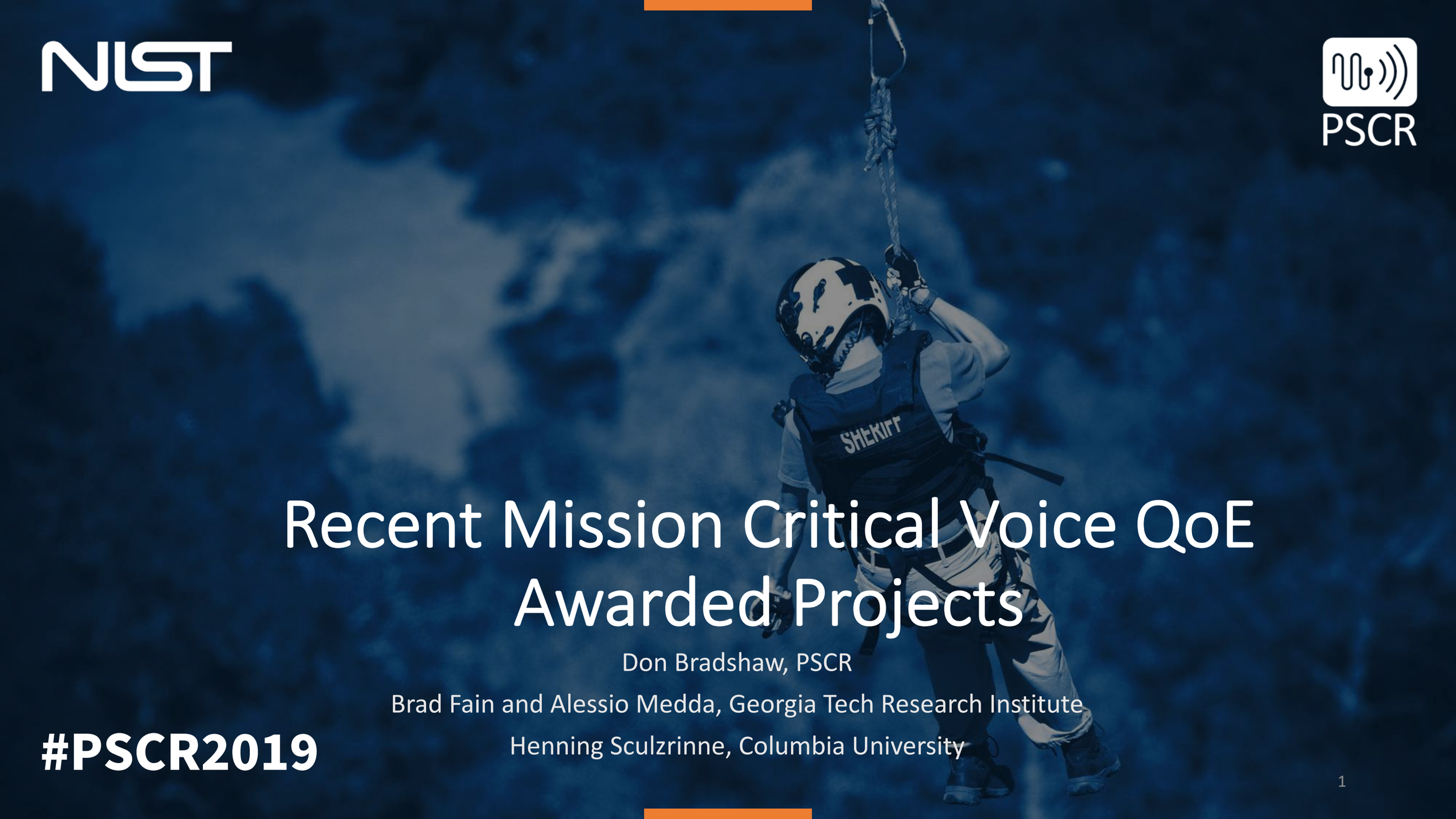


Recent Mission Critical Voice QoE Awarded Projects

Don Bradshaw, PSCR

Brad Fain and Alessio Medda, Georgia Tech Research Institute

Henning Sculzrinne, Columbia University

#PSCR2019

DISCLAIMER

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately.

Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

***Please note, unless mentioned in reference to a NIST Publication, all information and data presented is preliminary/in-progress and subject to change**

Summary

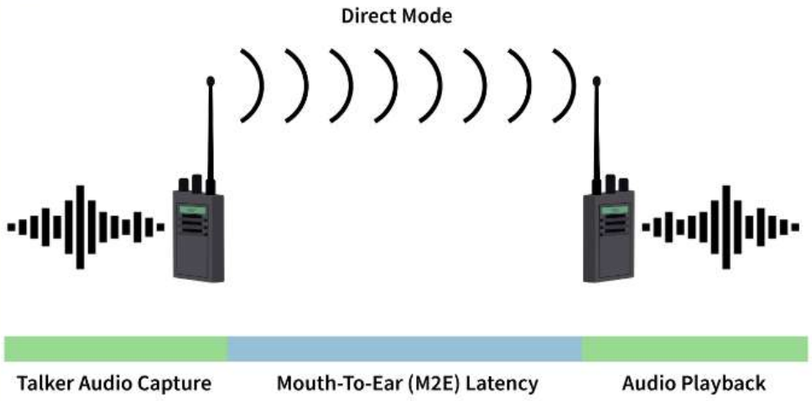
- Mission Critical Voice (MCV) Quality of Experience (QoE) Background
- PSCR's MCV QoE Measurement Development
- What Are Good Numbers?
- Federal Funding Opportunity Goals
- Georgia Tech Research Institute
- Columbia University

QoE KPIs for MCV - MCV Roundtable 2017

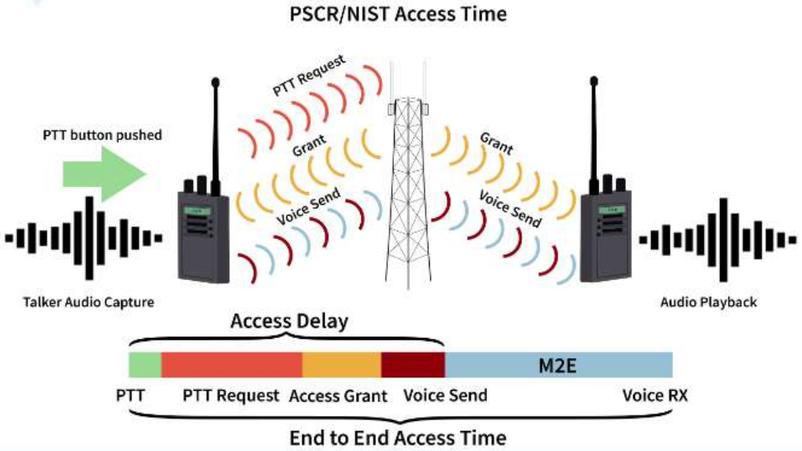
- Mouth-to-Ear (M2E) Latency
  - Time it Takes Audio to Get from Transmitting User to Receiving User
- End-to-End Access Time
  - Time Between Button Press and Receiving User Hearing Voice
  - M2E Latency + Access Delay
- Audio Quality/Intelligibility
  - Public Safety Cares Most About Intelligibility
- Access/Retention Probability
  - Ability to Establish Call
  - Ability to Retain Call

QoE KPIs for MCV

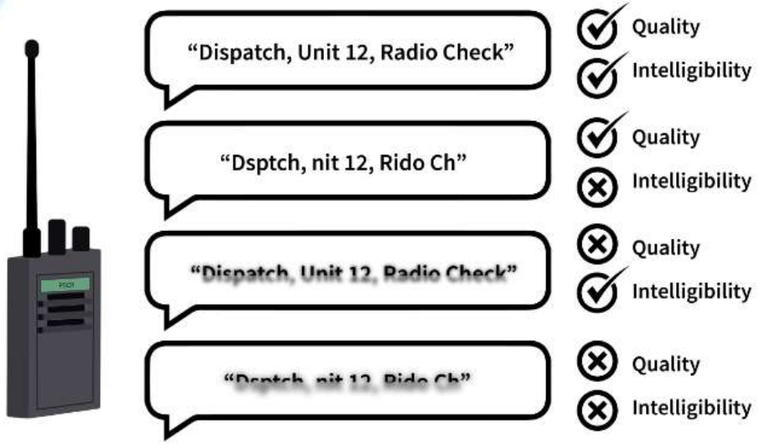
MOUTH TO EAR LATENCY



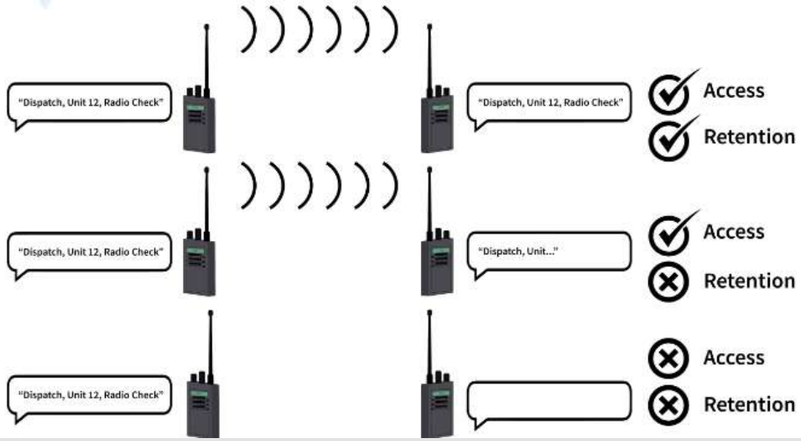
END TO END ACCESS TIME



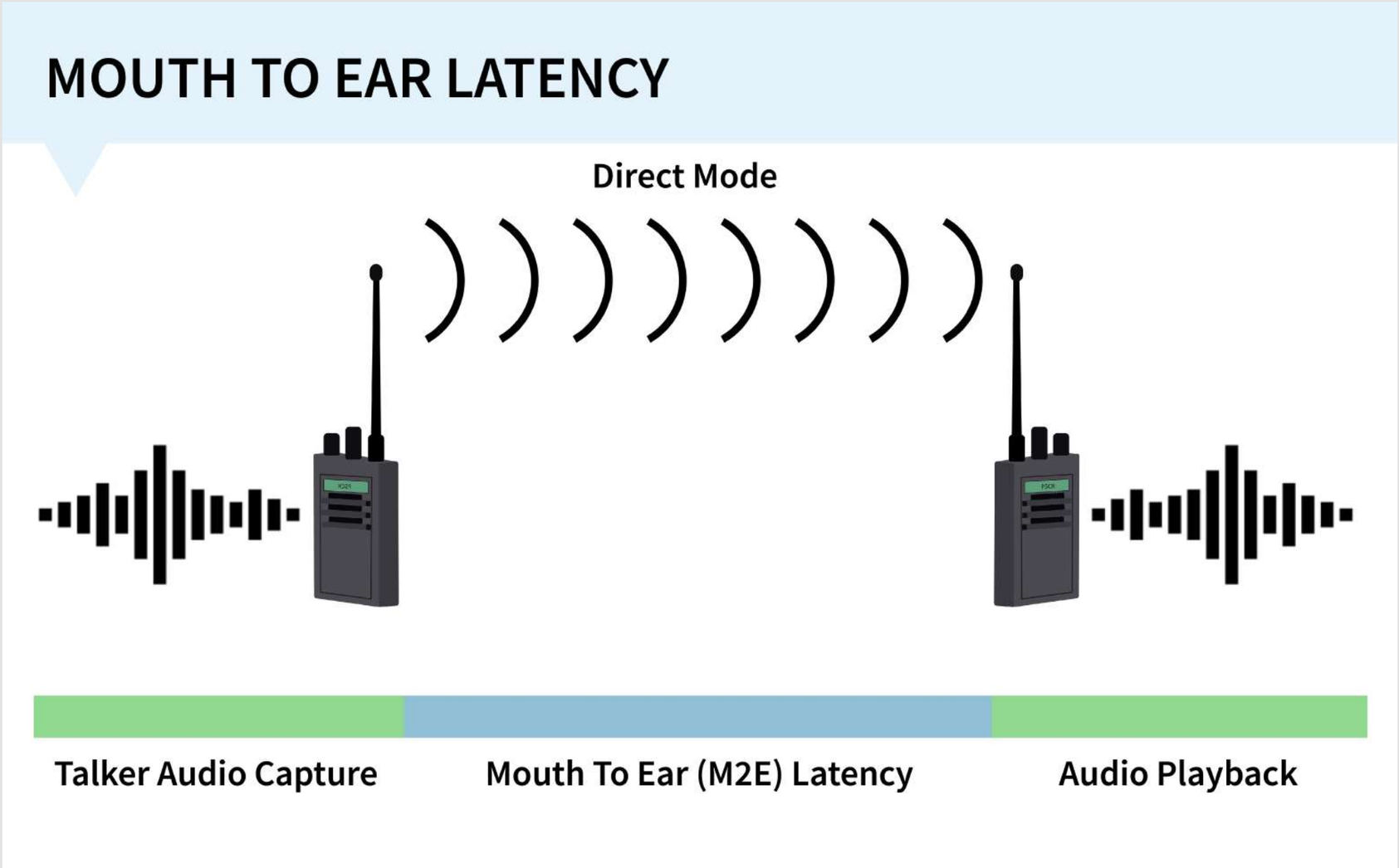
VOICE QUALITY & INTELLIGIBILITY



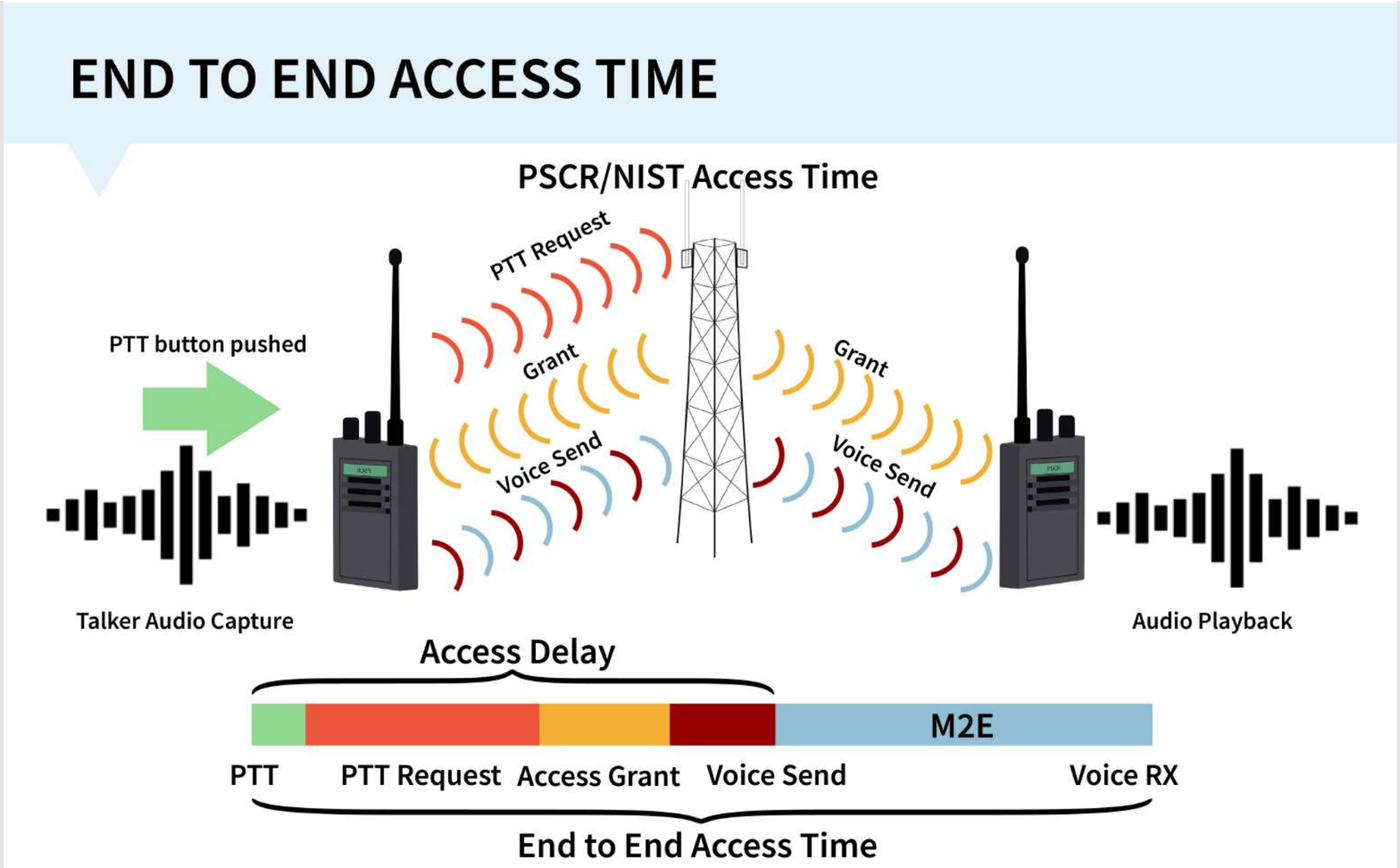
PROBABILITY OF ACCESS & RETENTION



QoE KPIs for MCV



QoE KPIs for MCV



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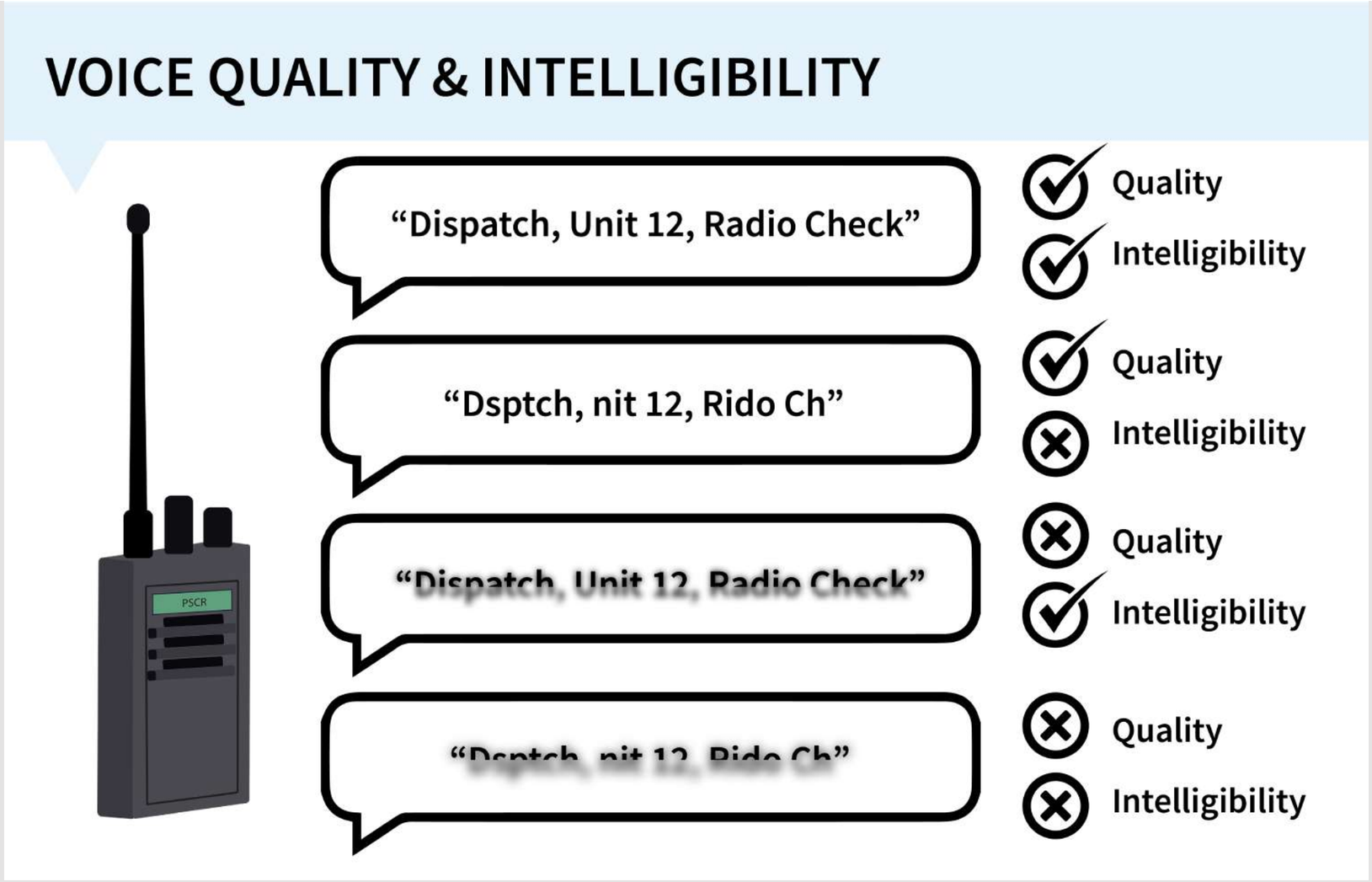
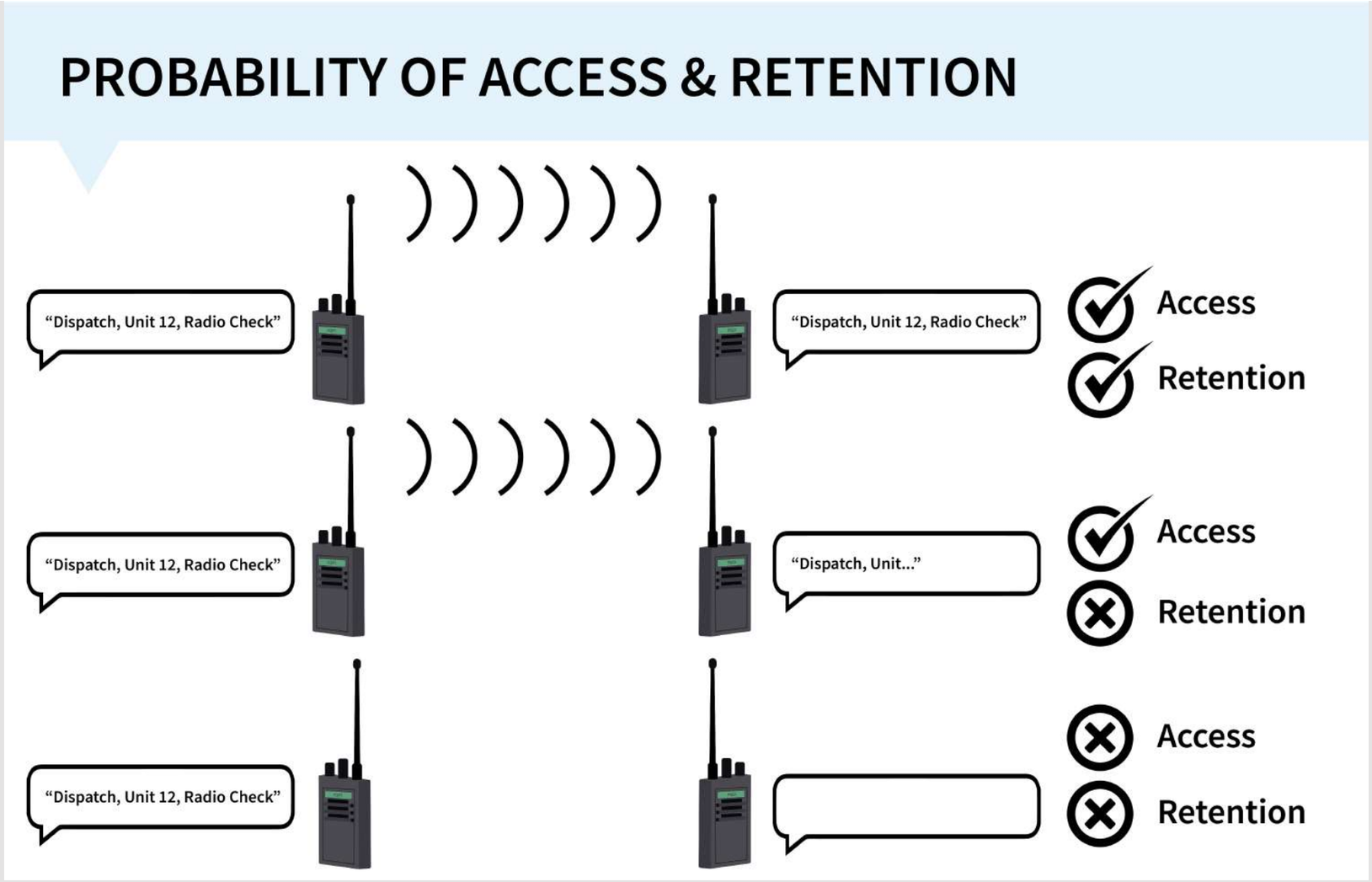
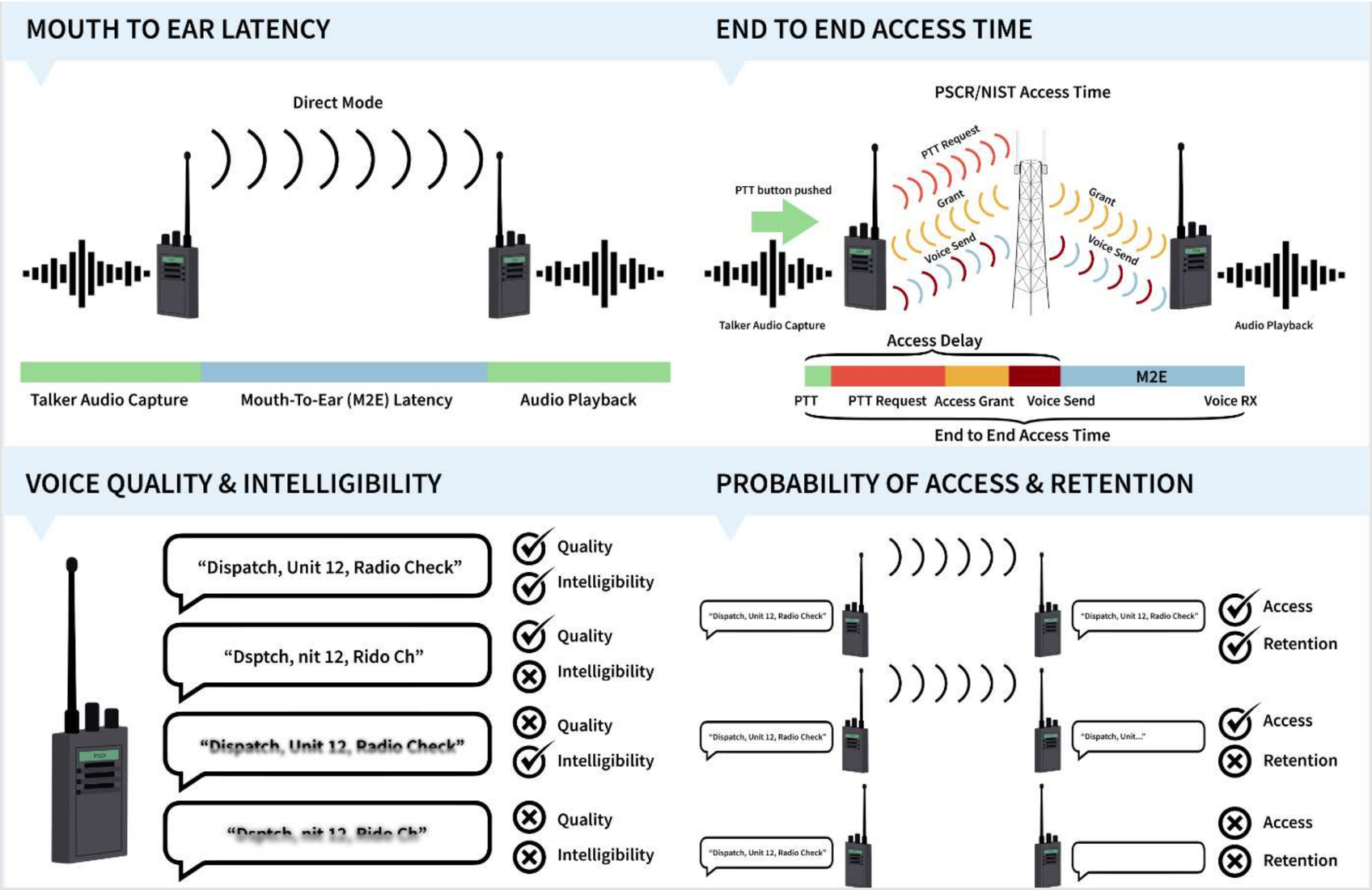


QoE KPIs for MCV



What Are Good Numbers?



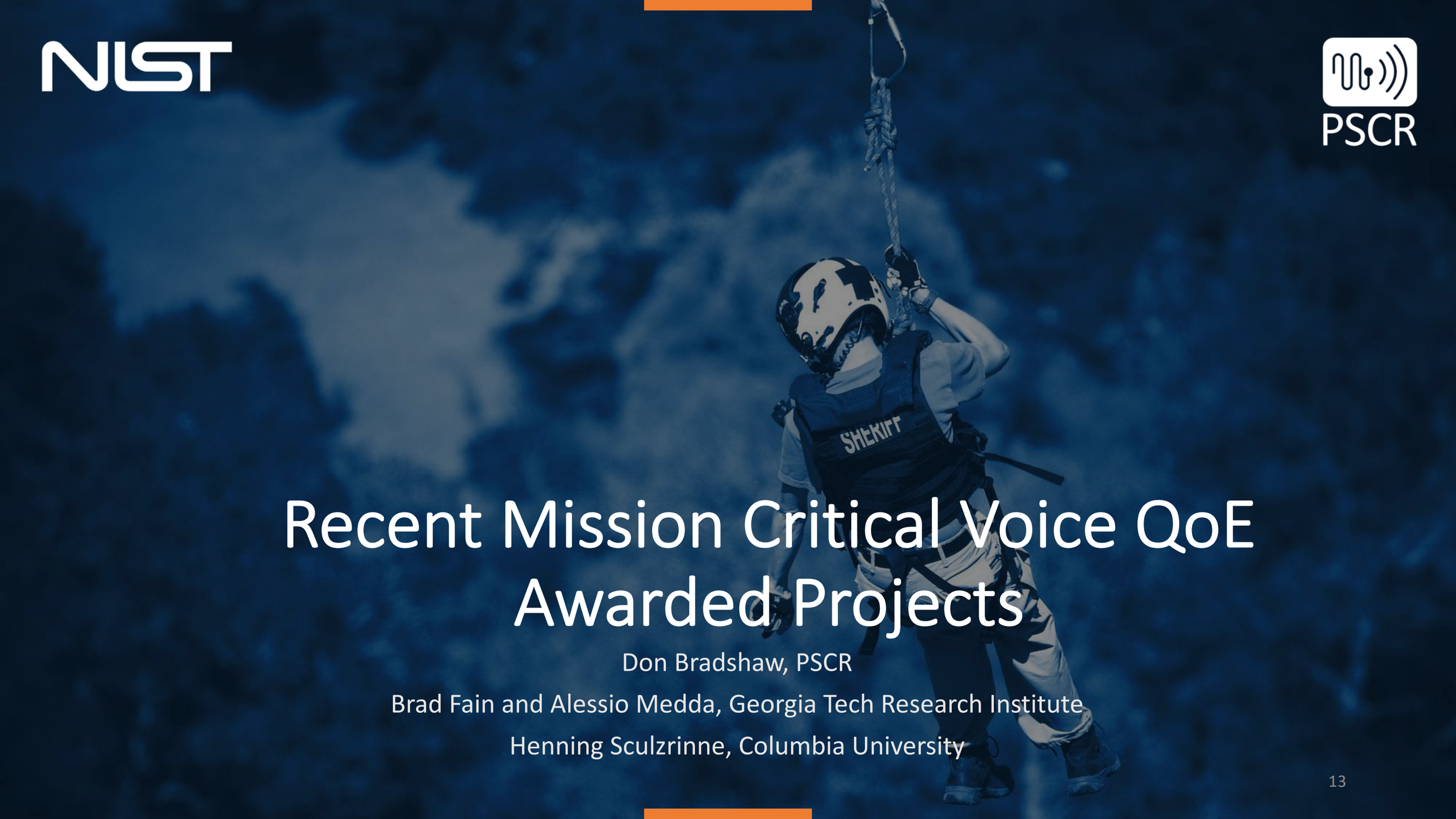
End-to-end Access Time Results for 85% Intelligibility

PTT Technology*	M2E Latency (ms)	Access Delay (ms)	End-to-End Access Time (ms)
Analog Direct	76.5 ± 0.3	136.5 ± 3.3	213.1 ± 3.3
Analog Conventional	78.5 ± 0.3	286.1 ± 2.5	364.7 ± 2.5
P25 Direct	220.9 ± 0.3	71.6 ± 4.1	292.4 ± 4.1
P25 Trunked (Phase 1 – FDMA)	356.6 ± 3.8	640.1 ± 5.1	996.7 ± 6.3
P25 Trunked (Phase 2 – TDMA)	575.9 ± 8.1	692.2 ± 7.1	1268.1 ± 10.7

*Analog Conventional operates in VHF band.
All P25 technologies operating in 700 MHz band.

Federal Funding Opportunity Goals

- LMR Simulation Tools
  - Equipment Like What First Responders Use
  - Measured Same as PSCR MCV QoE Measurements
- Development of Test Facilities, Scenarios and Protocols
  - Mimic Real-Life Operational Environments
- Development of Public Safety Testing Cadre
- Test and Measurement of Public Safety User Performance
- Analysis and Modeling of Public Safety User QoE



Recent Mission Critical Voice QoE Awarded Projects

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ARTEMIS

QUARC

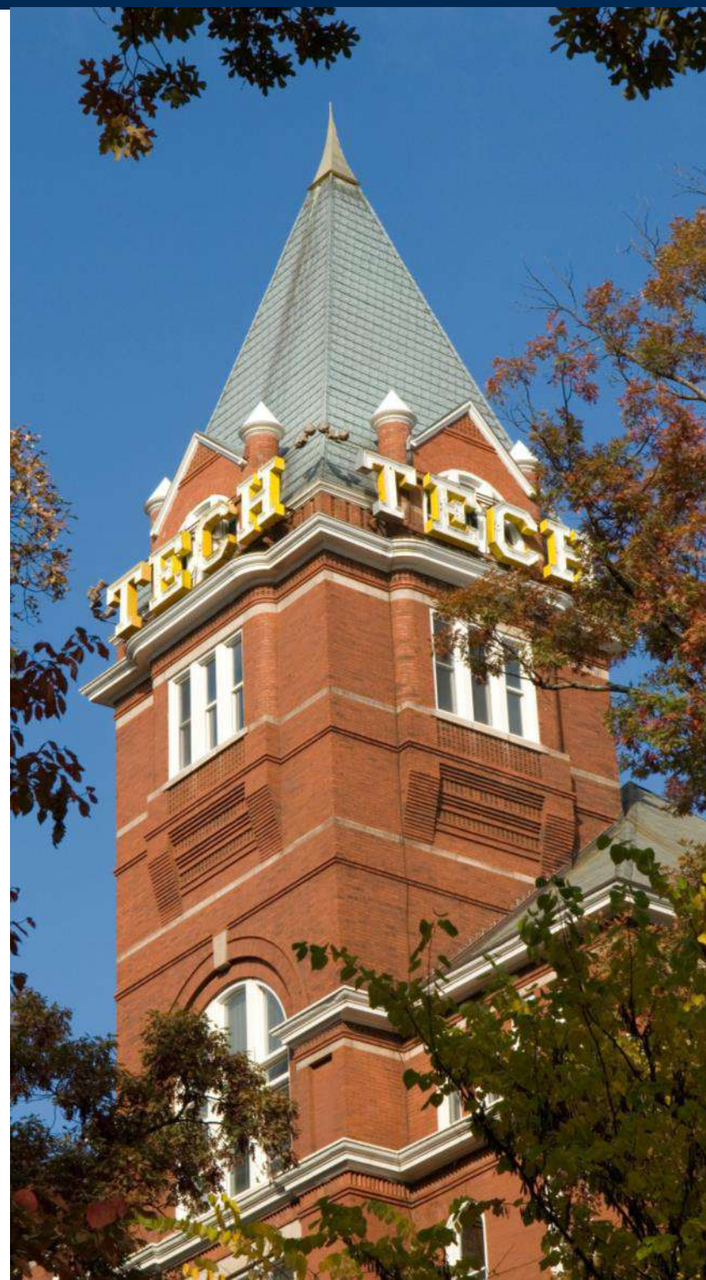
QUALITY UNDER ADJUSTABLE REALISTIC CONDITIONS

Project Overview

Brad Fain and Alessio Medda

July 8-12, 2019

PSCR Stakeholder Meeting, Chicago, IL

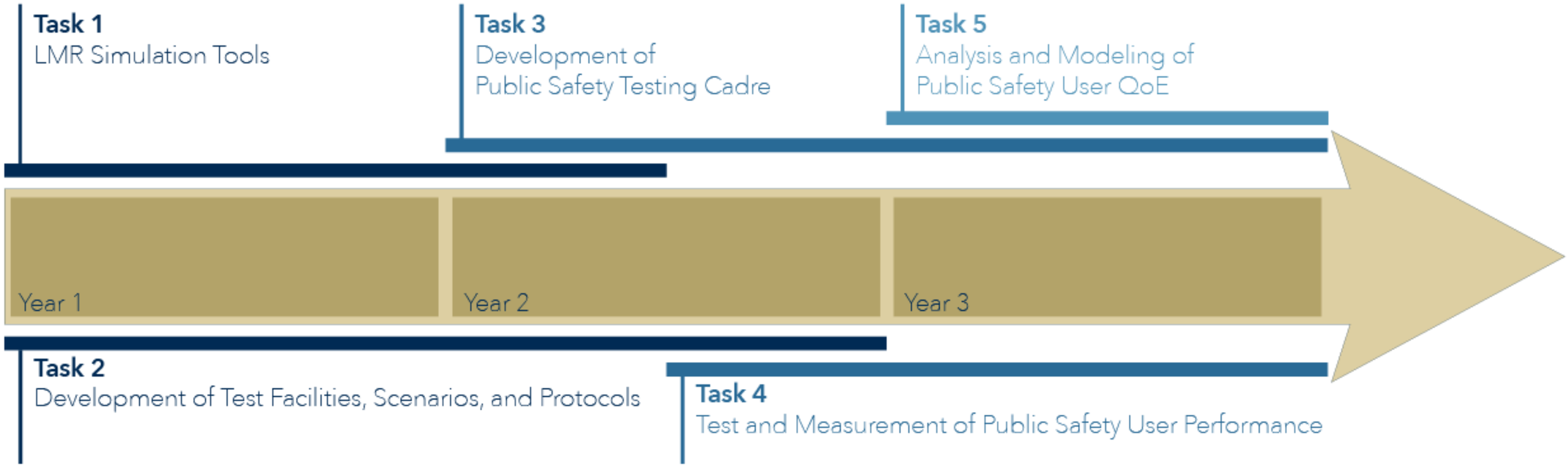


QUARC (Quality Under Adjustable Realistic Conditions)

To develop a framework for the evaluation of mission critical voice (MCV) quality of experience (QoE) for first responders operating in real field scenarios

- ❑ **GOAL 1** - Simulated Land Mobile Radio (LMR) Equipment Development
- ❑ **GOAL 2** - Development of Test Facilities, Test Scenarios, and Test Protocols for MCV QoE Tests
- ❑ **GOAL 3** - Development of Public Safety Testing Cadre
- ❑ **GOAL 4** - Test and Measurement of Public Safety Users' Performance
- ❑ **GOAL 5** - Analysis and Modeling of Public Safety User QoE

Project Schedule

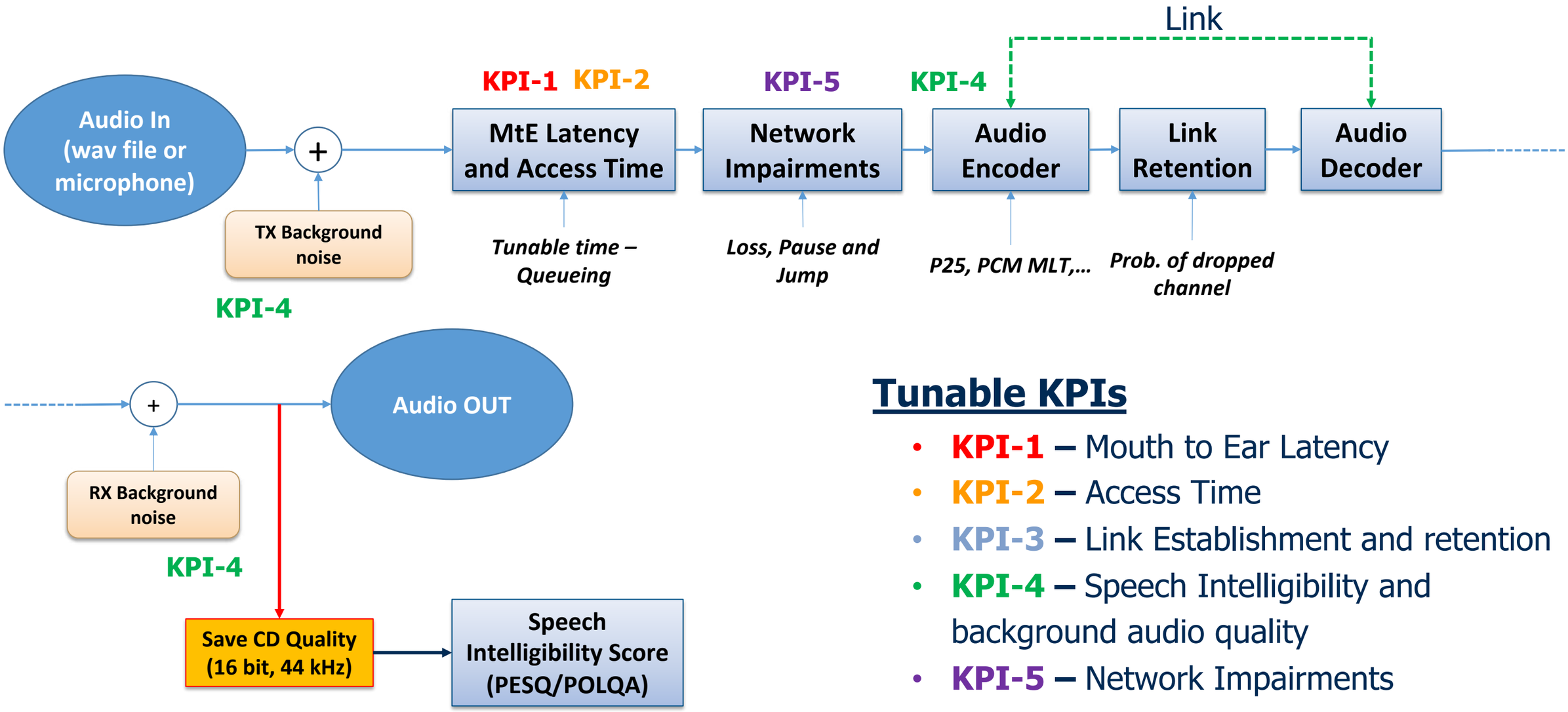


ARTEMIS

QUARC

Development Timeline

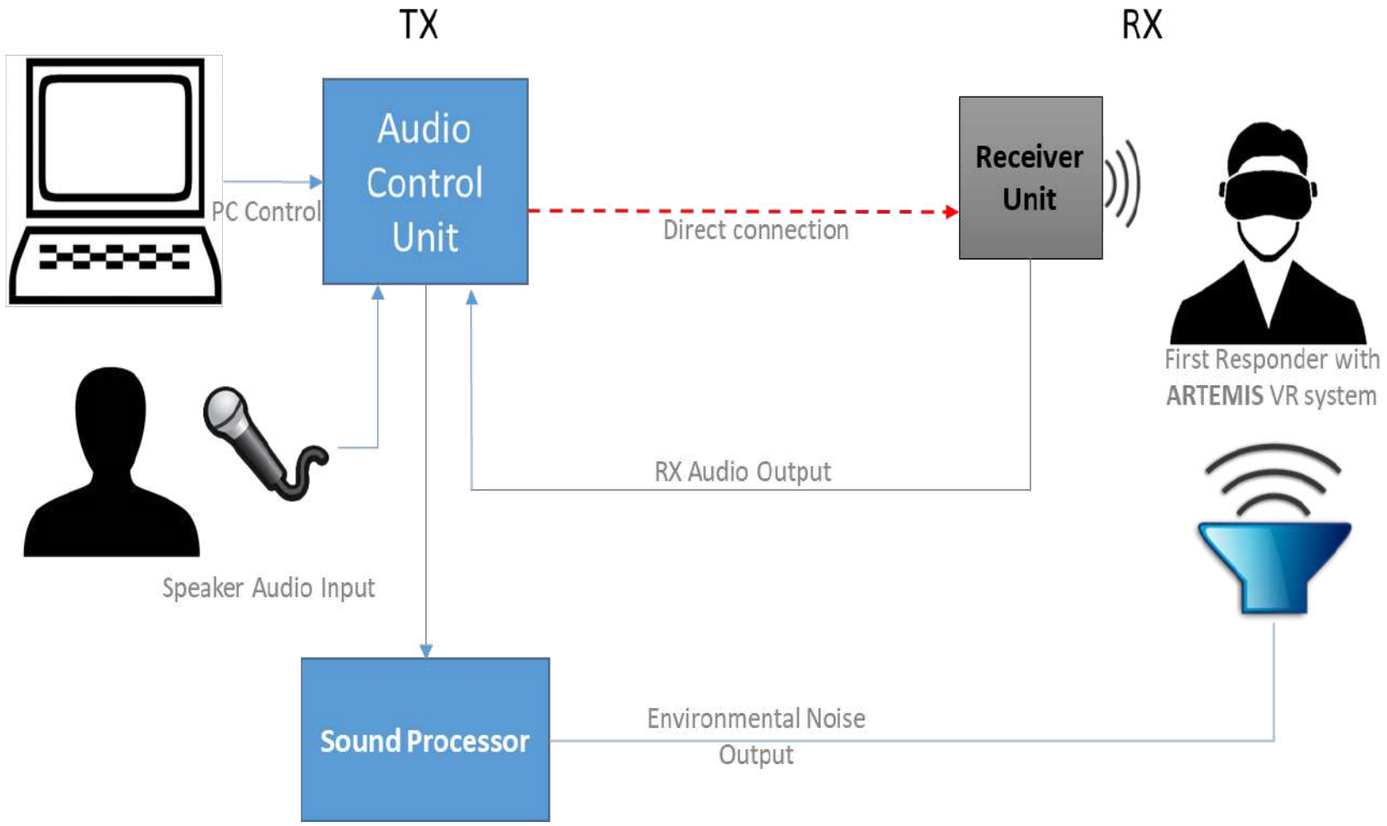
Tunable KPIs Implementation



Tunable KPIs

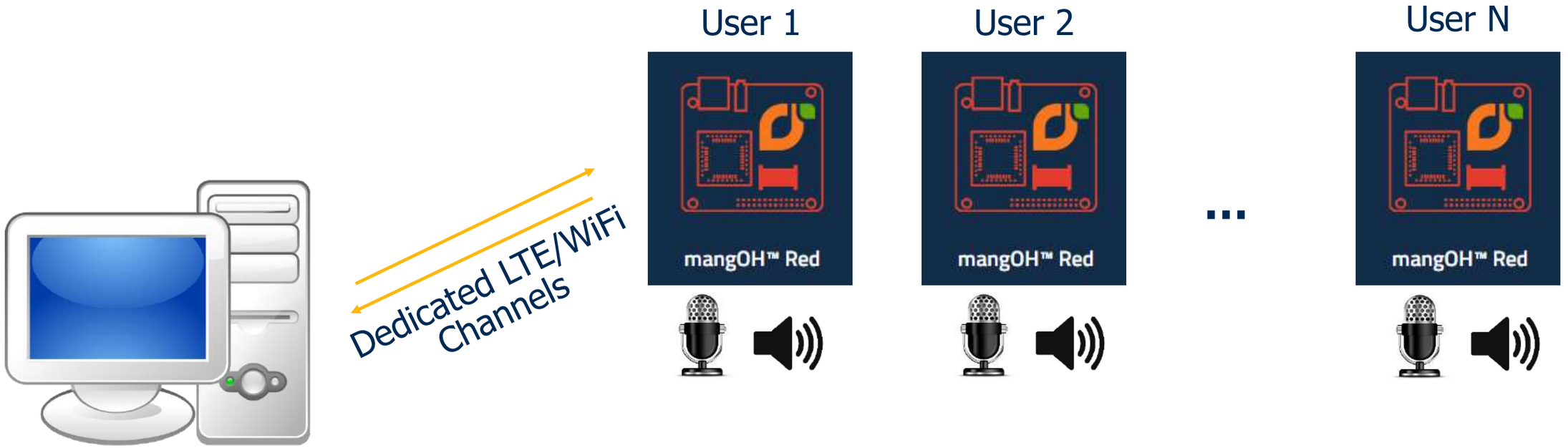
- **KPI-1** – Mouth to Ear Latency
- **KPI-2** – Access Time
- **KPI-3** – Link Establishment and retention
- **KPI-4** – Speech Intelligibility and background audio quality
- **KPI-5** – Network Impairments

Architecture for Laboratory Testing



- Possibility to test in VR environment or in normal conditions
- VR background noise guaranteed by 3D sound controlled over UNITY and reproduced using high quality flat response headsets
- Normal conditions uses a Dolby Atmos 5.1.2 system for reproducing background noise in 3D
- Units at the receiver end will be implemented by a push-to-talk speaker/microphone
- Possibility to input live voice (speaker) or to chose a pre-recorded utterance

Architecture for Field Testing



Centralized Node Controls all communications and KPIs

- Architecture based on Mangoh Development Kit
- Allows scalability with small footprint
- Integrated LTE, WiFi, BTLE

Testing Facility – The Guardian Center in Perry, GA

Thank you!

Brad Fain brad.fain@cacp.gatech.edu

Alessio Medda alessio.medda@gtri.gatech.edu

Experimentally-Driven Mapping of QoS-to-QoE for Mission-Critical Voice

Henning Schulzrinne (PI), Dan Rubenstein

CS@CU Computer Science

Columbia University in the City of New York

Charles Jennings, Norm Groner

RACERS
The Christian Regenhard Center for Emergency Response Studies

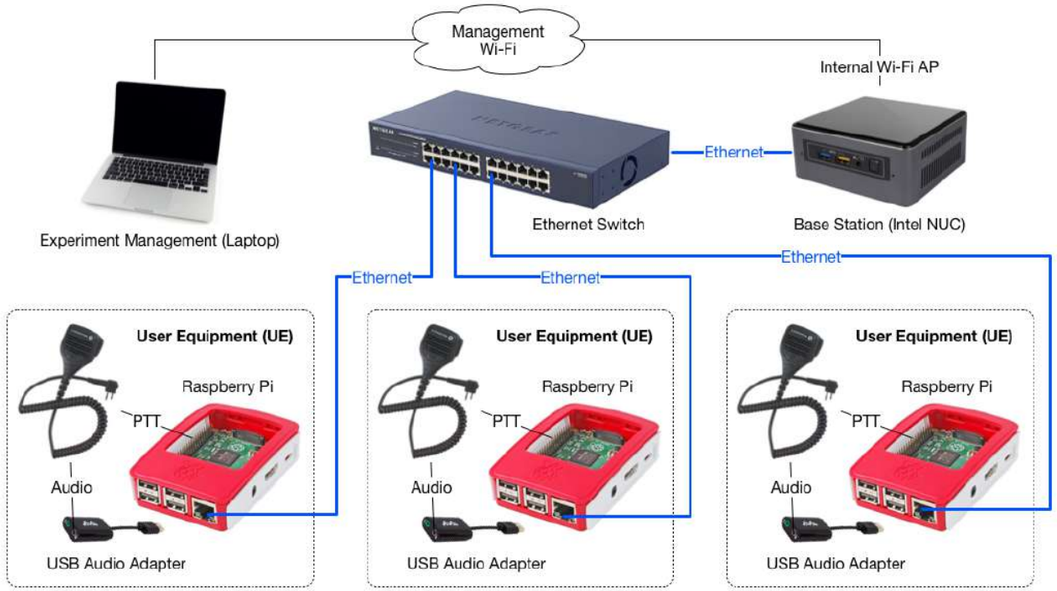
John Jay College of Criminal Justice

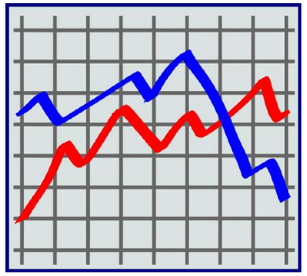
v1.3

Project objectives

- How does the quality of the communication channel affect first responder communications?

- Four phase approach:
  - Build communication testbed with tunable parameters that emulates realistic (poor) LMR communication channel conditions
  - Experiment using trained first responders to communicate across communication infrastructure
  - Measure communication performance (delay, accuracy)
  - Build mathematical models: channel conditions → performance measures



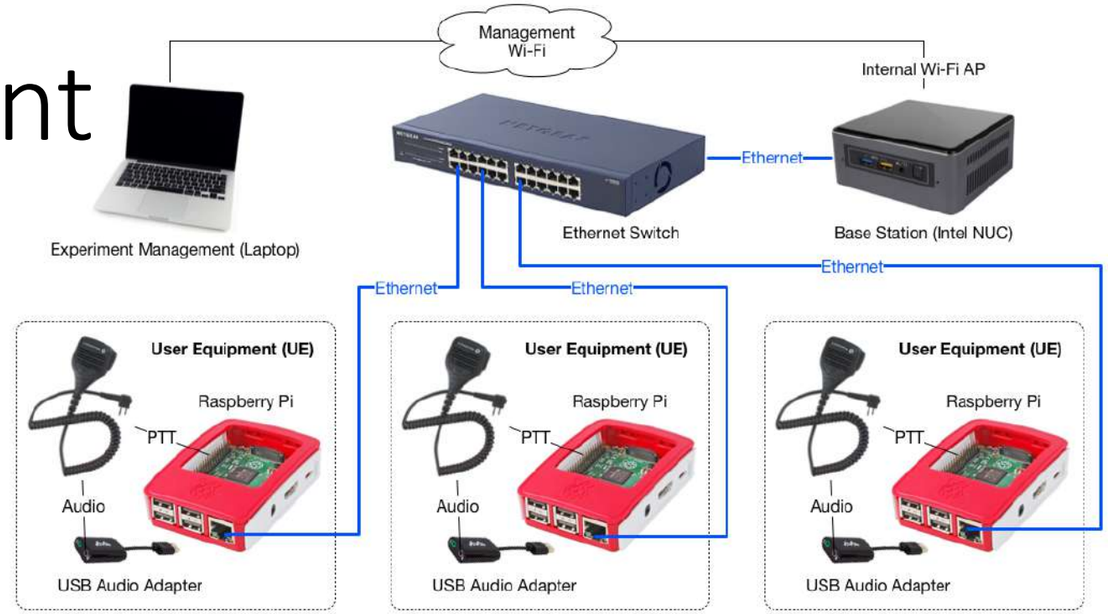


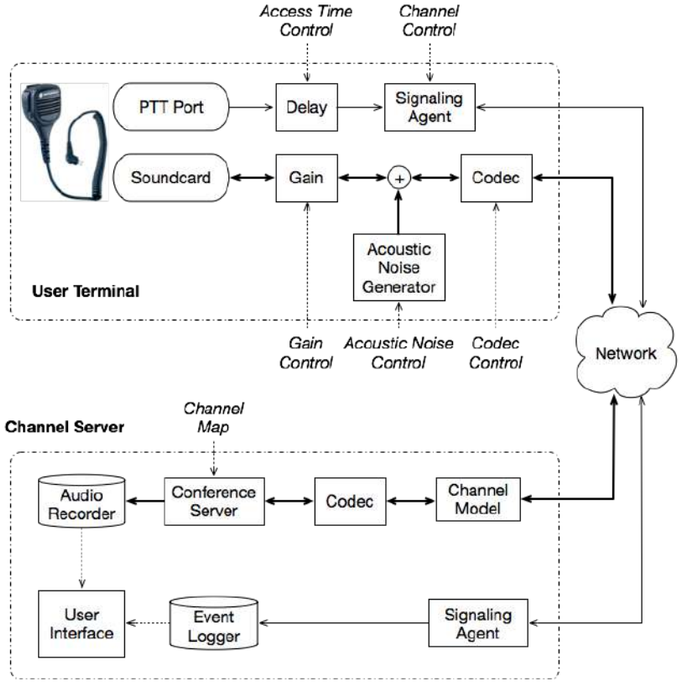
QoE measures

- Comprehension errors
  - e.g., repeat transmitted messages
- Task errors
  - e.g., wrong information recorded
- Usage errors
  - e.g., pressing talk to speak button too early or too late
- Length and latency of responses
  - e.g., pauses between requests and start of transmission
- Subjective ratings of user experience
  - e.g., rated frustration with ratios

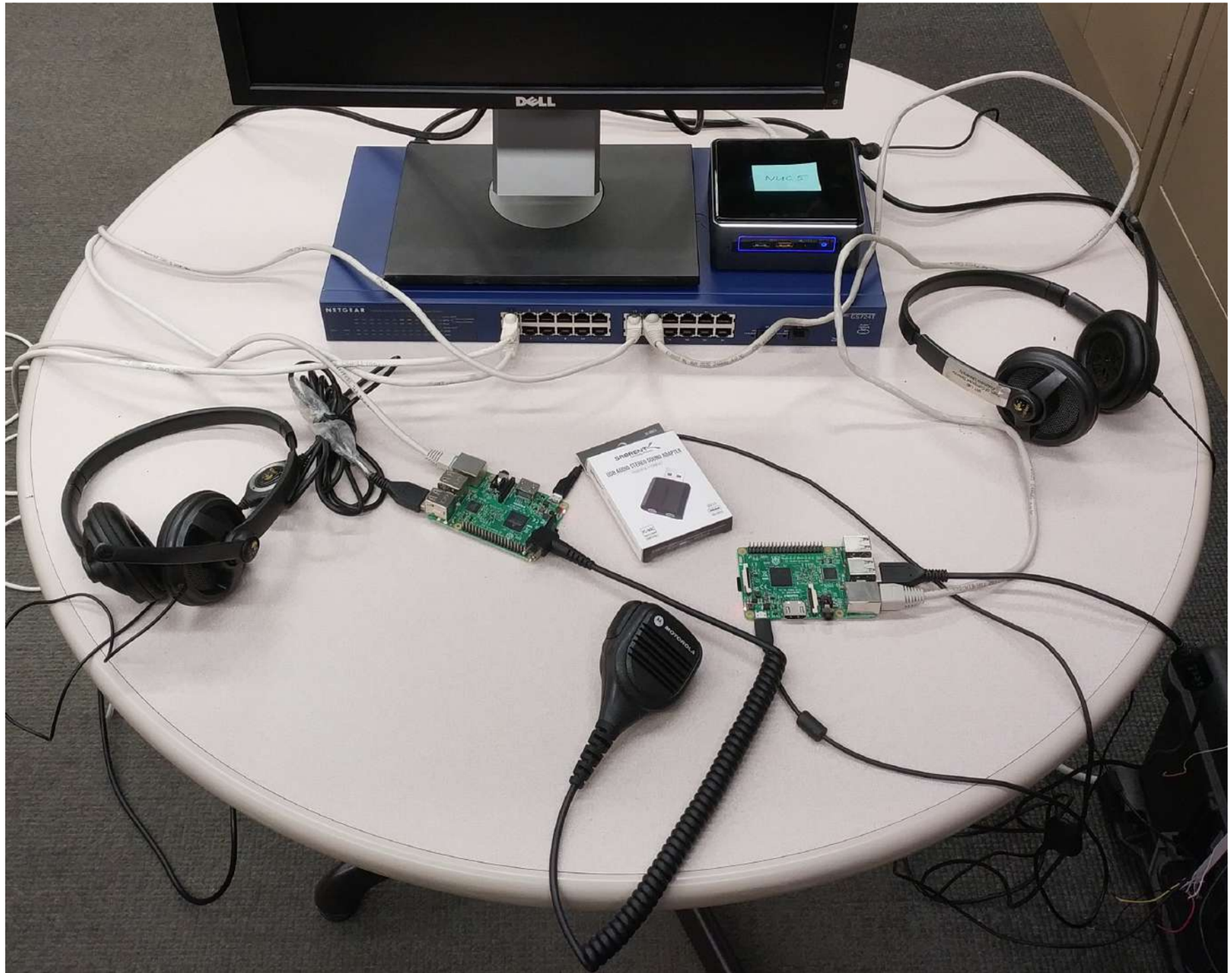
Year 1: Testbed development

- Intel NUC will manage all services
- End-user communication gear connected to Android or RPi Devices
- Centralized control to adjust communication quality parameters
  - mouth-to-ear and PTT delay
  - noise level
  - packet loss (outage bursts)

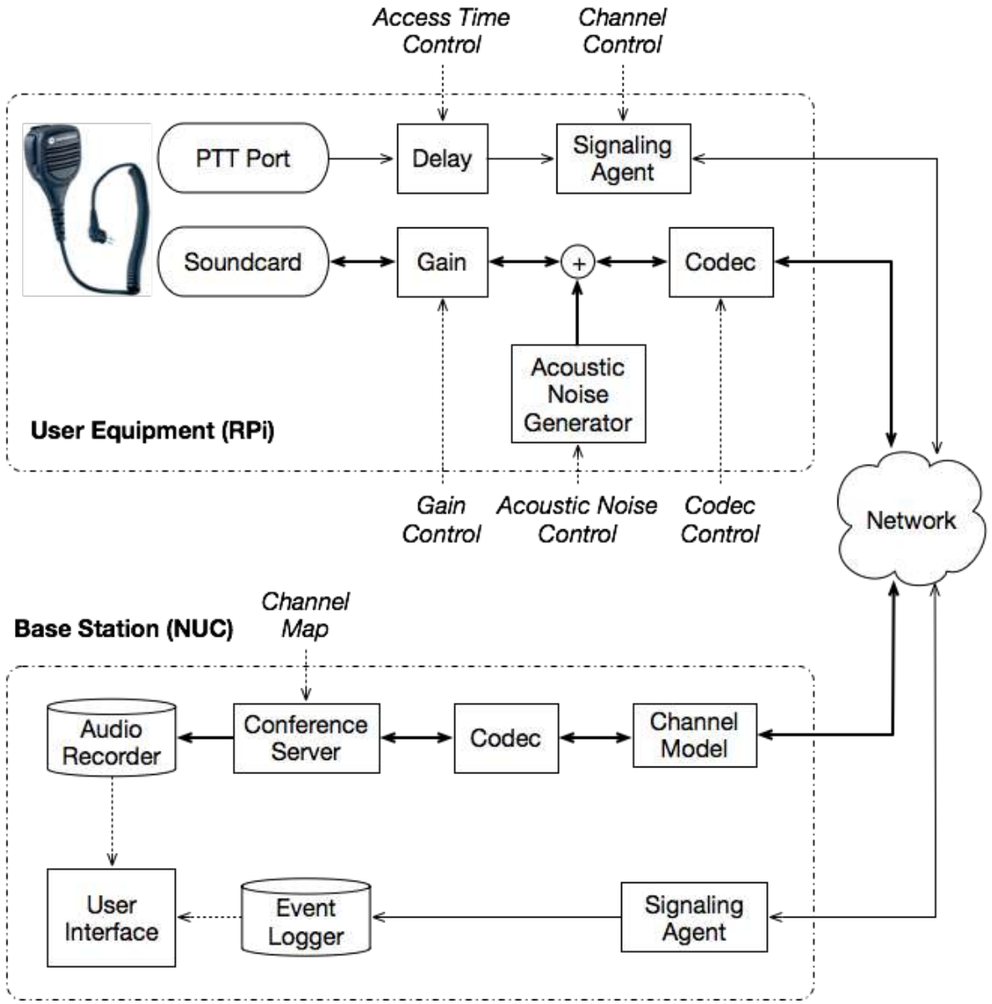


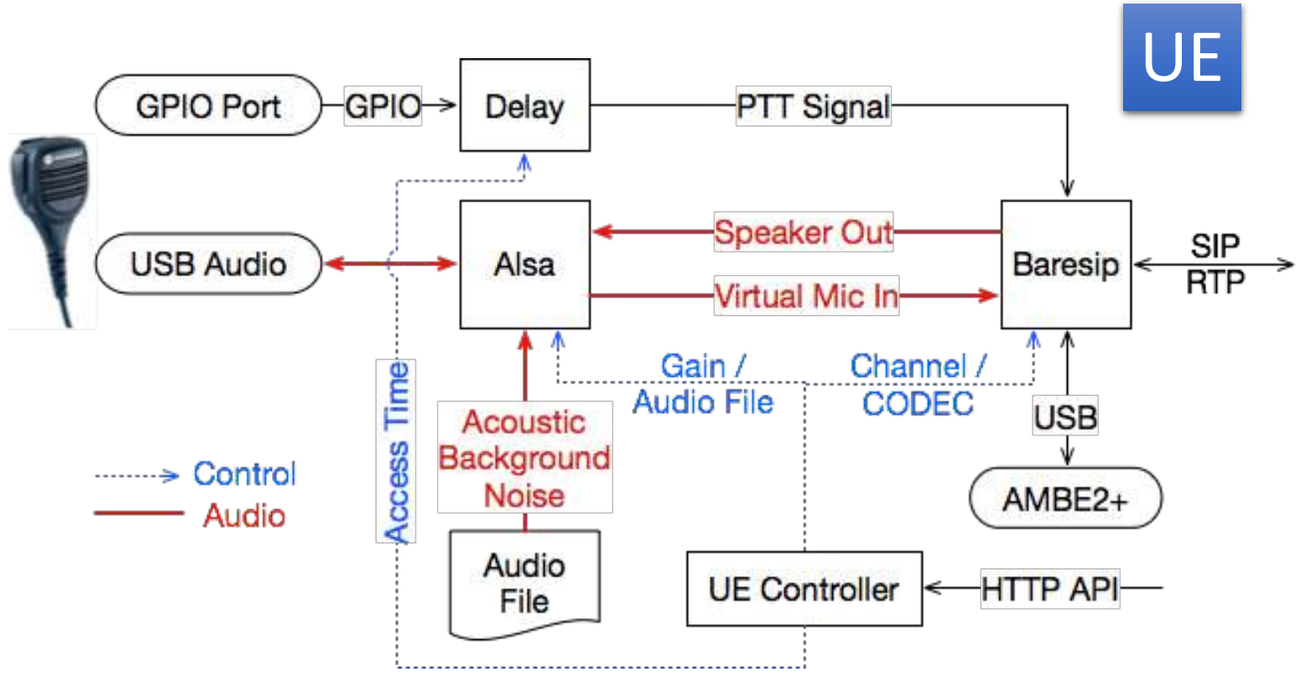


First (early) prototype



More detailed system architecture



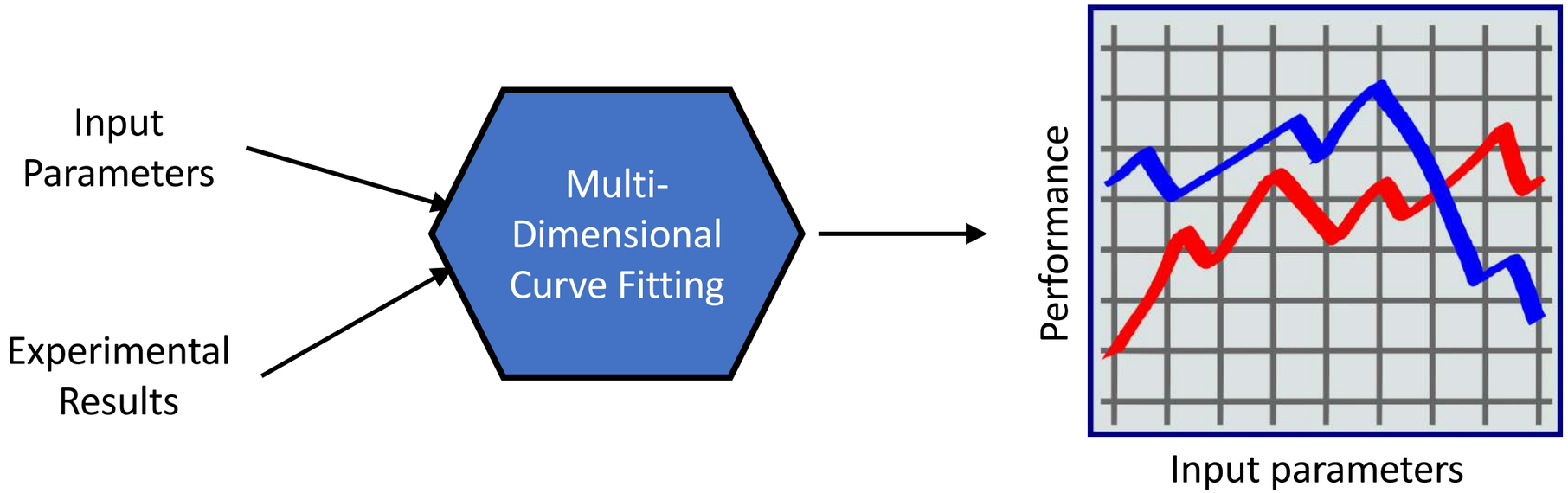


Year 2: Testing

- Generate scenarios that first responders will describe
- First responder officer volunteers will help design appropriate scenarios
- First responders “in-the-field” will test in the scenario (in a lab)
- QoE: measure communication time and accuracy

Year 3: Modeling

- Produce mappings from input parameters (delay, noise, loss) to output parameters (communication time and accuracy)



Accomplishments to date

- Testing platform development
  - Initial design of network-based general voice quality platform
    - portable, replicable, building on standard software
  - Demo: initial prototype using Raspberry Pi (Linux) + VoIP clients
- Engagement with local first responder organizations
  - Actively engaged with Columbia University's Office of Public Safety
    - James McShane, VP Public Safety
    - Jeannine Jennette, Executive Director, Public Safety
  - Empress EMS (major private EMS provider)
  - Teaneck, NJ fire department
  - *your name here* - inviting additional scenario input & test participants

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Come back for the

Next

BACK AT

Session

1:50 PM