technology development. (Source, far left: Shutterstock, Kuznetsov Alexey)



Questions

- **User-Centric Design:**
  - How can we ensure that new smart firefighting technologies are user-friendly and intuitive for first responders?
- **Integration with Existing Systems:**
  - How can technological solutions be seamlessly integrated with current operational protocols and existing equipment to ensure a smoother transition and immediate operational impact?”
- **Safety and Efficacy Validation:**
  - What mechanisms or protocols should be in place to validate the safety and efficacy of new technologies before widespread adoption amongst first responders?

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- **Training and Support:**
  - How can we develop robust training programs and ongoing support systems to alleviate concerns and challenges faced by first responders while transitioning to new technologies?
- **Data Management and Security:**
  - Given the sensitivity and critical nature of the information handled, what steps can be taken to ensure the utmost security and responsible management of data collected and processed by these new technologies?
- **Measuring Impact and Success:**
  - How should success be measured for new technology implementations, and what key performance indicators should be monitored to ensure technologies are delivering on their promise to enhance safety, reduce risk, and improve outcomes?

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- **Smart Truck:**
  - What did a truck need to do 50 years ago? What does a fire truck need to do today? 5-50 years from now?
- **Smart PPE:**
  - What did PPE need to do 50 years ago? What does PEE need to do today? 5-50 years from now?
- **Foam:**
  - Not all Foam is created equal. How to overcome Class A vs B differences?
- **Lithium Ion Batteries:**
  - What now, what next?
- **Listening:**
  - Are you actually listening to first responders on their problems? How can we translate insights of the problems into next gen solutions?

Table 1.1 Transformation from tradition-based fire fighting to Smart Fire Fighting.

Current State	Future State
Tradition-based tactics	Data-driven science-based tactics
Local information	Global information
Data-poor decision making	Information-rich decision making
Lack of awareness	Situational awareness
Untapped or unavailable data	Comprehensive data collection, analysis, and communication
Isolated equipment and building elements	Interconnected equipment and building monitoring, data, and control systems
Human operations	Human controlled, collaborative, and automated operations with inanimate objects (buildings, machines, etc.)

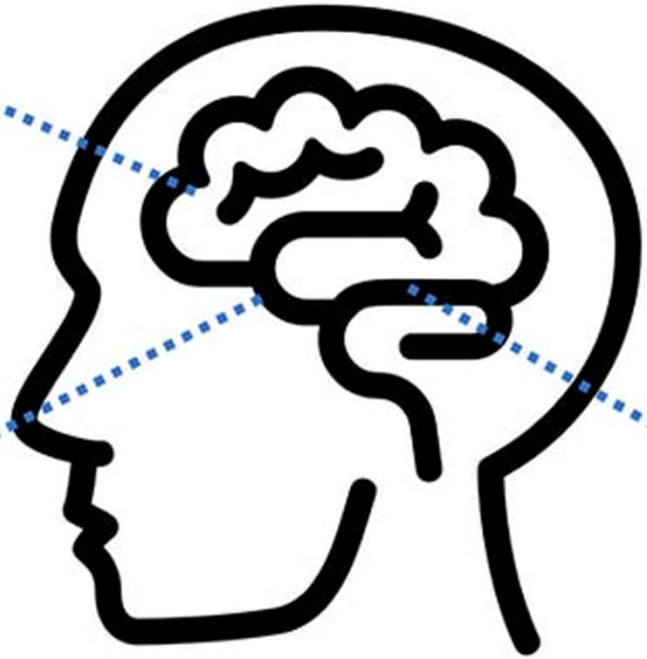
Table 1.2 Example of existing and emerging fire-related information sources.

Source	Information Type
Fire Fighter	• Radio • PASS alarm • Thermal imaging cameras • SCBA cylinder pressure • Physiological monitoring • Fire hose water flow • Fire fighter location
Building	• Floor plans, firewall ratings, locations of standpipes, building entrances, interior stairwells, elevators, hazardous materials • Annunciator panel • Carbon monoxide alarm • Fire alarm • Activity/motion sensors • Fire sprinklers • Building information models • Surveillance cameras • Local temperatures • Occupant location

Figure 1.1 Example of the Smart Fire Fighting process.

Cognitive Load Theory

Intrinsic Load
(complexity of new information)



Germane Load
(linking new info with current info)

Extraneous Load
(unnecessary and distracting info)

&

NOT

Figure 3.1 A tethered helmeted fire fighter prepares to enter a structure. (Source: Photograph from the Scottish Fire and Rescue Service Heritage Trust.)

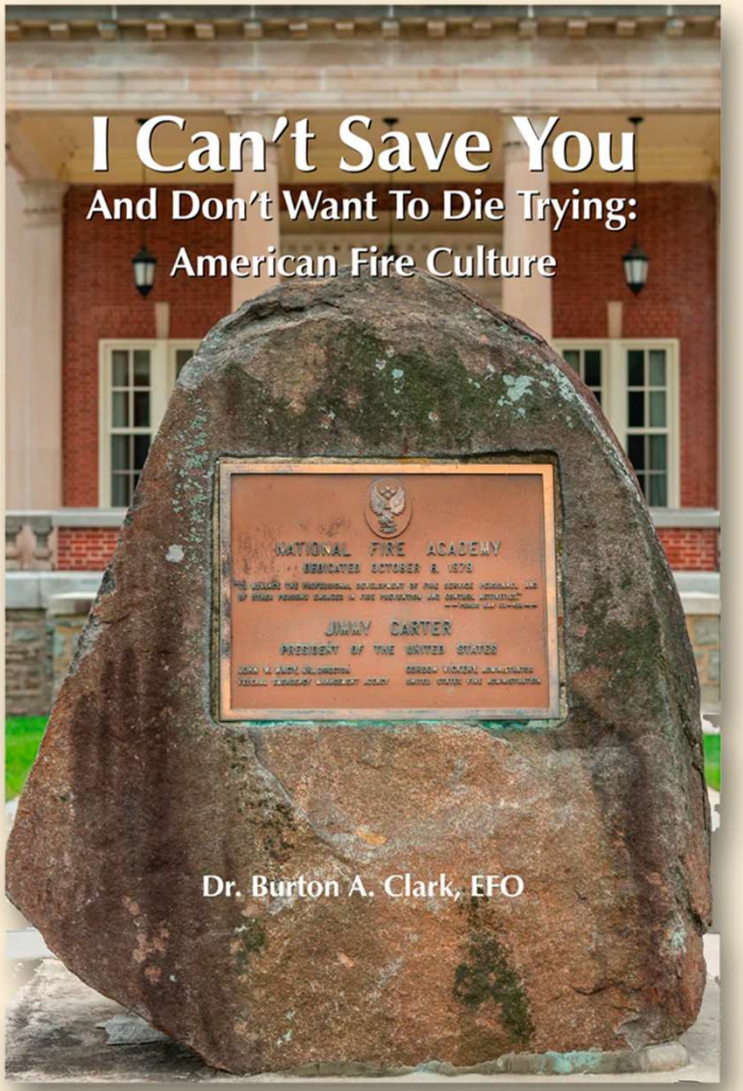
New Technologies

Positive and Negative Externalities of “Green Tech” & Electrification

Positive and Negative Externalities of “Green Tech” & Electrification

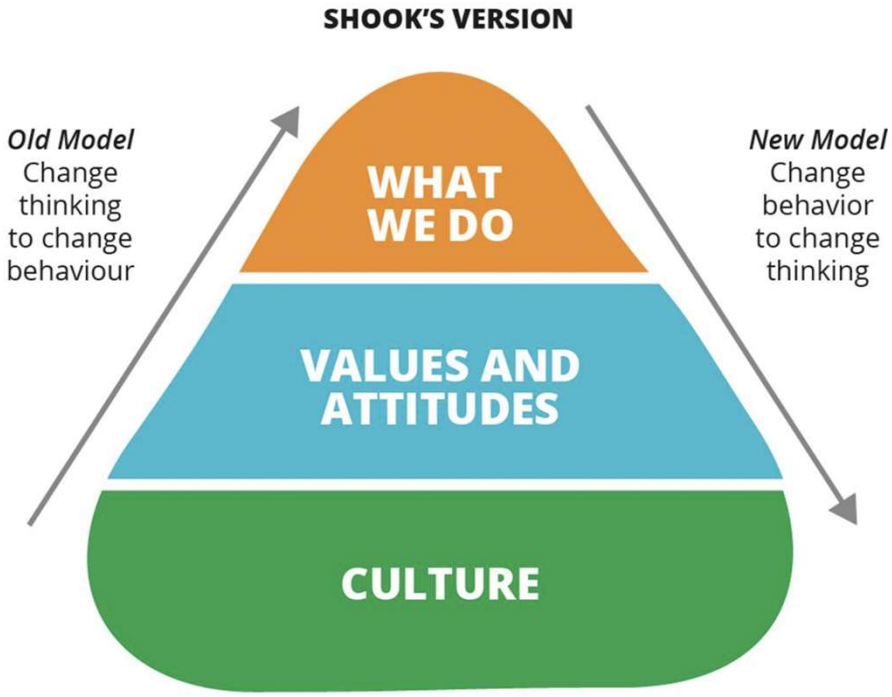
Technology That Makes a Difference

- Self Closing Doors
- HVAC Dampers
- Sprinkler Systems
- Smoke Alarms
- Seat Belts


I Can't Save You
And Don't Want To Die Trying:
American Fire Culture
NATIONAL FIRE ACADEMY
JIMMY CARTER
Dr. Burton A. Clark, EFO

People and Culture (PAC)

- **Meet people where they are at**
- How do you consume info?
- How do your users consume information?
- What cultural differences exists?
  - Listen to end users, watch, tinker, deliver value
- Study trends - what is relevant today? What is not relevant today?
- Don't force your losing agenda on others
- Don’t spend time talking about the way things used to be



Cultural and Geographical Differences

Actionable Data for Firefighting Operations

~Four major types of data:

1. Community-based information
2. Building occupant information
3. Building information
4. Information related to fire fighters and their tools

Figure 2.1 Typical communication realms for an emergency event.

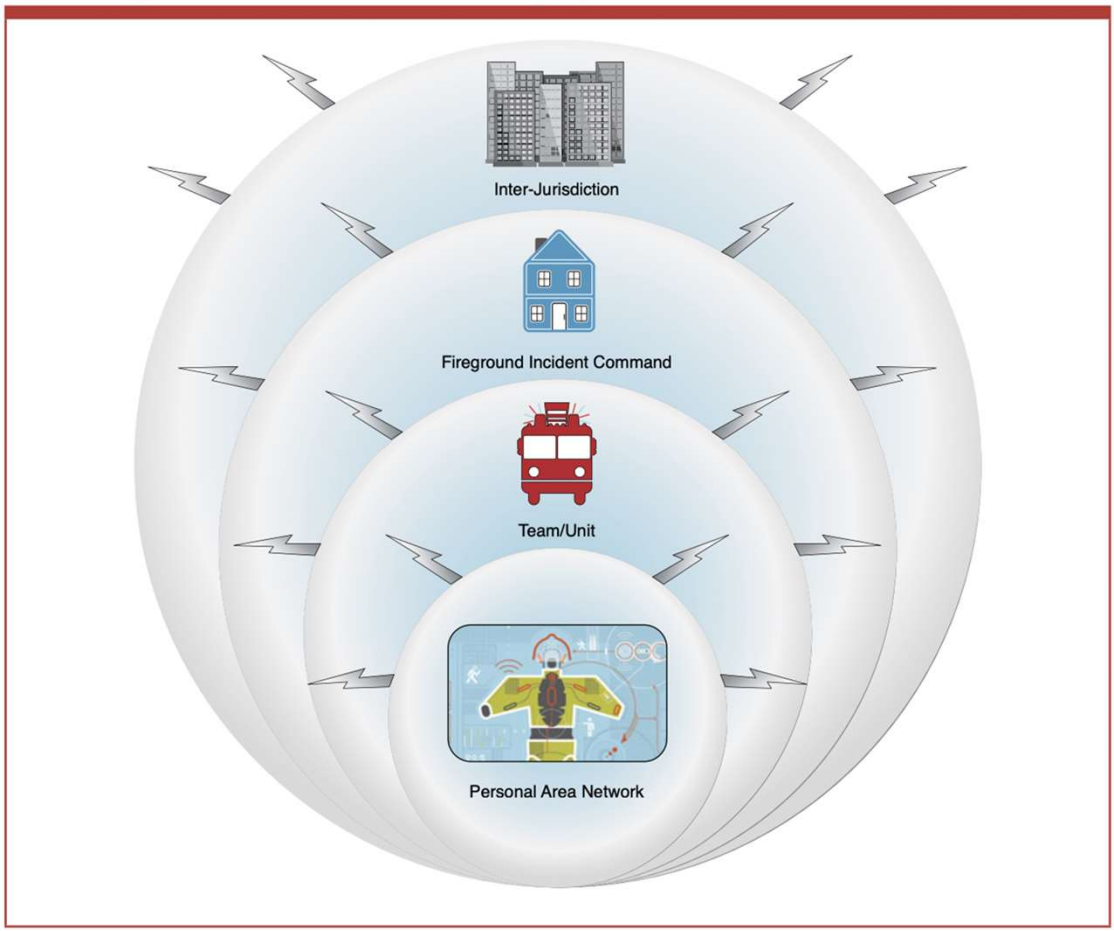
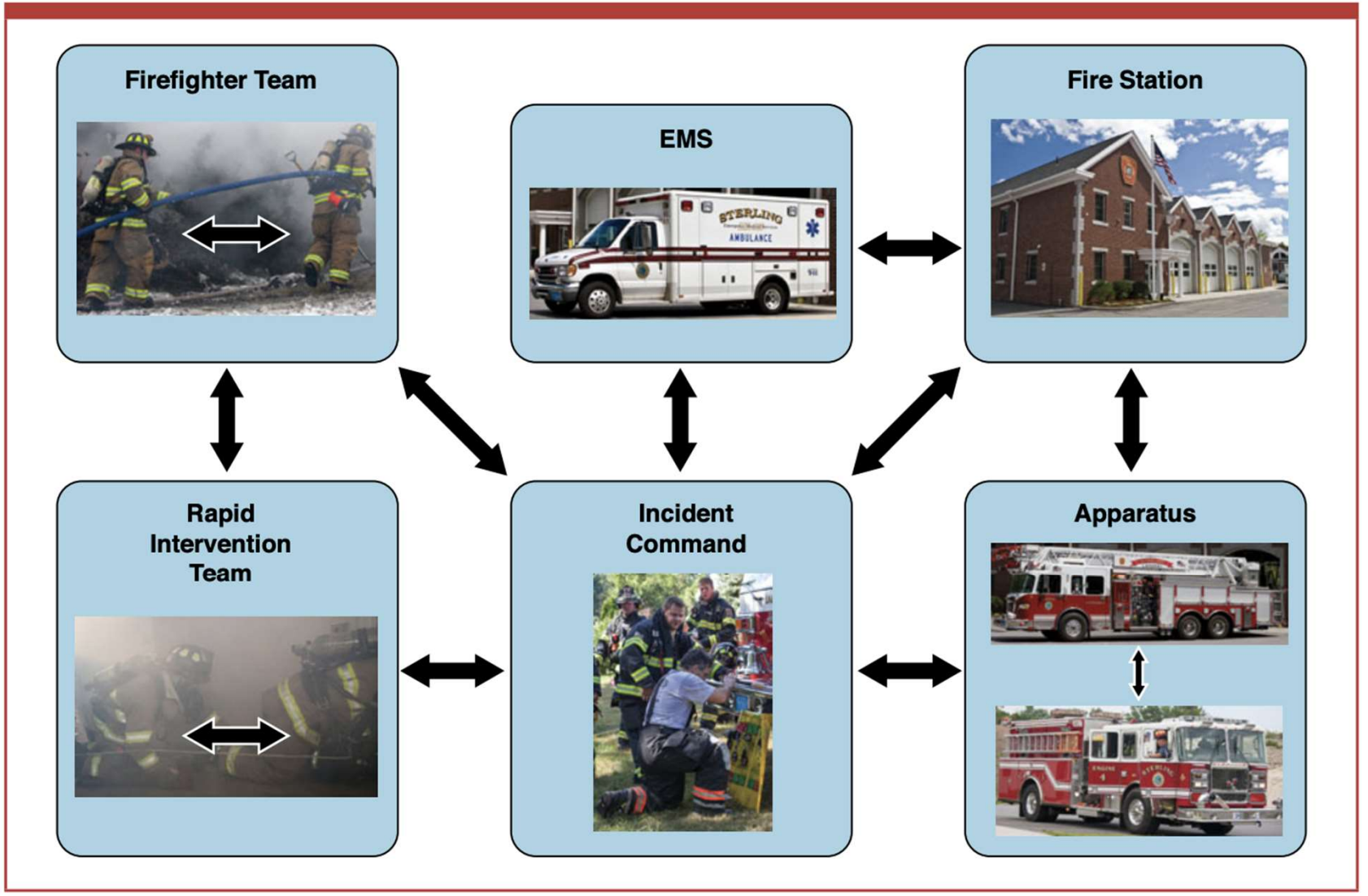
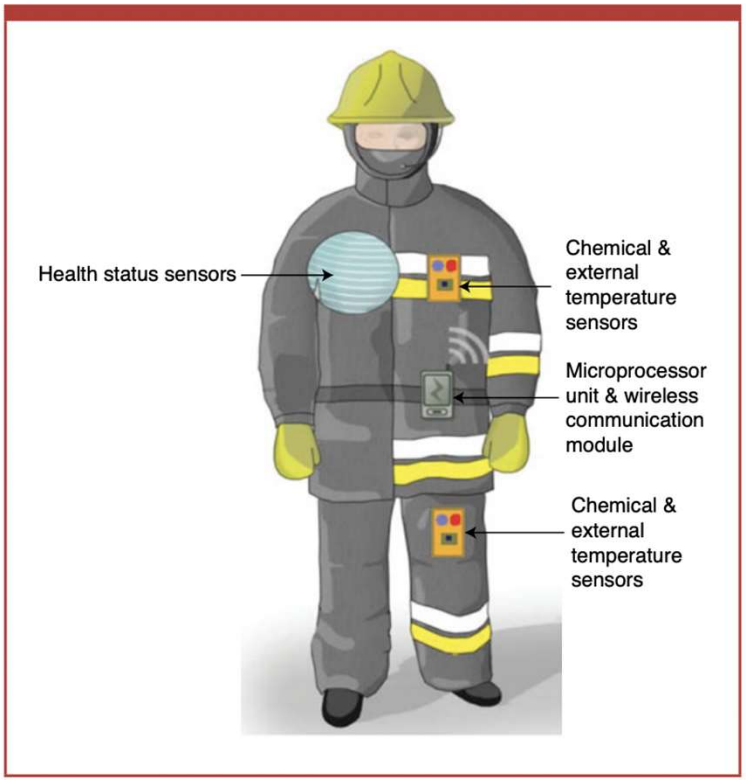


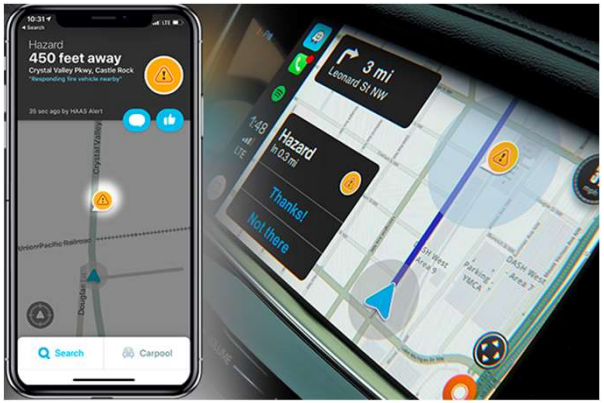
Figure 7.1 Interoperability at emergency incident. (Source: Courtesy of the Sterling, MA, Fire Department — Photographer Tina Gianos.)



Sensors as Part of PPE, Mobile Sensors and Stationary Sensors

Figure 3.2 Schematic of multisensor fire fighter PPE.





Vehicle Platform as a Data Center

Goal: Universal access to reliable connectivity and communications without having to think about it.

Step One: Turn on the vehicle. System automatically connects to available connectivity and provide wifi on board

Step Two: Perform standard SOPs with confidence that you will maintain connectivity to perform tasks & operations.

Acess to GEO & LEO Satellitle Connectivity

1

Access to LTE Cellular Networks: FirstNet, AT&T, T-Mobile

2

Connect to physical antenna conduits on vehicle platform

3

Blend connection with Smart Blended Satellite and LTE Blender on platform

4

Extend WiFi Mesh network on board and with deployable nodes

5

Utilize Smart connected devices such as drones, phones, tablets, cameras

6

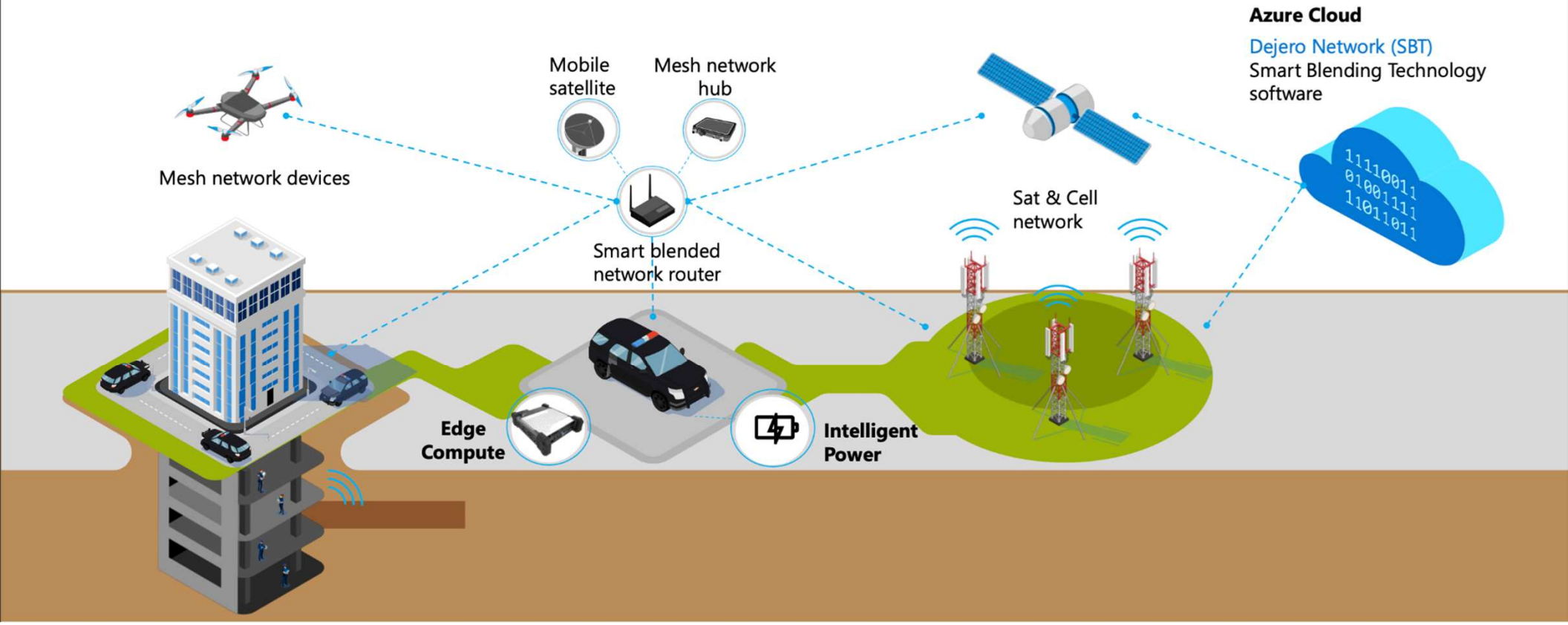
Leverage cloud connectivity to run APPs, AI, LLM, ML

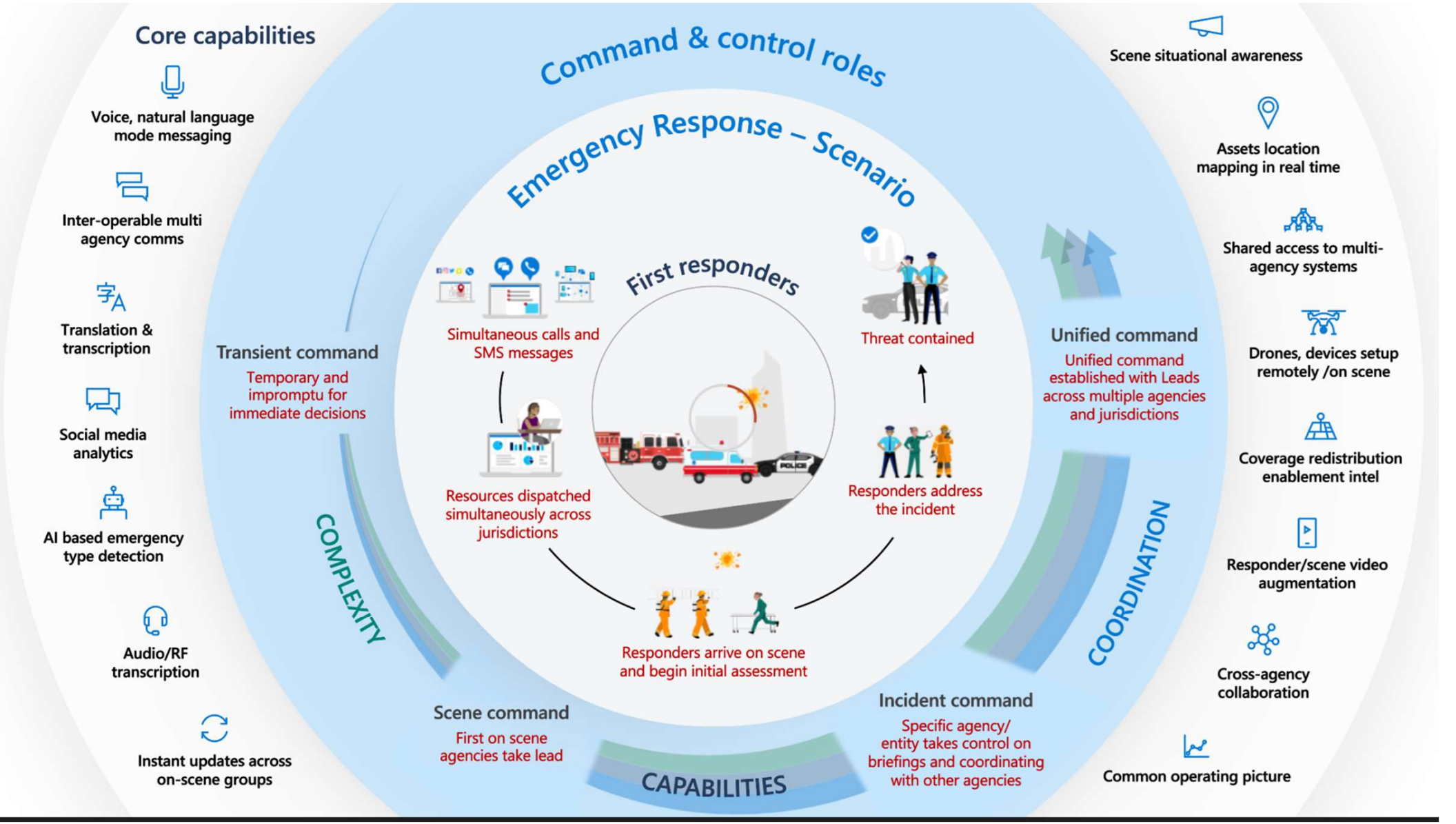
7

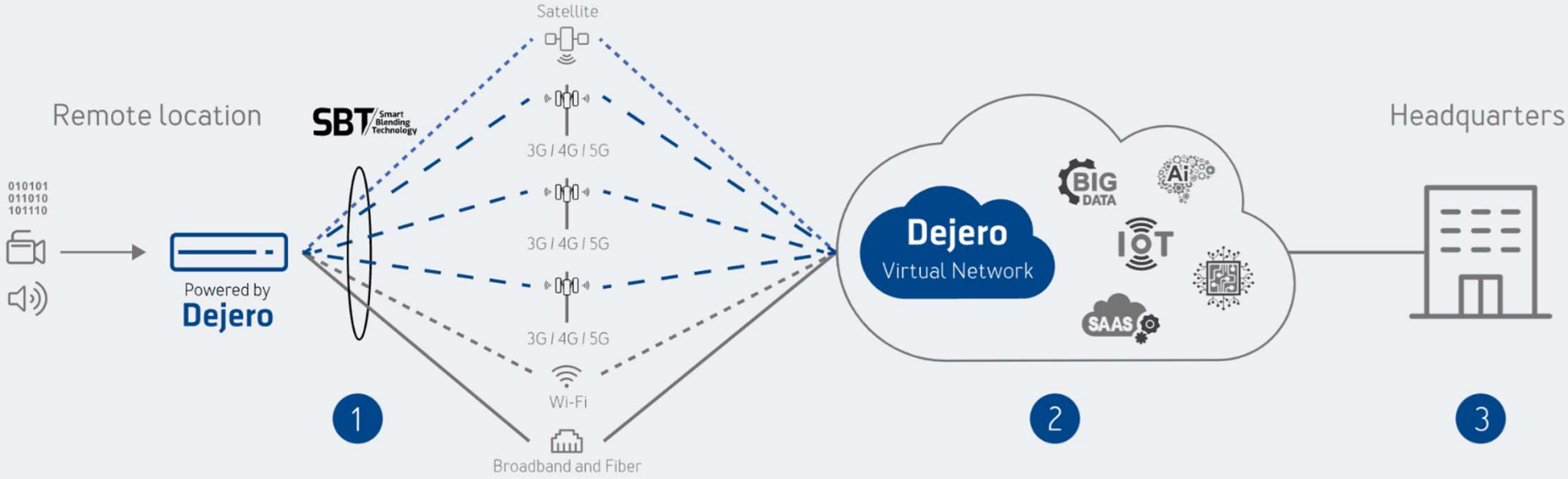
First Responders focus on task at hand, follow SOPs to protect lives & proerty and mitigate risk

8

Resilient: Compute, Connectivity, Power




Core capabilities
Voice, natural language mode messaging
Inter-operable multi agency comms
Translation & transcription
Social media analytics
AI based emergency type detection
Audio/RF transcription
Instant updates across on-scene groups
Command & control roles
Emergency Response – Scenario
First responders
Simultaneous calls and SMS messages
Resources dispatched simultaneously across jurisdictions
Responders arrive on scene and begin initial assessment
Responders address the incident
Threat contained
Transient command
Temporary and impromptu for immediate decisions
Scene command
First on scene agencies take lead
Incident command
Specific agency/ entity takes control on briefings and coordinating with other agencies
Unified command
Unified command established with Leads across multiple agencies and jurisdictions
COMPLEXITY
COORDINATION
CAPABILITIES
Scene situational awareness
Assets location mapping in real time
Shared access to multi-agency systems
Drones, devices setup remotely /on scene
Coverage redistribution enablement intel
Responder/scene video augmentation
Cross-agency collaboration
Common operating picture



1. Combine the bandwidth of multiple network providers and diverse technologies with *Smart Blending Technology™*

2. Access cloud resources such as compute, storage and software...

3. ...or connect to resources at headquarters or datacenters

System Integration of 21st century technology

Satellite Communications: Satcom access while on the move in remote areas

Mesh Network: Extension of communications via mesh network for flexible coverage

LTE & Communications Aggregations: Smart blended network connectivity

In Vehicle Power System: Lithium Energy Module with AC Inverter

Edge Computing, AI, Cloud: Cloud software stack for edge computing

Interactive Tablet Devices: high power touch devices for first responder operations

First Responder and Asset Tracking: Seamless tracking and accountability software

VTOL Drone: Quickly deployable quadcopter robot for situational awareness

Video Streaming: Real time transfer of video data from assets in field to vehicle

Modular Roof Rack System: Winch and other special features

Ford

Darley

BRONCO

Dejero

hypha MESH

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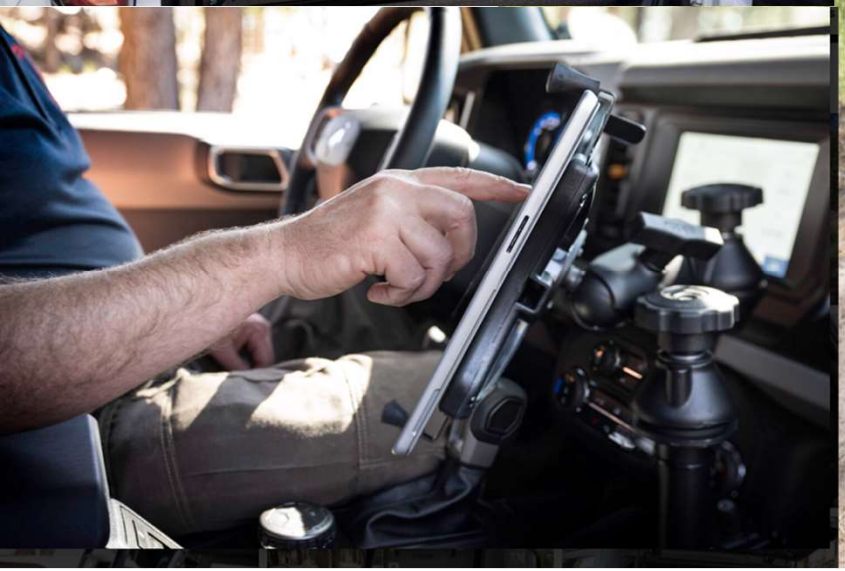
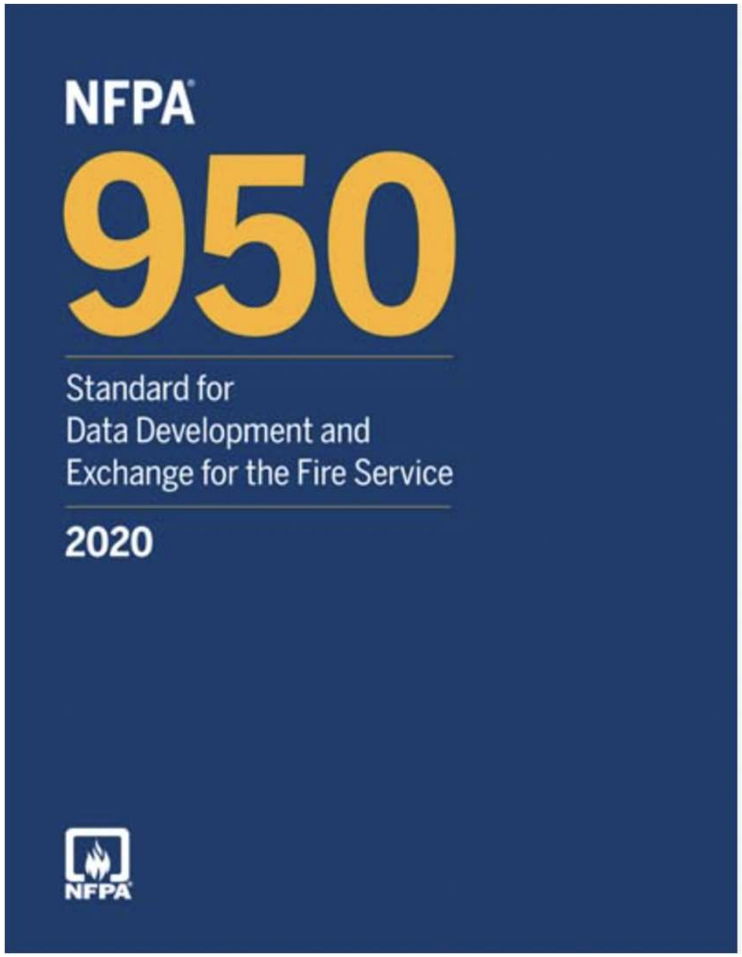



BRONCO

Standards

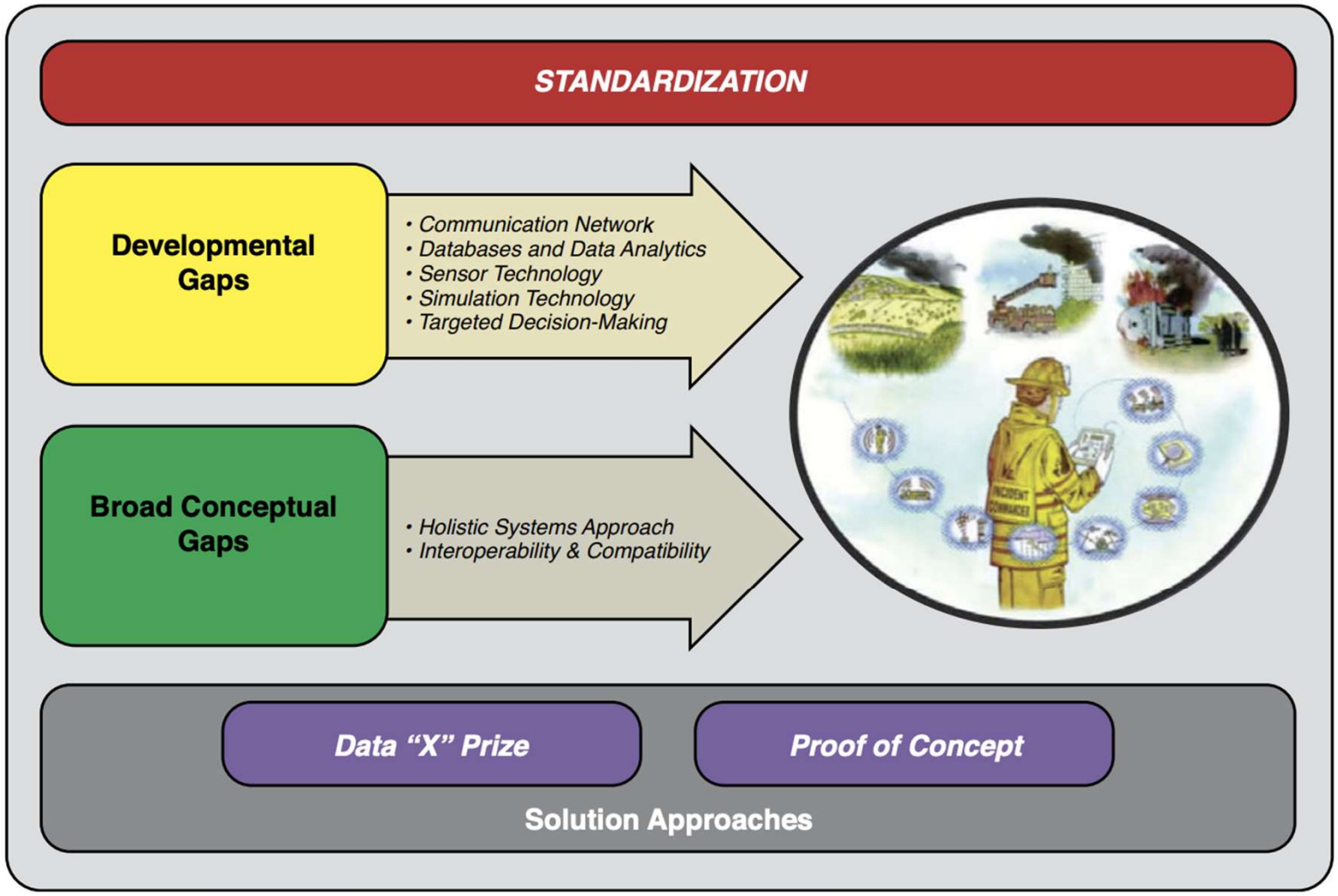
- 30,000 fire departments in the USA
- NFPA 950, Standard for Data Development and Exchange for the Fire Service
- NFPA 951, Guide to Building and Utilizing Digital Information
- ISO 37120, Sustainable Development of Communities — Indicators for City Services and Quality of Life [17].



Challenges with New Tech & Standards

- Secure standard methods of **transmitting a standard set of data** in a standardized format
- Standardized information for first responders and standard building **data models**
- **Ownership and maintenance** of and data schemas and queries for databases
- Choice of standard communication protocols and **user interfaces**
- Establishment of criteria to **automatically route 9-1-1** calls based on message content
- Implementation of appropriate authorization, **authentication**, and security protocols
- Development of **multi-hazard scenarios** for system design and **compliance**
- **Interoperability** standards for both **software and hardware**
- Standards for accessing and using **cloud-based services**
- Plug-and-play architectures that facilitate **integration of cyber and physical components**

Figure 14.1 Research priorities for CPS-Smart Fire Fighting.

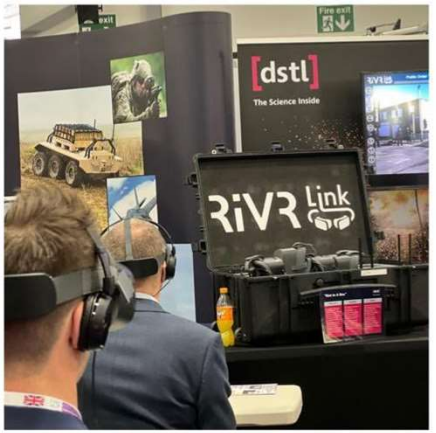


Tools in the Tool Bag for First Responders

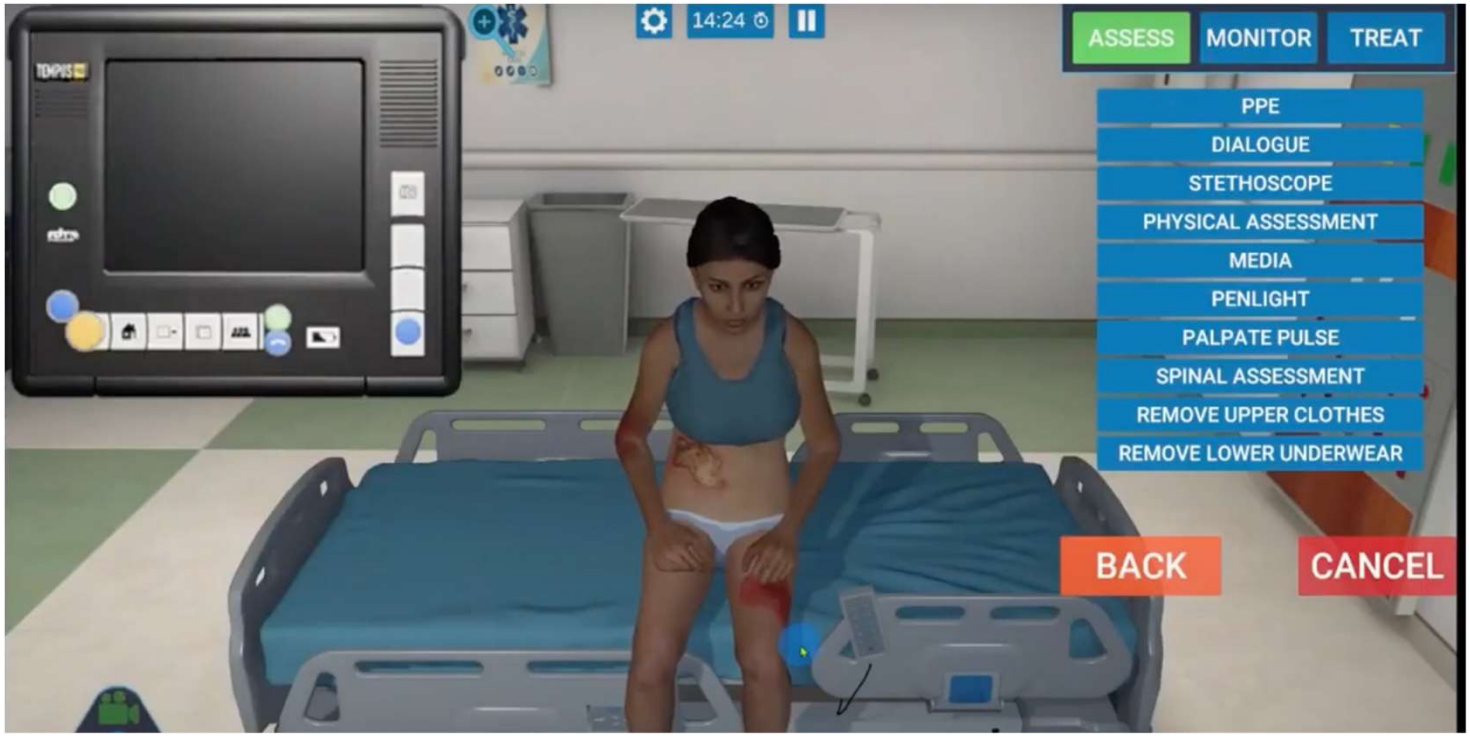
Drones

Virtual Reality Training

Virtual Reality Training



Virtual Reality Training



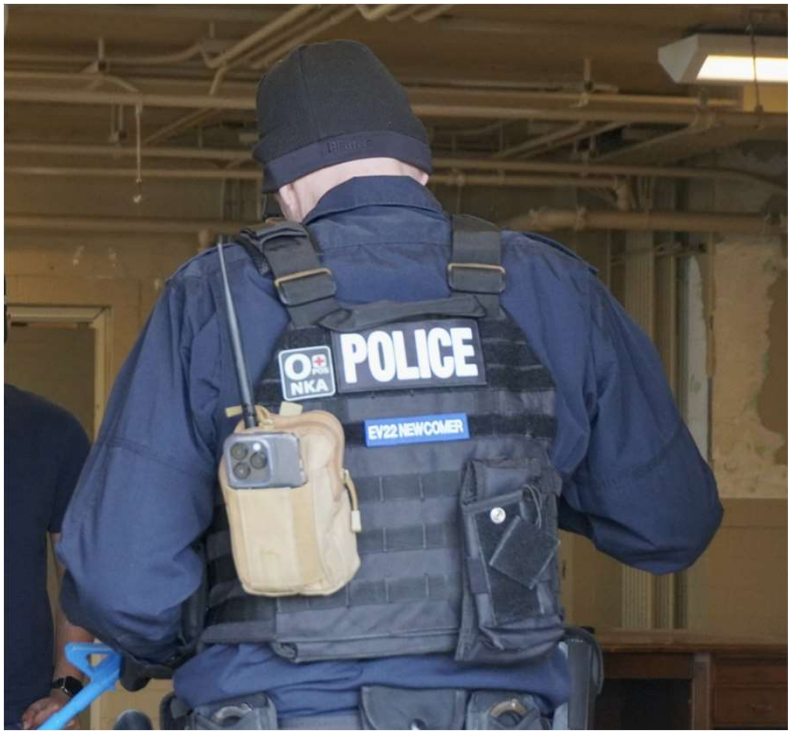
Personal Accountability, Biometrics & Indoor Localization

FIRST RESPONDER CHALLENGE Smart Tracking

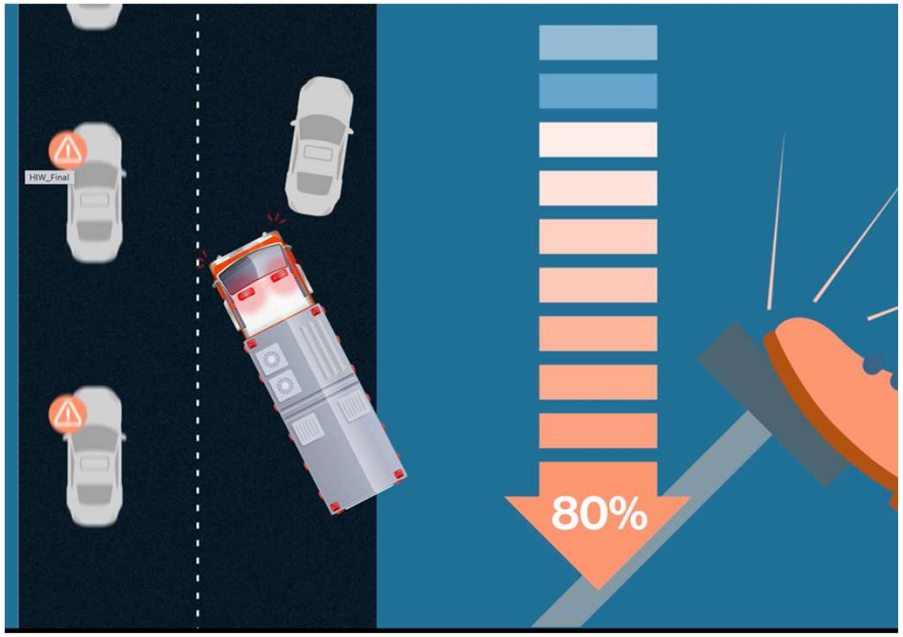
NIST

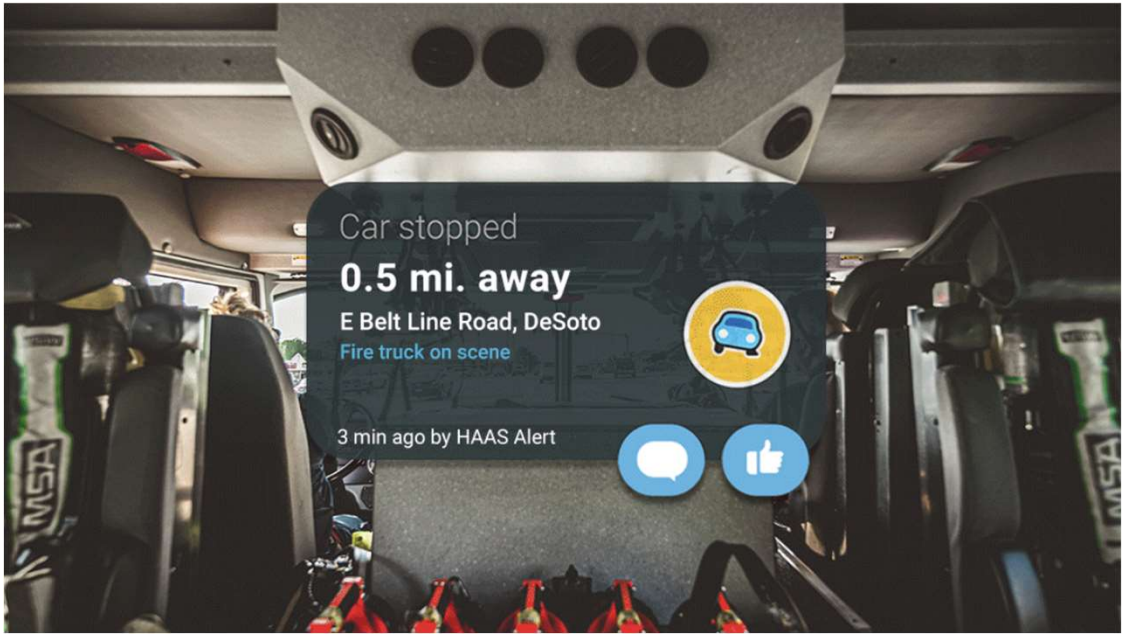
PSCR PUBLIC SAFETY COMMUNICATIONS RESEARCH

LUDDY SCHOOL OF INFORMATICS, COMPUTING, AND ENGINEERING
INDIANA UNIVERSITY



Vehicle to Vehicle Alerting System





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Part 2 of our FRST Challenge - Phase 4 Mini Series: Hello Smart Firefighting Community! Welcome to another episode of covering real world innovations via interviews with fire service and technology industry experts t…

SMART FIREFIGHTING
PODCAST

THE POWER OF LISTENING TO THE FIRE SERVICE

WITH DR. LORI MOORE-MERRELL

INTERSCHUTZ

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