INTERNET2 TECHNOLOGY
EVALUATION CENTER

ATIS Next G Alliance Public Safety Vertical Future Use Cases

Feb 26, 2025

Michael E Fox – Executive Director, ITEC – michael.fox@tamu.edu

Texas A&M University

- Founded 1876. One of the largest public universities in the nation.
  - 16 colleges & schools; 94 doctoral programs; ~79,000 students, ~2300 cadets
  - AAU member; ~4,200 faculty; ~60 National Academy Members
  - R1 Doctoral University; top 10 public universities
  - Over $1.25B in research expenditures; #1 in the nation for Engineering research expenditures
- One of only 24 land-, sea-, and space-grant institutions in the nation

The Texas A&M University System

Eleven Universities

- Texas A&M University
- Prairie View A&M University
- A&M Commerce
- Tarleton State University
- Texas A&M University Kingsville
- Texas A&M University Corpus Christi
- Texas A&M International University
- Texas A&M University Texarkana
- West Texas A&M University
- Texas A&M University Central Texas
- Texas A&M University San Antonio

Eight State Agencies

- Texas A&M AgriLife Research
- Texas A&M Engineering Experiment Station
- Texas A&M Forest Service
- Texas A&M AgriLife Extension
- Texas A&M Engineering Extension Service
- Texas A&M Veterinary Medical Diagnostic Laboratory
- Texas A&M Transportation Institute
- TDEM, The Texas A&M University System

System Campus

RELLIS

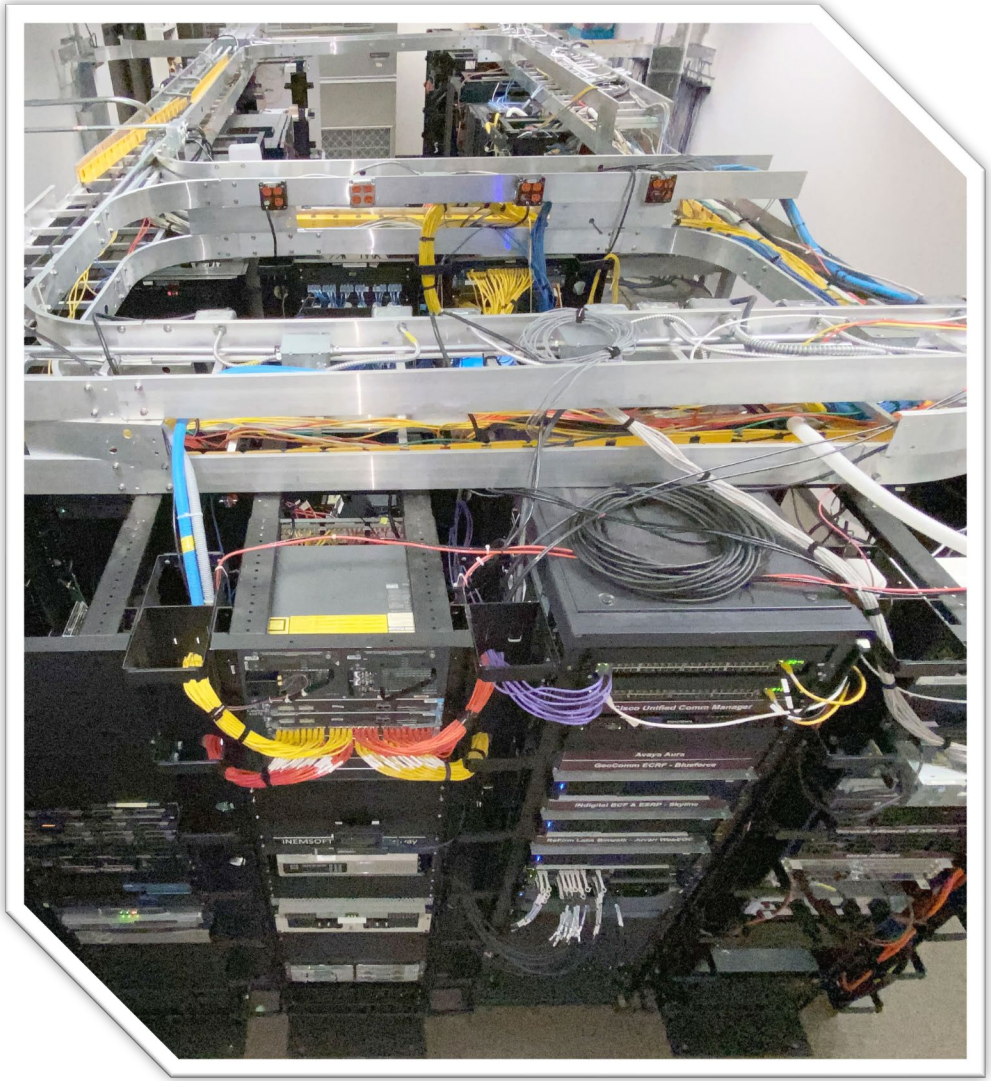
Office of Research

Office of Research

- Texas A&M Innovation
- National Laboratories Office
- Bush Combat Development Complex
- Texas A&M Semiconductor Institute
- **Internet2 Technology Evaluation Center**
- Research Security Office
- Research Compliance Office
- Research Development Office
- Research Administration Office
- Texas A&M Fort Worth

Internet2 Technology Evaluation Center (ITEC)

- Applied research center
- Wireless and Next Generation communications systems
- Public safety, defense, transportation, energy, critical infrastructure
- Interoperability, cybersecurity
- Some recent and current wireless activity
  - 4G/5G wireless security
  - Dynamic spectrum sharing
  - Predictive networking and autonomy
  - Mission Critical Services / Sidelink interop
  - Next Gen 9-1-1 interop & security
  - Positioning, Navigation, Timing / GPS denied
  - Vehicle to Everything (V2X)
  - …



How NOT To Predict the Future …

- Albert Einstein (1932)
  - “There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will.”
- Thomas Watson, chairman of IBM (1943)
  - I think there is a world market for maybe five computers.”
- Ken Olsen, President and Chairman of Digital Equipment Corp (DEC) (1977)
  - There is no reason for any individual to have a computer in his home.”
- Marty Cooper, inventor of the cellular phone (1981)
  - “Cellular phones will absolutely not replace local wire systems.”
- Robert Metcalfe, Founder of 3Com (1995)
  - “I predict the Internet will soon go spectacularly supernova and in 1996 catastrophically collapse.”
- Steve Ballmer, Microsoft CEO (2007)
  - “There’s no chance that the iPhone is going to get any significant market share.”

The 9-1-1 Call

Today: UE makes it easy to make a *VOICE* 9-1-1 call

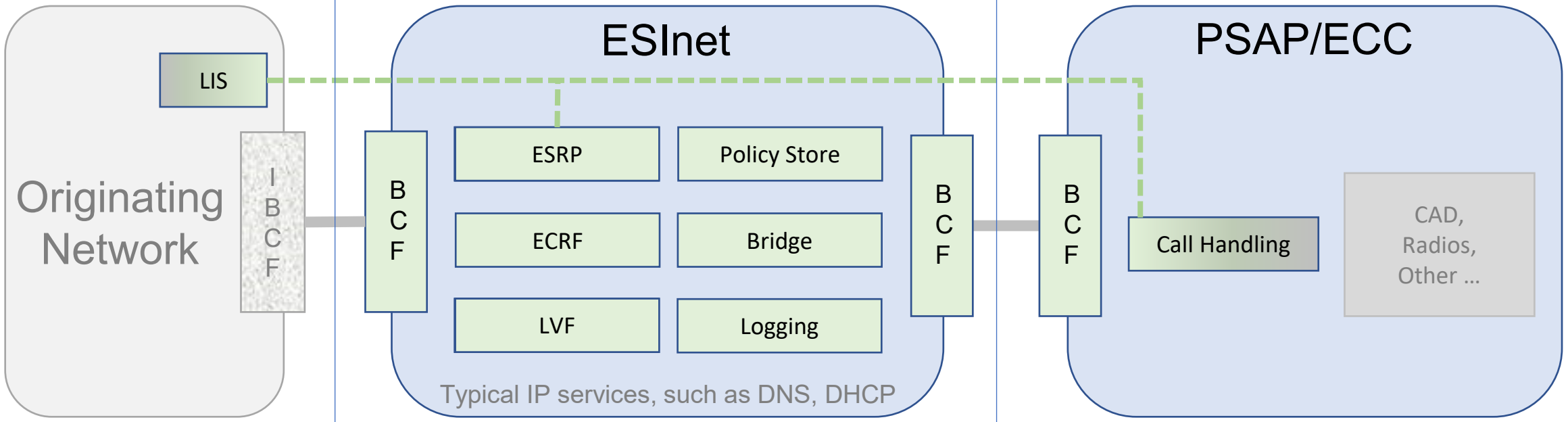
Coming Soon: Make native text, video, telematics calls

Next Gen 9-1-1 High Level Architecture

ATIS-0700015

NENA i3 STA-010.3
(ATIS-0500032 Not Shown)

NENA NG-PSAP STA-023.1

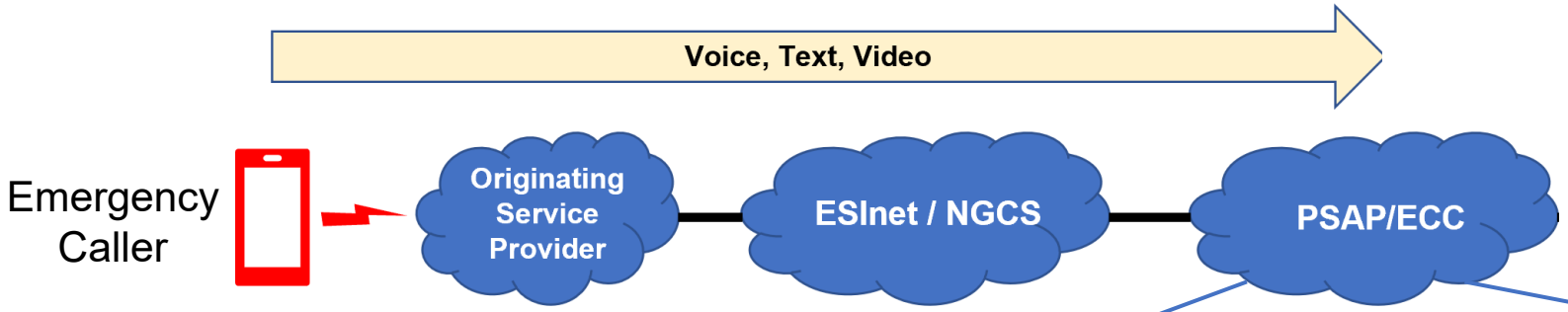


ESInet = Emergency Services IP Network
PSAP = Public Safety Answering Point
ECC = Emergency Communications Center

BCF = Border Control Function
ESRP = Emergency Services Routing Proxy
ECRF = Emergency Call Routing Function

LIS = Location Information Server
LVF = Location Validation Function

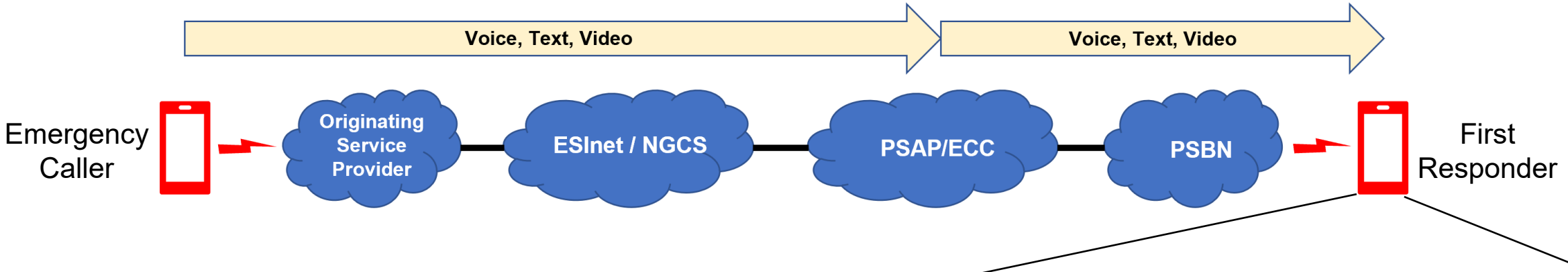
Example: Wireless Next Gen 9-1-1 Video Call



- Voice, text, video, telematics
- Native IMS/NENA-i3 calls
  - No over-the-top applications!
- Example implementation:

TEXAS A&M UNIVERSITY
INTEROP INSTITUTE
MAY 6-10, 2024

Example: Extend Call to First Responder



- In transit assessment
  - Fire: damage, rescue assessment
  - Law: identify suspect
  - EMS: assistance with CPR
- Improved situational awareness for first responders
- Improved survival for the public

9-1-1 Challenges

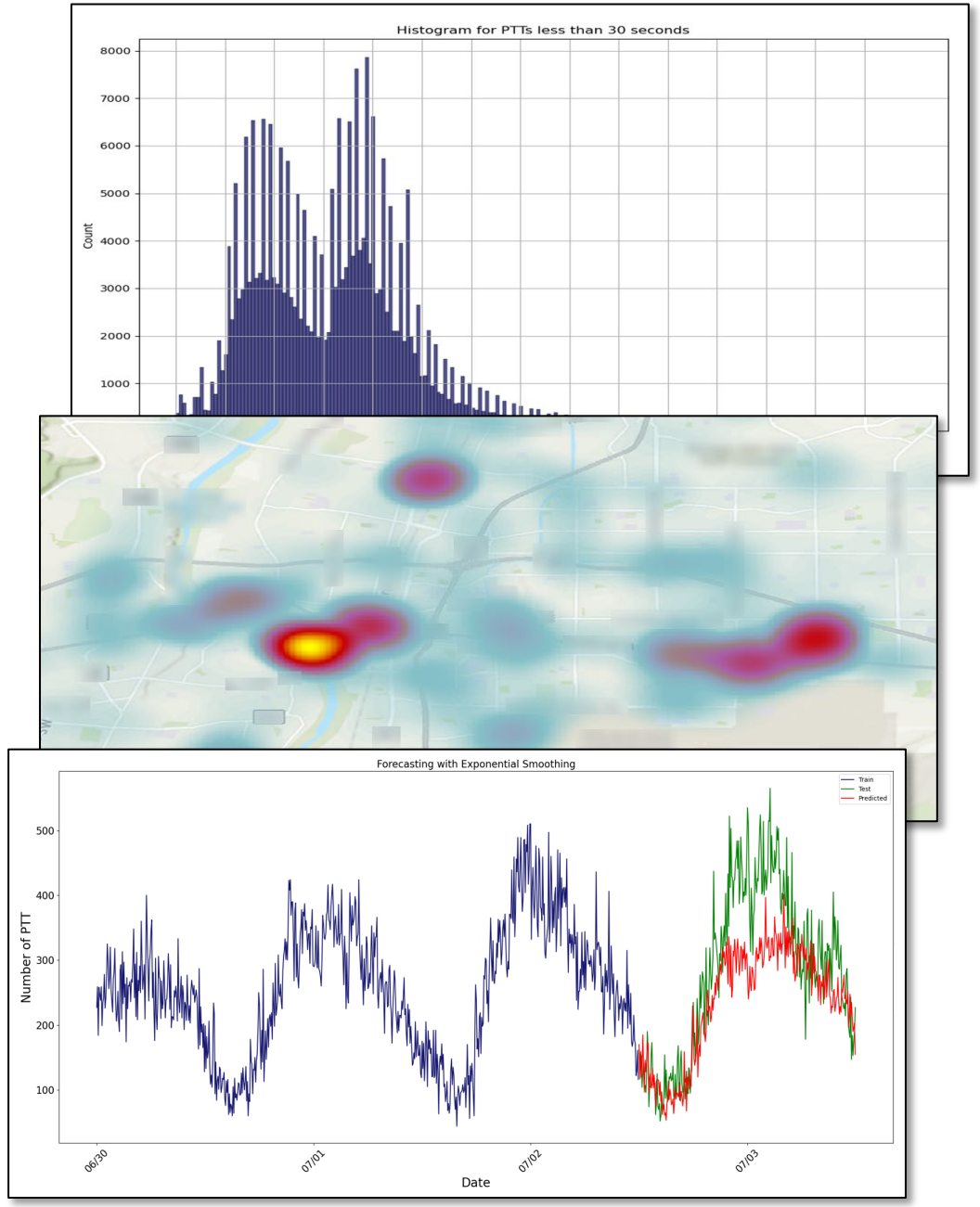
- 9-1-1 Caller to PSAP/ECC
  - Multiple callers. Perhaps hundreds or thousands. Duplicate info? Differentiate from TDOS?
  - Multiple media types (voice, text, video, telematics); increased bandwidth
  - Competition for spectrum: personal calls, social networking
- PSAP/ECC to First Responders
  - Multiple jurisdictions: federal, state, tribal, local. Multiple services: Fire, EMS, Law, utilities, …
  - Integration with situational awareness tools. Possibility of data overload.
  - Spectrum competition from the public (personal calls, social networking)
  - Spectrum competition from other responders (UAS, UGS, UMS feeds; sensors; tactical comms, …)
  - 2-way communication (command) vs. 1-way (drone video uploads, situational awareness)
- Incident's Impact on Infrastructure
  - Towers down, DAS incapacitated, front/mid/backhaul cut, local capacity exceeded, …
  - Interference: unintentional vs. intentional/jamming

Mission Critical Communications

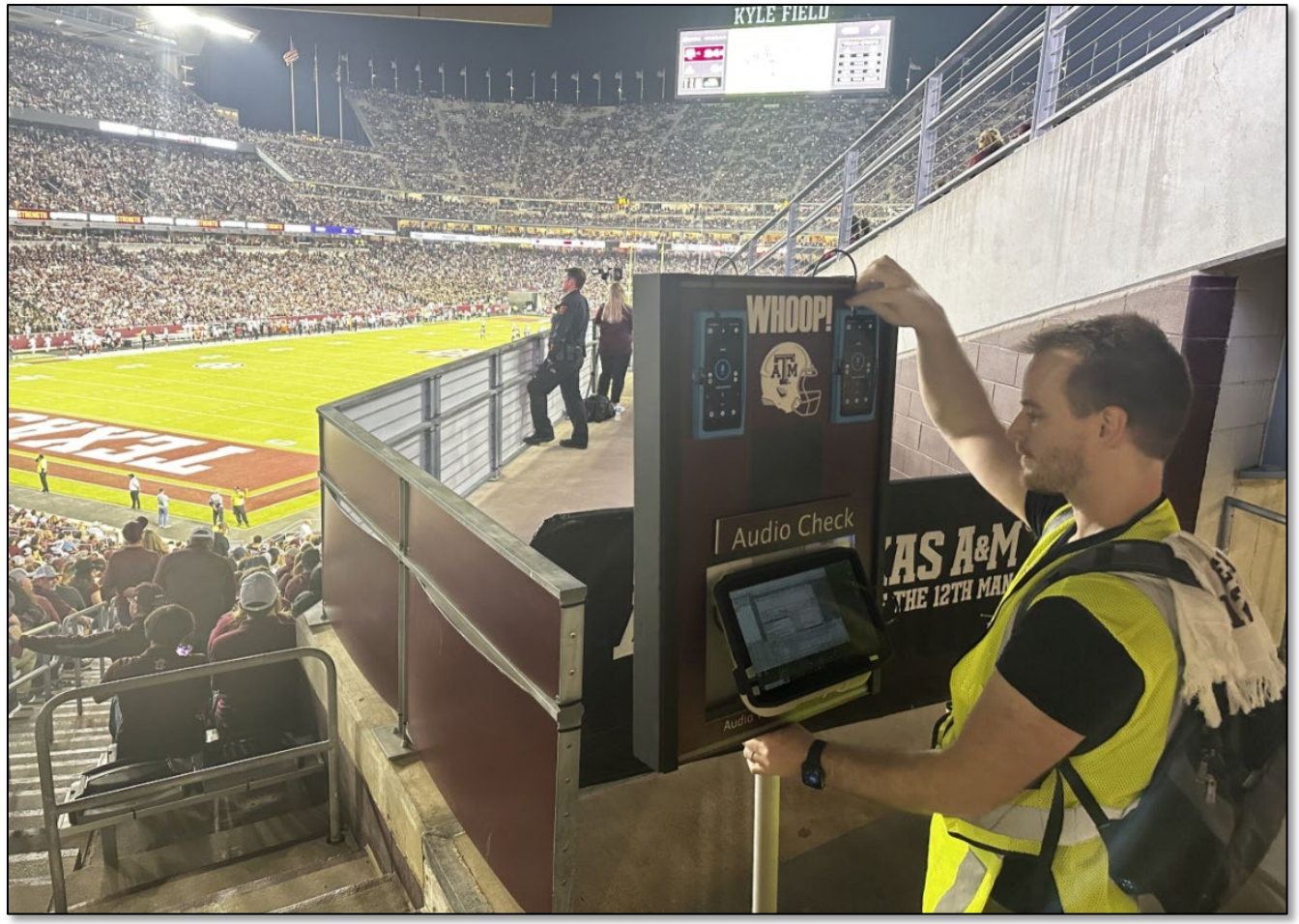
(When) Will Cellular Replace P25?

Public Safety PTT Analysis

- Gather time, location, duration of P25 PTTs during significant events around the country
- Conduct cluster, spacial, and temporal analysis to create a predictive model
- Results can inform what effect this type of event would have on a cellular network using MCPTT



Priority and Preemption

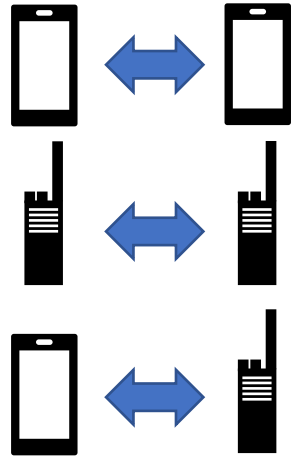


- MCPTT vs Over-the-top
- Texas A&M football game
  - Attendance: 105,815
- Two service providers
  - AT&T
  - Verizon
- Average of POLQA (ITU-T P.863) test results
  - MCPTT MOS = 3.28
  - OTT MOS = 0.58

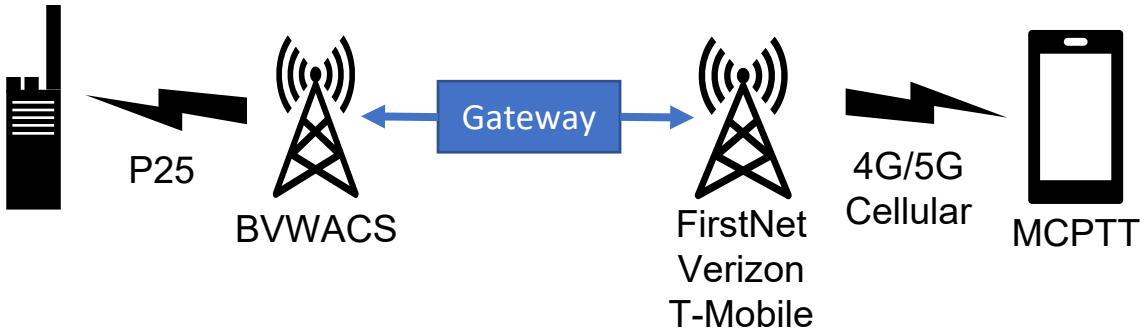
POLQA = Perceptual Objective Listening Quality Analysis
MOS = Mean Opinion Score (1-5)

Migrating from P25 to Mission Critical Push-to-Talk

- Quality and Interoperability
  - Conformance and interoperability testing of MCPTT clients, servers
  - Quality testing: MCPTT/MCPTT (voice & video); P25/P25; MCPTT/P25
  - Service provider to service provider NNIs



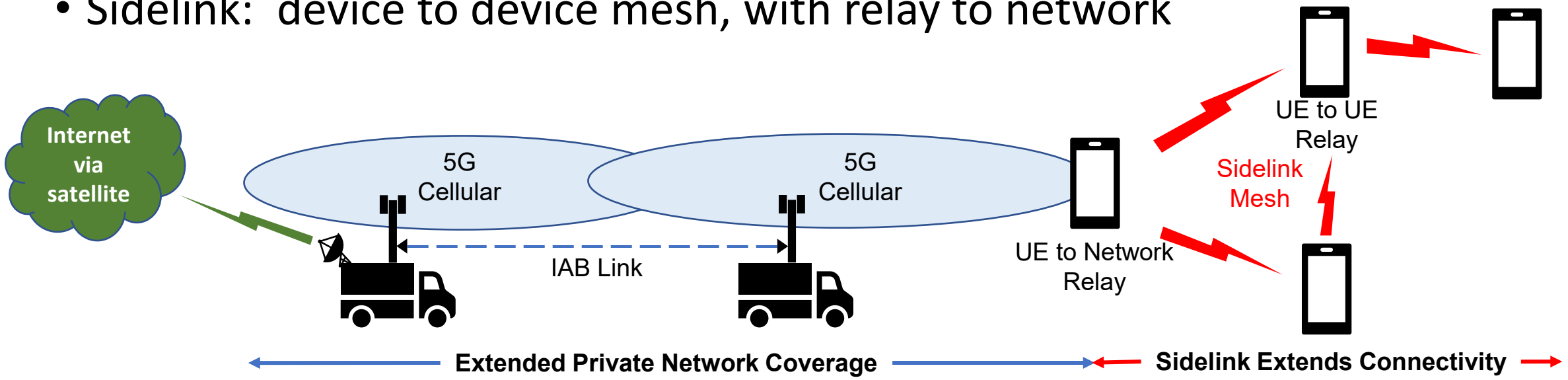
- Interop 2024 Exercise: Gateway P25 Radios to FirstNet, Verizon, T-Mobile
  - Multiple shared talk groups for any-to-any comms



Austere and RF-challenged Environments

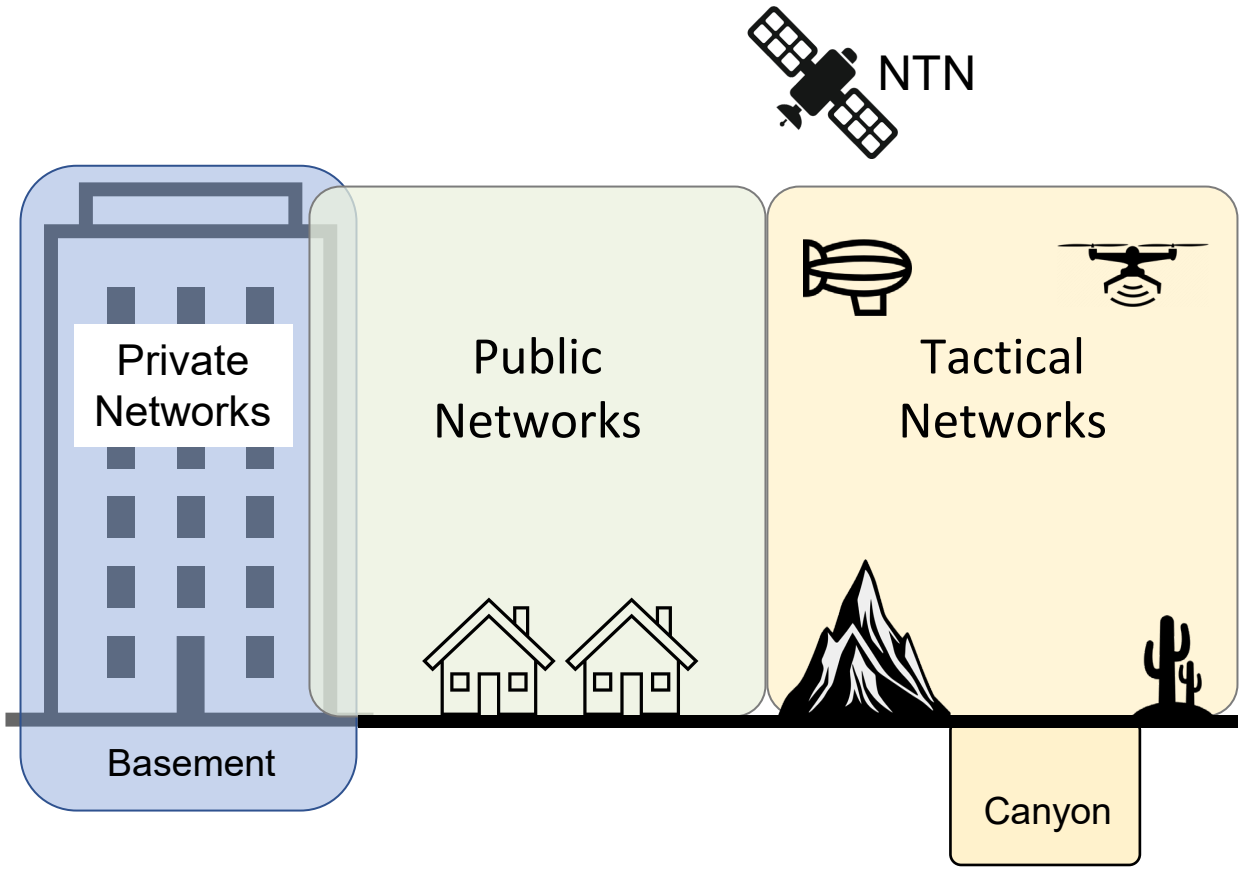
Private/Tactical Connectivity Bubble

- Two Vehicle Private Network
  - One network with extended coverage of two cell sites for larger incidents
  - Push-to-Talk/Text/Video; TAK
  - Internet connectivity via satellite
- Sidelink: device to device mesh, with relay to network



Mission Critical = Continuous Connectivity

- Seamless switching
  - Public / Private / Sidelink / NTN / non-3GPP
- Dynamic spectrum
  - Licensed, unlicensed, shared, non-3GPP
- Dynamic channel
  - Outdoors, indoors, multipath, …
- Predictive networks
  - Aware of multiple options
  - Analyze likelihood of losing signal
  - Switch to alternate before loss of connectivity
- Privacy and security concerns
  - Zero Trust Arch & quantum safe encryption



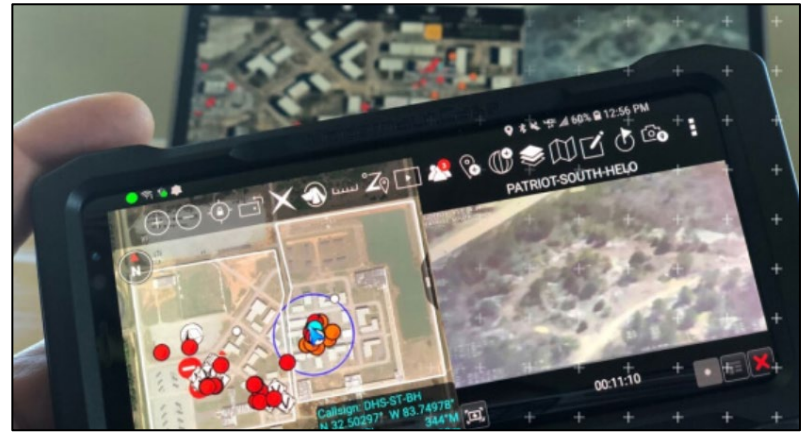
Significant UE Issues Remain

- Operation with gloves, without looking, without emitting light
- Ruggedized, intrinsically safe devices and accessories
- RF power, especially Sidelink vs. P25 direct mode

Situational Awareness

Cloud-native and extended reality opportunities

Situational Awareness

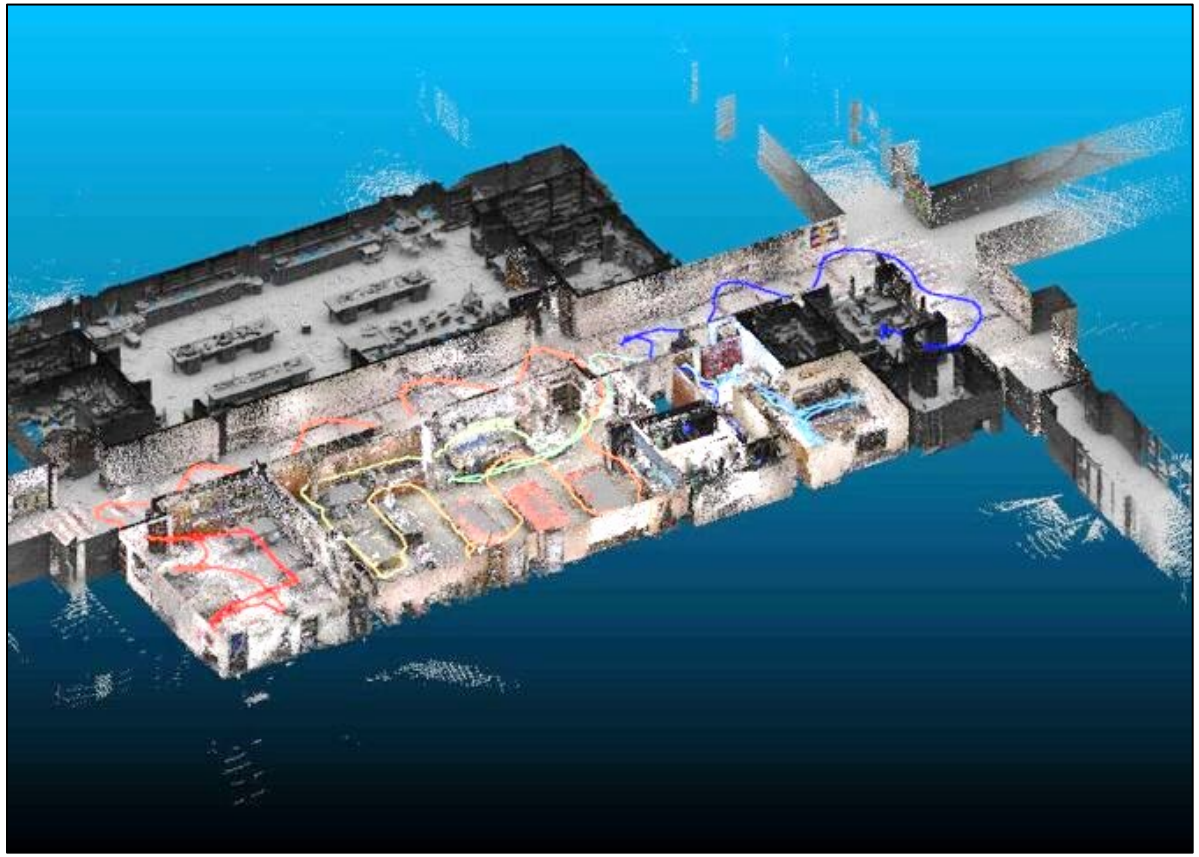


ATAK – Android Team Awareness Kit

- More mapping and coordination tools
- More sensors, more video (much more!)
  - Local: body worn sensors, cameras; dash cameras
  - Surveillance: fixed, robot mounted, drone mounted
  - Thermal (infrared), night vision, and higher resolution; CBRN
- Need to stream/share direct from the robot or drone
  - Old:
    - land the drone, download the SD card, upload to server
    - Issues: insufficient RF bandwidth, backhaul bandwidth
  - New:
    - Stream direct from drone to (multiple) UE(s)
    - Local processing (perhaps within the drone)

Big Data

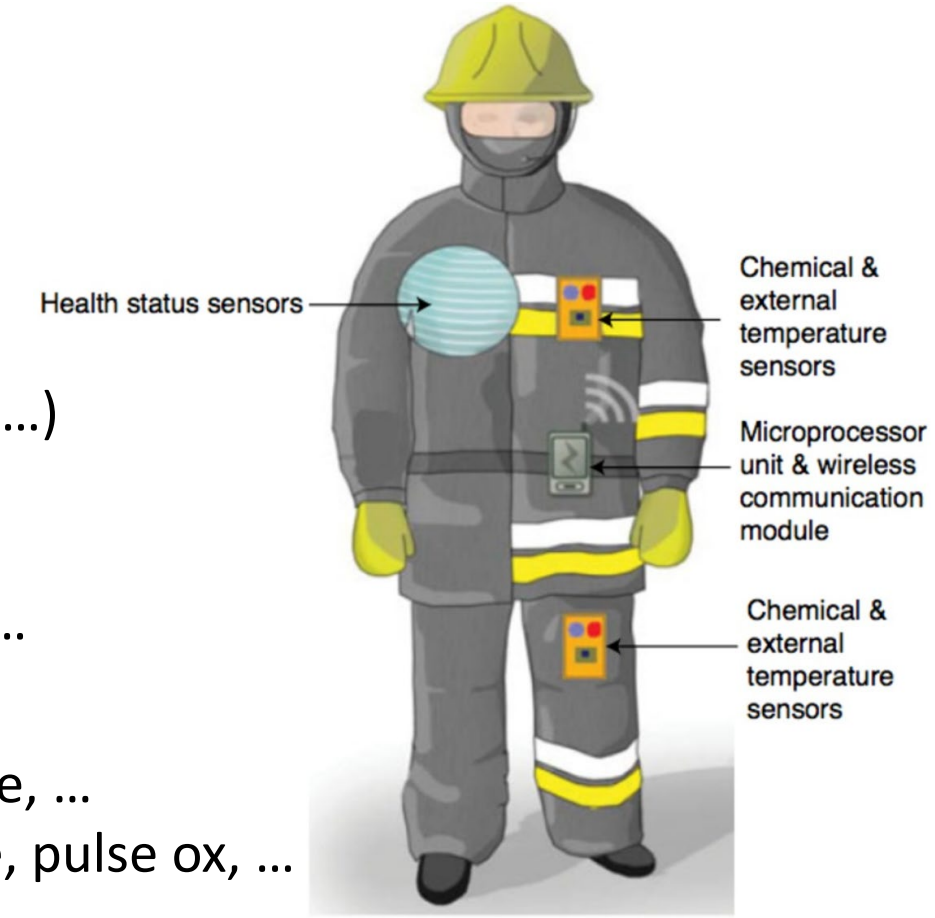
- LiDAR – Light Detection and Ranging
  - Remote sensing process; collect measurements for 3D models
  - Hand-held, tripod, backpack, robot, drone
  - Latest mobile phones have LiDAR scanners
- Point Clouds
  - Represent spatial data as a collection of coordinates
  - Can be rendered as pixels or converted to polygons for 3D representation of structures, objects
- Public Safety Examples
  - Indoor and outdoor mapping
  - Search path mapping
  - Escape route mapping



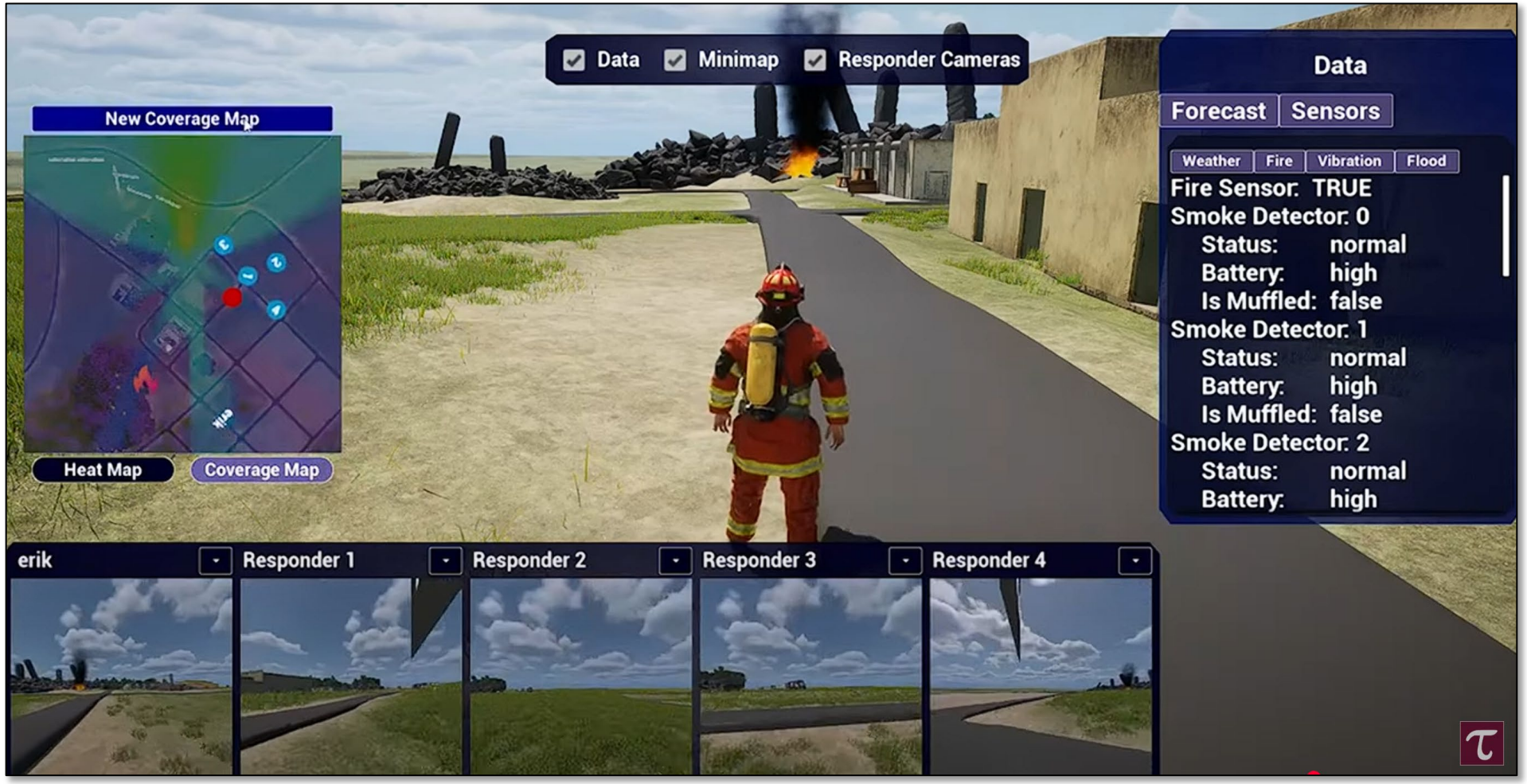
Source: National Institute of Standards and Technology

Wearables and Sensors

- Communications
  - Audio, data, video (body-cam, dash-cam, deployables, …)
  - Location tracking (X,Y,Z coordinates)
  - Telementoring (EMS)
  - AR/VR: search routes, escape routes, team locations, …
- Heath status – Smart PPE
  - First responder: Body temp, heart rate, respiration rate, …
  - EMS: 12 lead electrocardiogram (ECG), blood pressure, pulse ox, …
- External environment
  - Temperature; particulate; chemical, biological, radiological, nuclear (CBRN); shot spotter; …
- Inertial Engines (such as in phones) for navigation and tracking without GPS



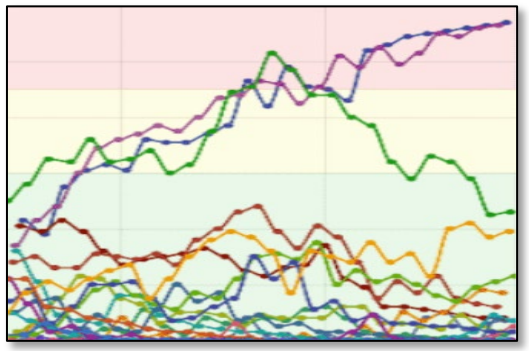
Digital Twin with RF Coverage Mapping



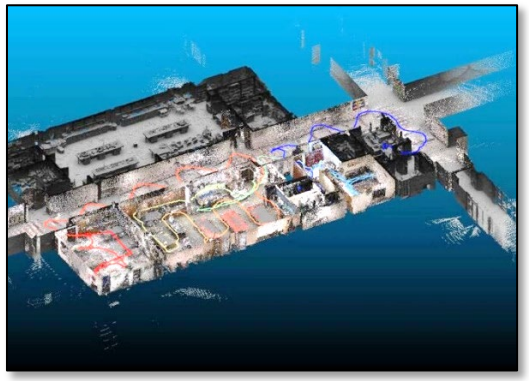
Extended Reality for First Responders

Network

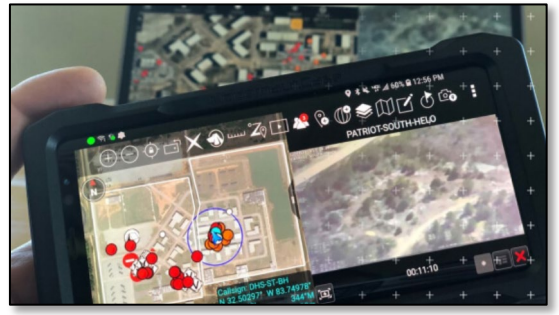
Physical & RF Digital Twin



Sensor Data; Inertial Location



Realtime mapping



Team Situational Awareness

Surveillance Video

Command Center / EOC

IoT / Digital Twin / SA / AI Integration

- Integrated Components:
  - IoT Sensors at Disaster City from NIST AI3 project
  - Digital Twin from NIST Digital Twin project
  - Team Awareness Kit (TAK) from DoD Situational Awareness project
  - AI from DoT project

- Result:
  - Sensor status and exercise personnel movements were displayed as 2D icons in TAK, 3D avatars in digital twin
  - AI monitored sensors, notified first responders of danger, made recommendations for action

Opportunities With 6G

6G Opportunities for Public Safety

- 9-1-1 and Mission Critical Voice, Data, Video, XR
  - Seamless movement between private, public, Sidelink, NTN, non-3GPP, …
  - Predictive channel analytics to proactively switch and avoid disruption
  - Priority, preemption, dynamic spectrum allocation, up/down split
  - Distributed sensing (network and UE) for comprehensive characterization of environment
  - Dynamic channel state info: MCS selection, beam mgmt, mobility mgmt
- Situational Awareness
  - 3D positioning, inertial engines, 1000s of other sensors, surveillance video
  - Distributed cloud (edge & UE) compute for reduced latency and bandwidth
  - Digital twins (physical and RF) to inform first responders and network
  - AI/ML-based fusion of data into situational awareness for first responders & command
- Network Security
  - Zero Trust Architecture and Quantum-safe encryption to mitigate security concerns
  - Federated identity and access management for multi-jurisdiction responses
  - Automated, dynamic response to interference (intentional or unintentional)

THE TEXAS A&M UNIVERSITY SYSTEM

INTERNET2 TECHNOLOGY EVALUATION CENTER

https://itec.tamu.edu

info@itec.tamu.edu