

Network Simulator for Public Safety Communications

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Motivations

**Modeling Public
Safety Scenarios**

**Case Study: High school
shooting incident**



Advancing Public Safety Communications R&D



Develop widely accessible tools



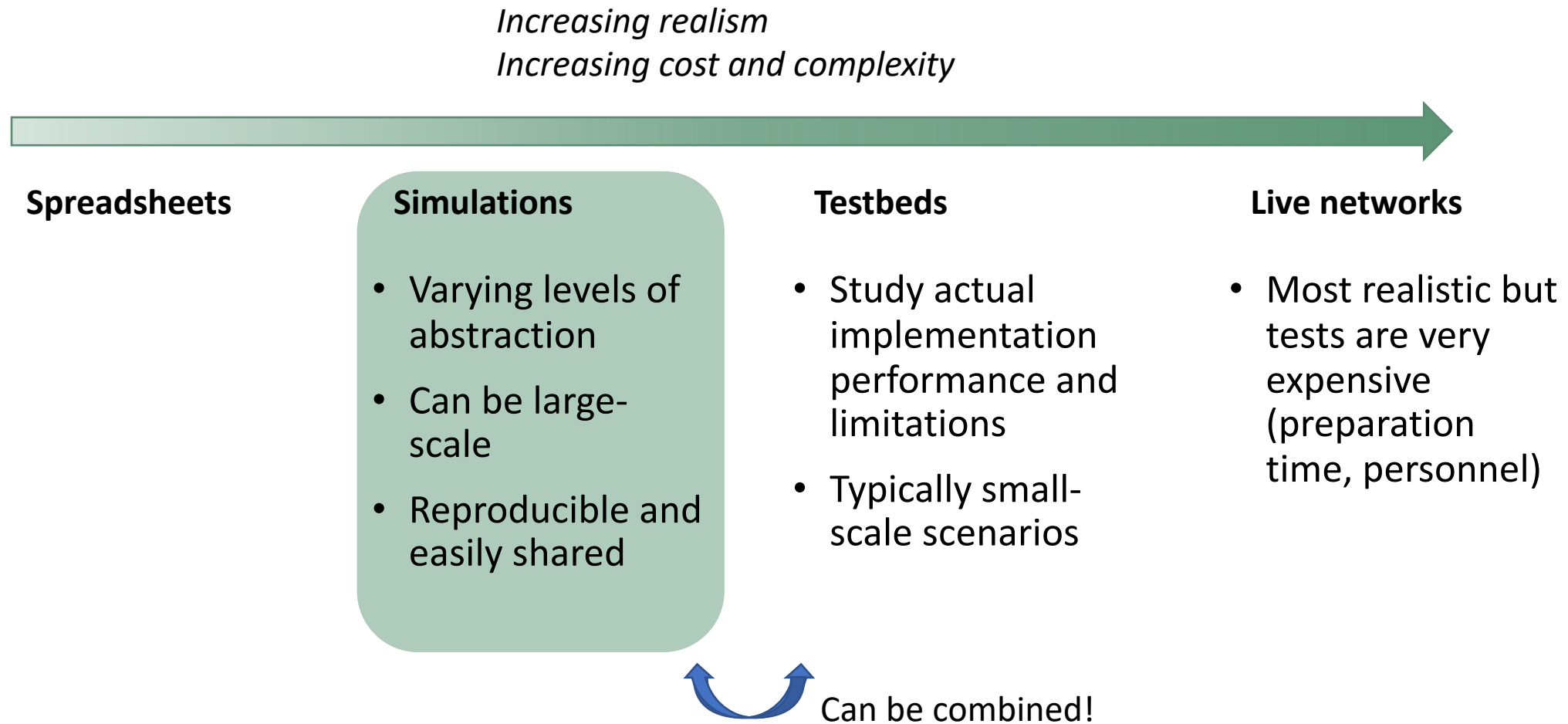
Leverage existing open-source projects



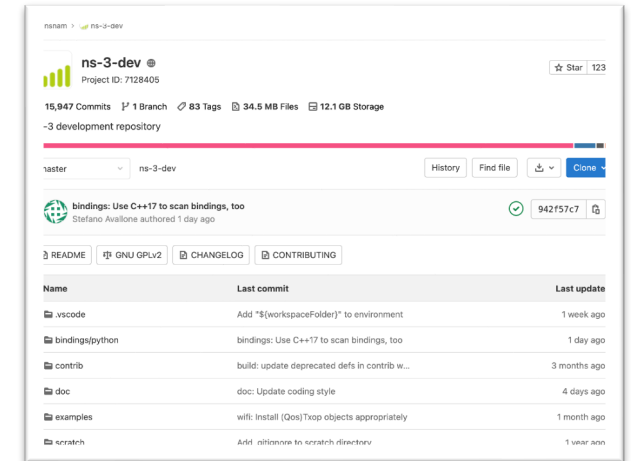
Leverage collaboration with other researchers

The Role of Simulations

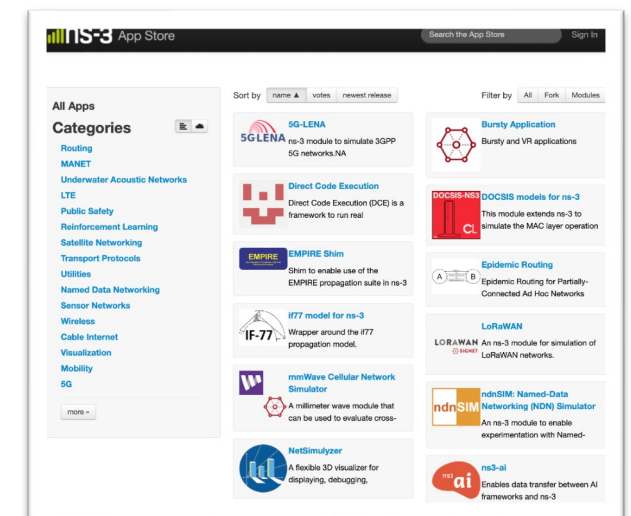
First-order assessment of throughput, capacity, performance, etc.



- Open-source
- Active community modeling Fourth Generation (4G) and Fifth Generation (5G) technologies
 - 3GPP Long Term Evolution (LTE) and New Radio (NR)
 - Extensive Wi-Fi module
 - Millimeter Wave (mmWave) communication
 - Internet and transport protocols
 - Vehicle to Everything (V2X) communication
 - Machine Learning / Artificial Intelligence
- Support various modes of operation
 - Run entire process as a simulation
 - Run in real-time mode, with possible interaction with internal Linux containers or with external testbed equipment



<https://gitlab.com/nsnam/ns-3-dev>



<https://apps.nsnam.org>

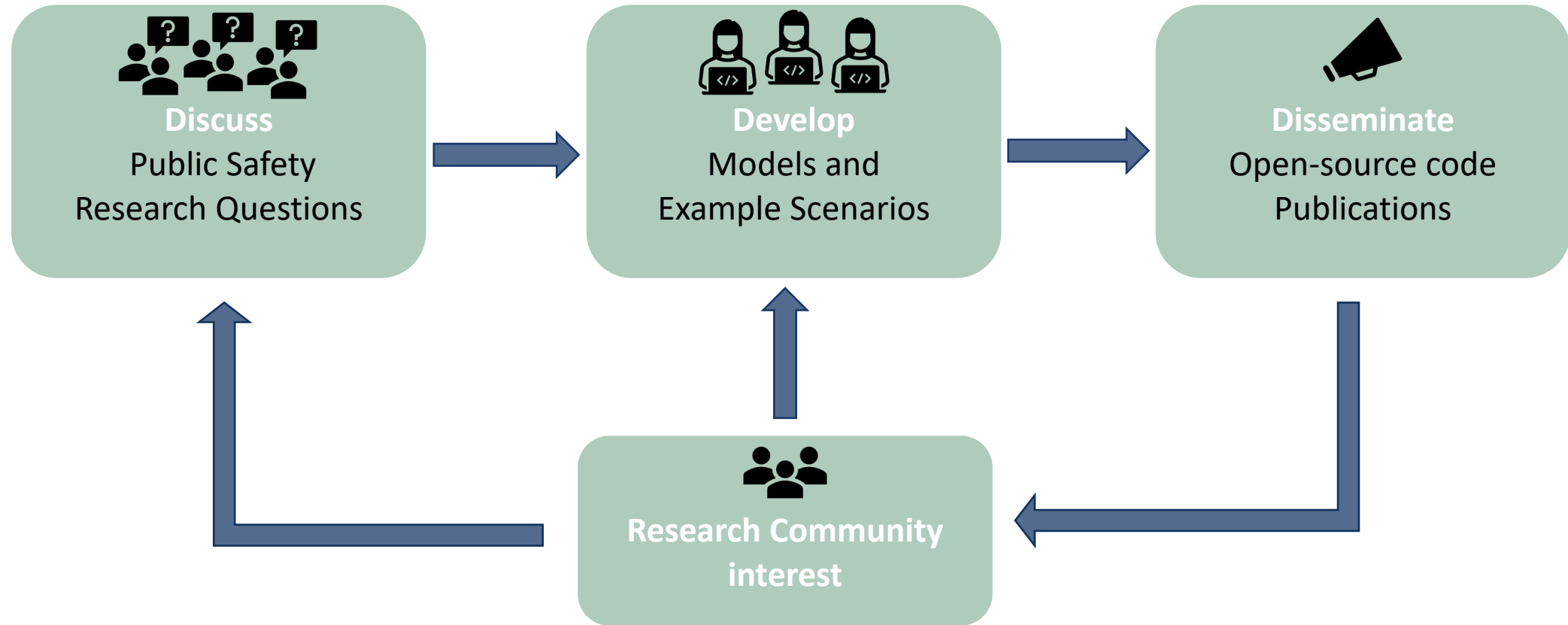


Discuss
Public Safety
Research Questions

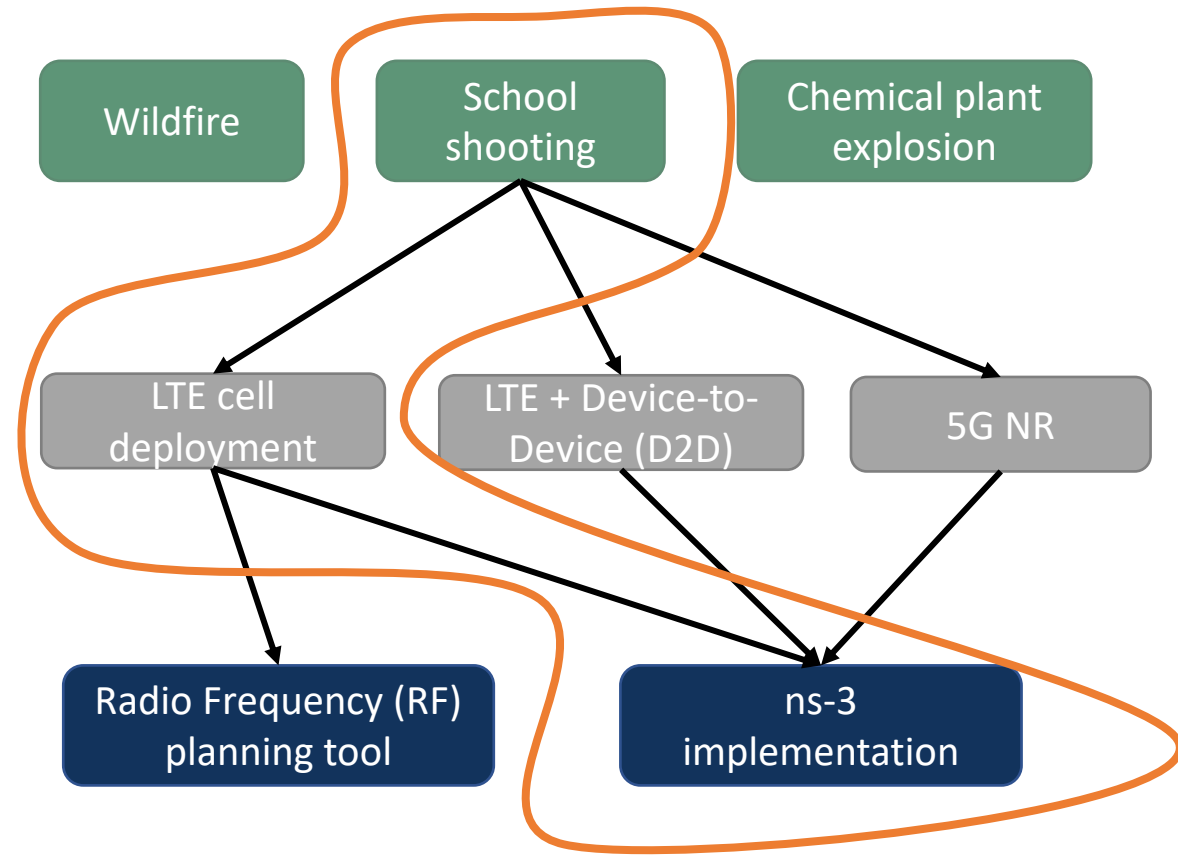
Examples:

- How does Mission Critical Push-to-Talk (MCPTT)-enabled core network performance differ from 'over-the-top' MCPTT deployment?
- How do network capacity requirements change as a scenario evolves?
- How to design a resource scheduler for a User Equipment (UE)-to-network relay?
- What are the performance expectations of 5G NR sidelink?

Technical Approach



Modeling Public Safety Scenarios



New or Improved Models



Applications

MCPTT (on* and off network)
Video streaming
HyperText Transfer Protocol
(HTTP)
Session Initiation Protocol (SIP)*
Generic client/server model



Technologies

LTE Proximity Services (ProSe)*
LTE UE-to-Network Relay
Wireless Backhaul*
Drone energy model
NR V2X*
NR Prose



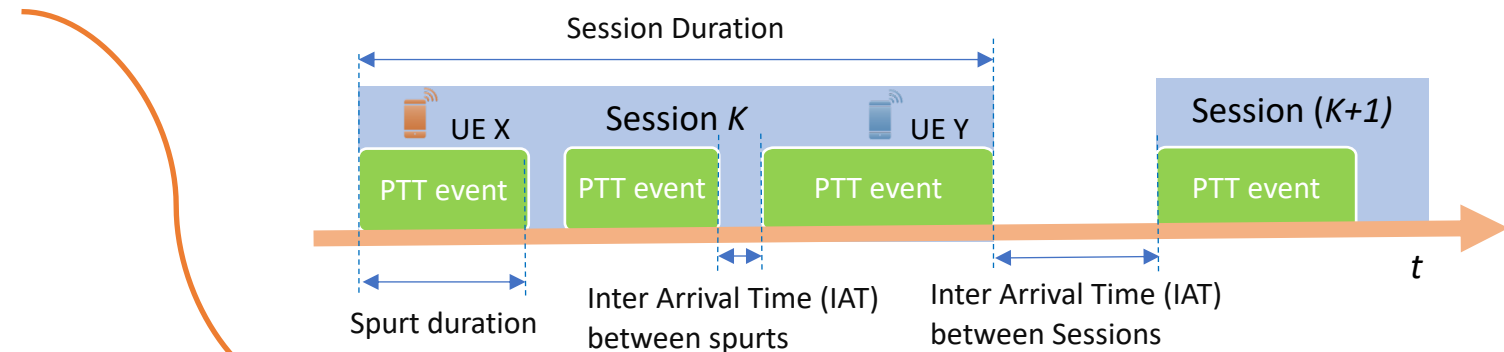
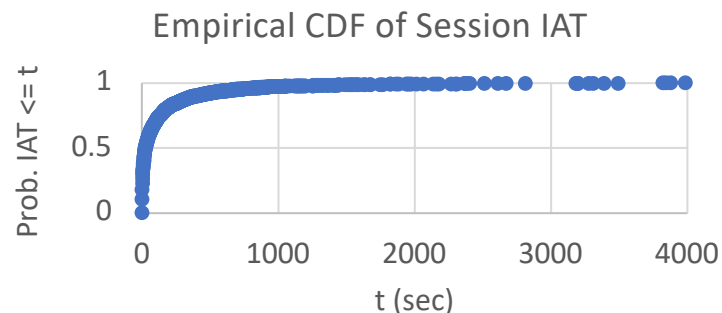
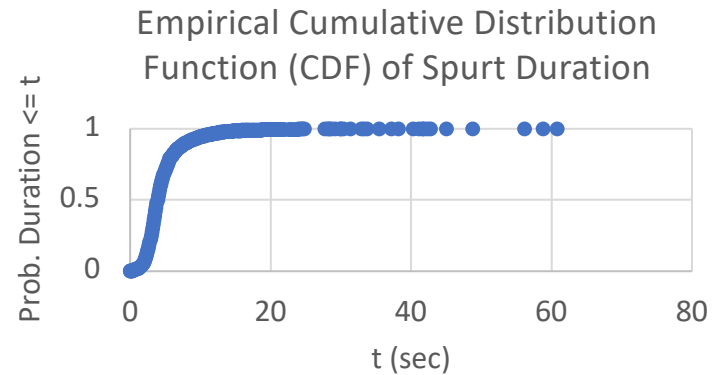
Scenarios

Incident framework
School shooting
Group mobility*
Visualizer (NetSimulyzer)

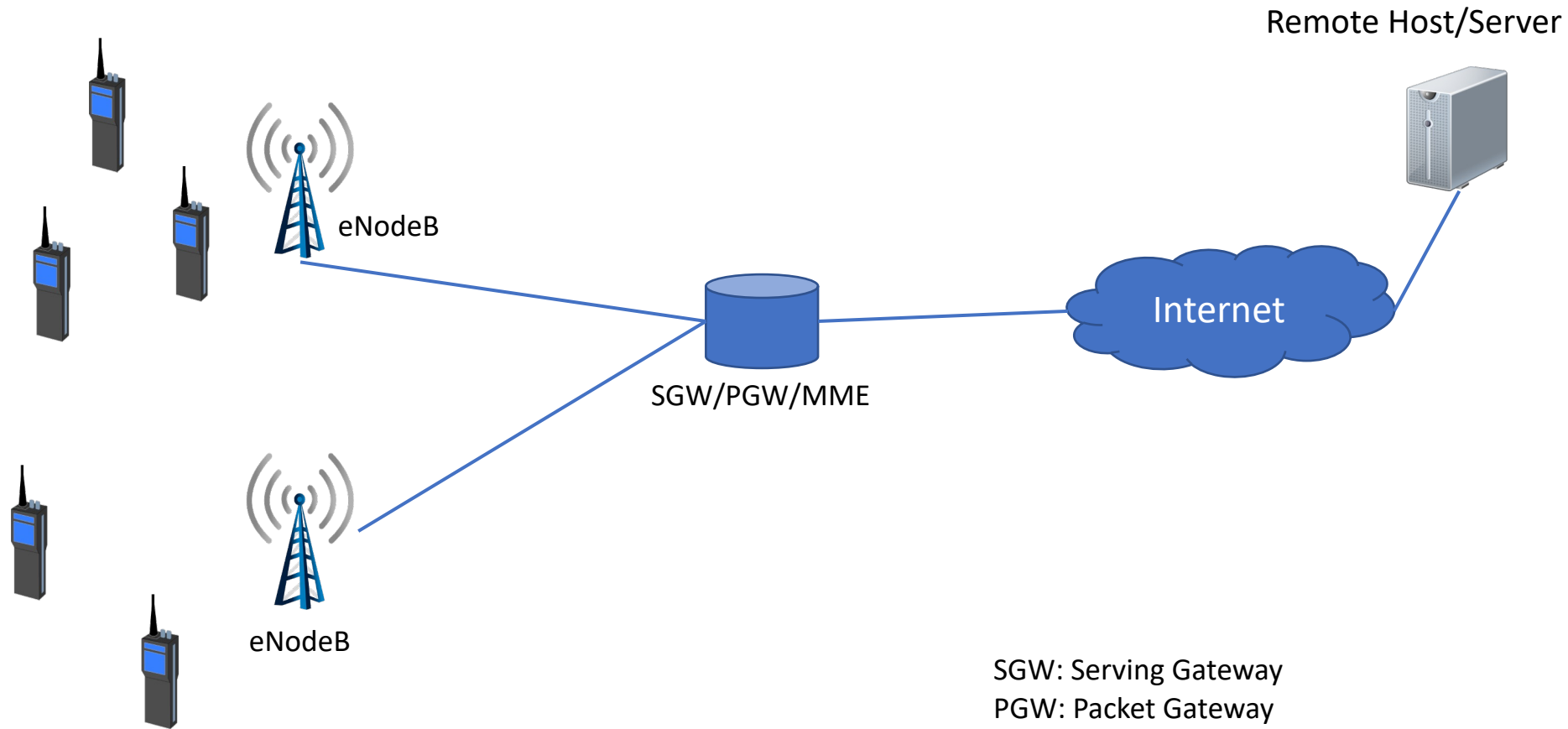
* Involves one or more collaborators

New MCPTT Application

- High fidelity model of the application to enable detailed study of key performance parameters (e.g., tail distributions of mouth-to-ear latency)
 - Off-network over LTE and NR sidelink
 - On-network using SIP/IP Multimedia Subsystem (IMS) server
- User behavior attributes based on call logs from public safety agencies



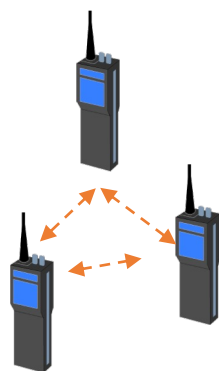
Improved LTE Model



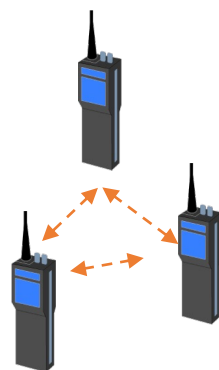
SGW: Serving Gateway
PGW: Packet Gateway
MME: Mobility Management Entity
eNodeB: Evolved Node-B (base station)

Improved LTE Model

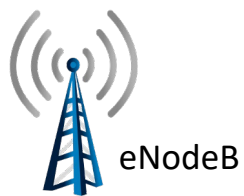
Out-of-coverage D2D



In-coverage D2D



Flexible core deployment



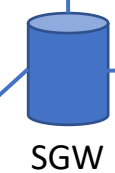
eNodeB



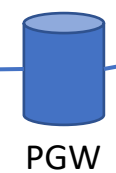
Any type
of
backhaul



MME



SGW



PGW

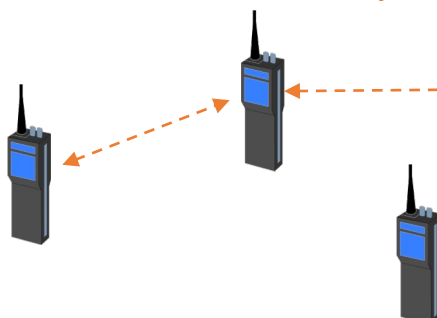


Internet



Remote Host/Server

UE-to-Network Relay



eNodeB

SGW: Serving Gateway

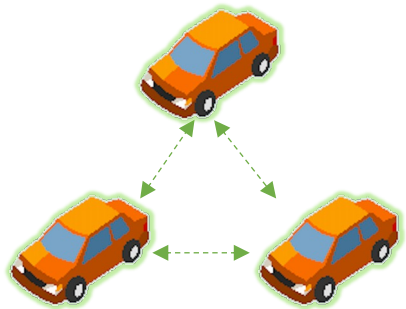
PGW: Packet Gateway

MME: Mobility Management Entity

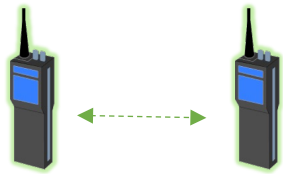
eNodeB: Evolved Node-B (base station)

Improving 5G NR Model

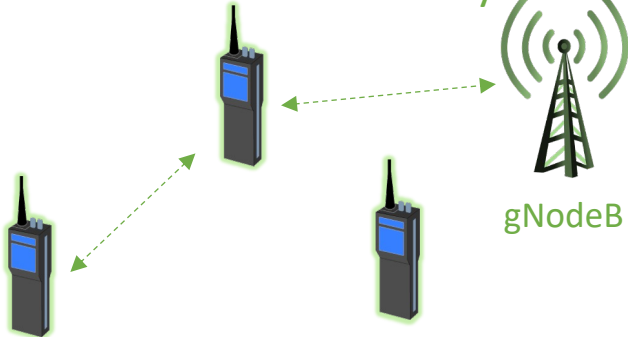
Out-of-coverage V2X



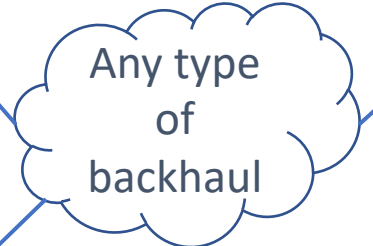
Out-of-coverage ProSe unicast



UE-to-Network Relay



gNodeB



Any type of backhaul



MME



SGW



PGW



Internet

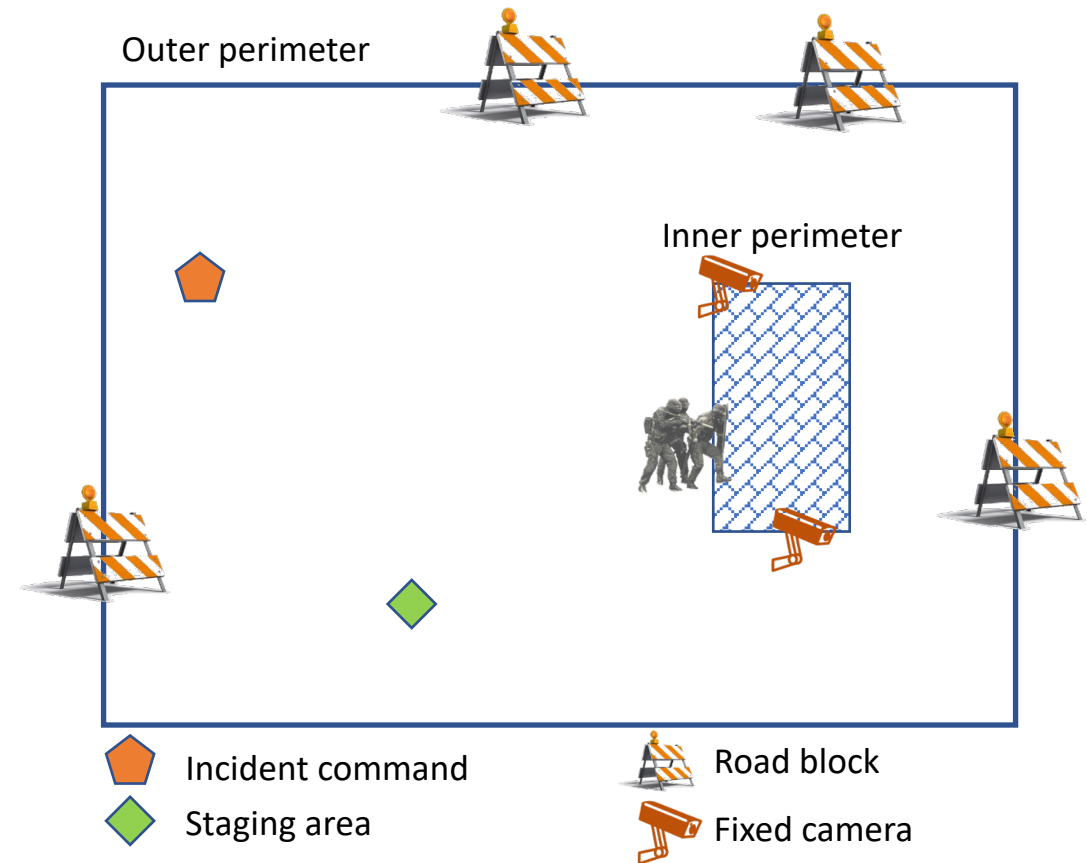


Remote Host/Server

gNodeB: Next generation Node-B

High School Shooting Incident

- Report of an active shooter at a large high school and involves casualties
- More than 100 public safety responders representing:
 - Special Weapons And Tactics (SWAT) teams
 - Law enforcement (for perimeter security)
 - Emergency Medical Services (EMS)
 - Firefighters
 - Incident Command / Unified Command (IC/UC)
- First responders use a mix of real-time streaming video, telemetry, biometrics, pre-plans, and other applications (more than 20 different applications in total)



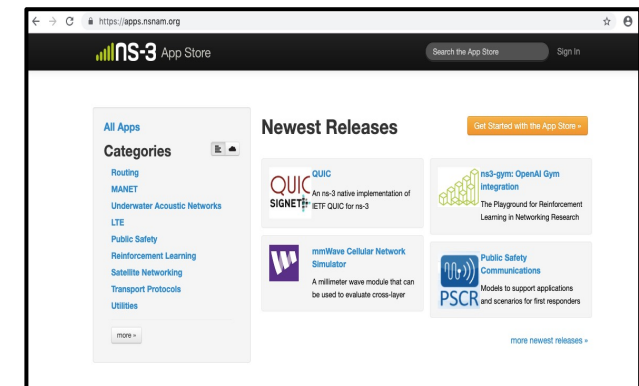
Scenario Visualization



- Real world public safety scenarios are complex
- Realistic inputs and models are needed
- Simulations can provide a performance assessment in scenarios where testbeds or real deployments are not feasible
- Simulators are becoming more capable of reporting Quality of Experience (QoE) metrics

The ns-3 Public Safety Communications (PSC) module (currently version 5.0) is publicly available:

- <https://github.com/usnistgov/psc-ns3>
- <https://github.com/usnistgov/NetSimulyzer>



Also available in the ns-3 App Store

Thank you

Contact: richard.rouil@nist.gov

Project: <https://www.nist.gov/programs-projects/network-modeling-public-safety-communications>