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FirstNet LTE Overview

Office of the Chief Technology Officer

Evolution of Cellular Standards

- LTE is a global standard developed by 3GPP (3rd Generation Partnership Project)

- Roadmap for future growth of the technology into LTE Advanced

- Future releases will include public safety requirements, including mission critical voice

- All U.S. carriers migrating to a single standard for the first time

LTE Technical Highlights
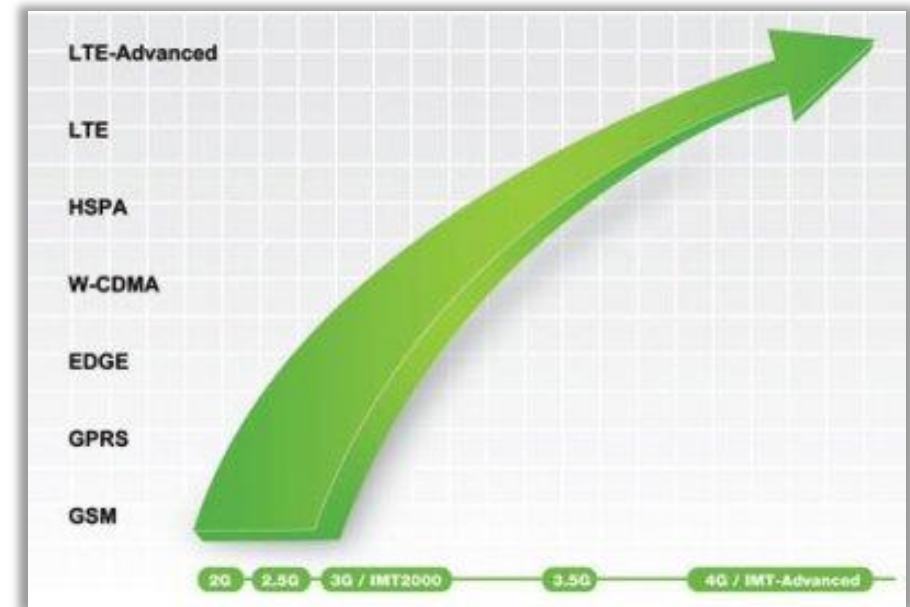
- Voice
  - Voice over LTE (VoLTE) – being deployed currently
  - Mission Critical Push to Talk - standards are being developed

- **All-IP** (Internet Protocol) architecture designed for low latency and high resiliency

- Quality of Service Priority and Preemption capabilities

- Inter-network **mobility and interoperability** with commercial carriers

- **Security and authentication**

- **Modern antenna techniques** to support improved performance

LMR vs. LTE

LMR

- Channels pre-configured per site
- Overlapping coverage using different frequency
- Fixed bandwidth / throughput per channel
- Users on one channel don't impact others

LTE

- All sites operate on same frequency thus overlapping coverage needs to be minimized
- "Channels" managed dynamically at each site
- Bandwidth determined by need and availability *minimizing congestion concerns*
- One large data "pipe"
  - *Up to* 74 Mbps capacity near cell tower
  - Capacity reduces as you move away from tower
  - Can handle many users with differing data demands (e.g. field reporting, dispatching)

LMR Channel 1
LMR Channel 2
LMR Channel 3
⋮
LMR Channel n

Each channel supports a conversation

10 MHz Public Safety LTE Band

Police Streaming Video
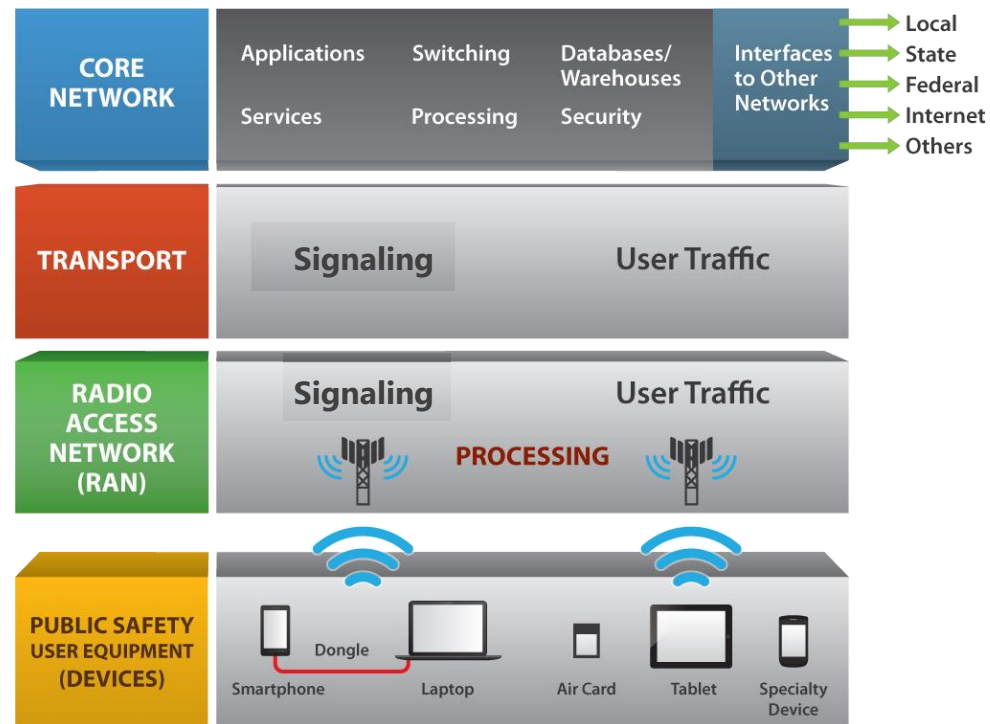
Medical Telemetry

Messaging

Variable Data Rate per User – 1 to 100(s) Simultaneous Users

Basic LTE Network Components

At a very high level, the network has 4 basic components:

- Core Network Evolved Packet Core (EPC) or "Core"
- Transport "Backhaul"
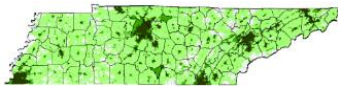- Radio Access Network or "Radio Sites"
- User Equipment (UE) or "User Device"

# Devices – The Most Important Element to Public Safety

|	Portables	In-Vehicle Routers	Specialized	Accessories
Device Types				
Category Driver	• Build up to an economy of scale		• Special operational needs e.g. in-building, rural	• Unique uses
Function	• Smartphone • Tablets • Modems	• Routers • Hotspots • Consoles	• Drones • Portable repeaters • Rovers	• Ruggedized cases • Battery packs • Chargers, mics.
Connectivity	• LTE, CDMA, HSPA • LMR/ P25 • Wi-Fi, Bluetooth • Direct mode	• LTE, CDMA, HSPA • Wi-Fi • Ethernet • USB	• LTE, CDMA, HSPA • LMR/ P25 • Satellite	• Bluetooth
Location Enabled	Yes	Yes	Some	n/a
Band 14 Support	2H14	1H14	2015+	n/a

The Challenge of Scope = Coverage + Users

Coverage

- **Where is reliable coverage needed?**

- **For what *level of service*/device types?**

- **Using what potential *delivery networks*?**

+
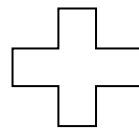
Capacity

- **How many total users for *20 MHz of spectrum*?**

- **What is their operational area?**

- **What type of applications do they use?**
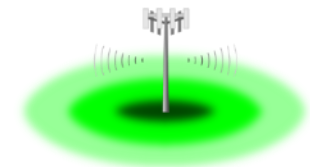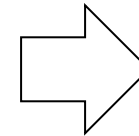
Radio Access Network (RAN) Design

- **Estimated number of sites**

- **Initial cost estimate for *public safety users***
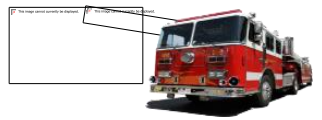- **Parameters for asset data collection**

The RAN will be a Combination of Terrestrial, Satellite, and 'Deployables'

Hybrid approach enables public safety users
to take their wireless coverage, services, and capacity with them
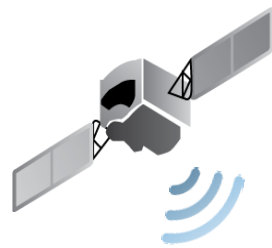
Off-net mode, no satellite or Core – comms among incident personnel 750-1000 sq. ft.

Mobile Communications units (mobile comms) on PS vehicles – become a mobile cell site/system mounted with an LTE Picocell: Incident Area Network (IAN) 750-1000 sq. ft.

Public Safety Towers (boomers) 10-25 miles

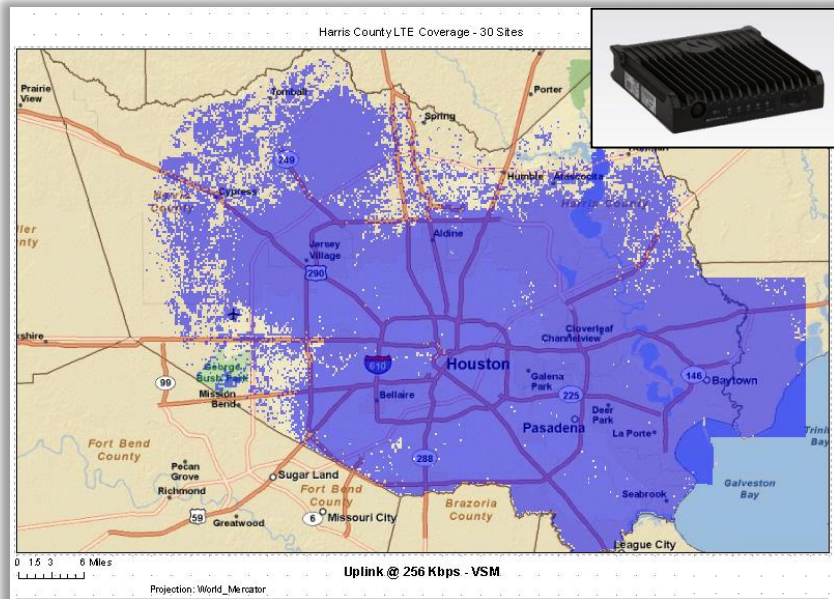**Macrocell LTE up to 1-10 miles**

Microcell LTE up to 1 mile
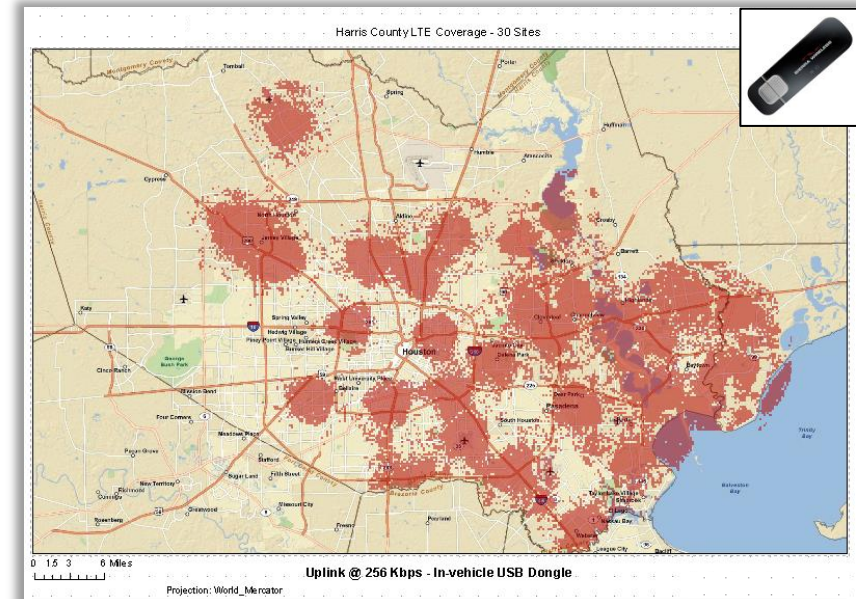
LTE Coverage: Device Type Comparison

- Like portable versus mobile LMR radios, different LTE device types will have different performances

Vehicular modem

USB dongle

Example plots from old coverage predictions provided simply for comparison purposes.

Transport Between RAN and Core

RAN Backhaul Network

Service Options
- Microwave 150M/
- 300M/1G/2.5G
- Leased 100M/1G Ethernet
- IRU Lit Fiber Lambda/Wave
- IRU dark Fiber

Aggregation Transport Network

Service Options
- Leased 10G/100G
- IRU Lit Fiber Lambda/Wave
- IRU dark Fiber

National Transmission Network

Service Options
- Leased 10G/100G
- IRU Lit Fiber Lambda/Wave
- IRU dark Fiber
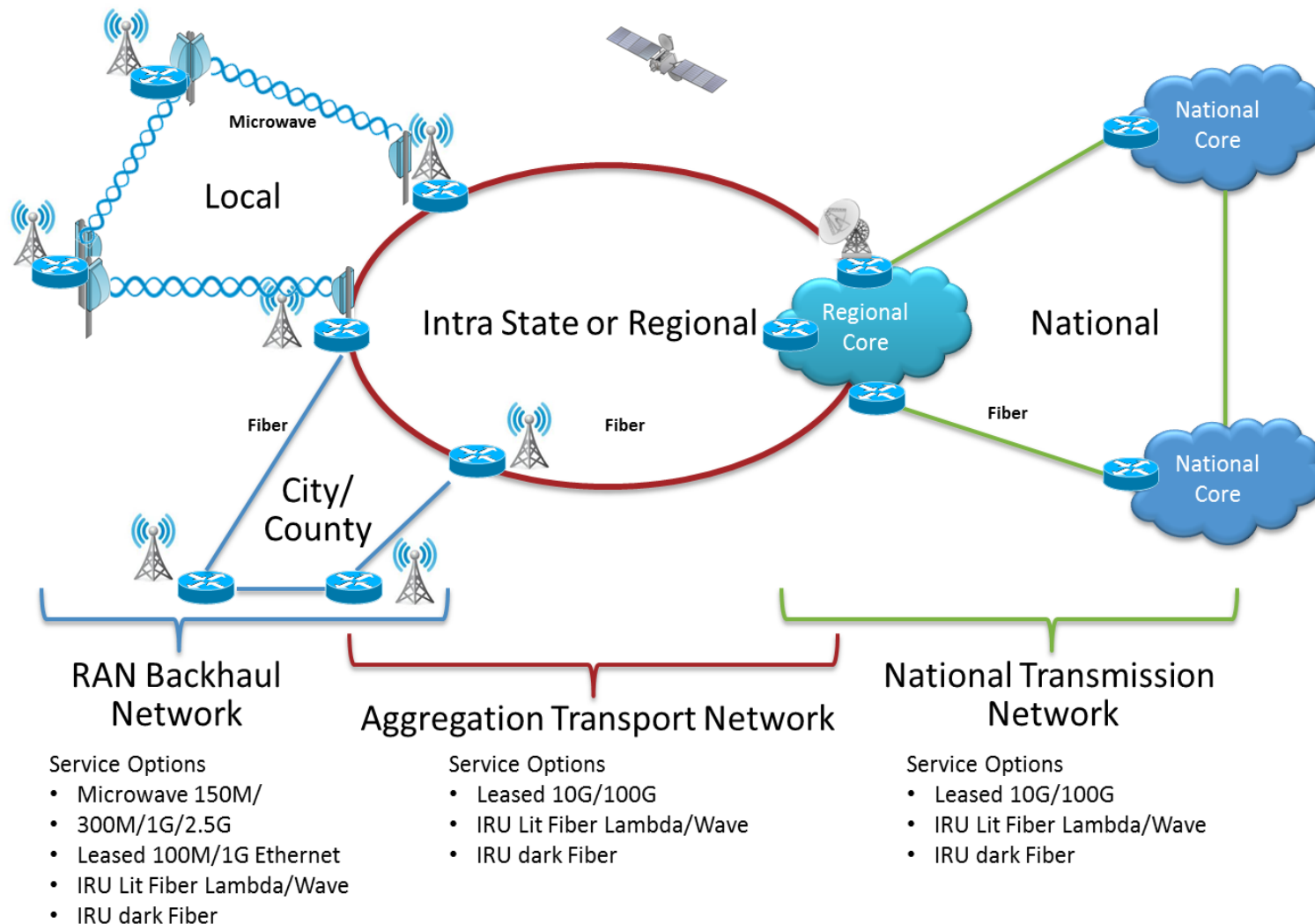
The Core is for Traffic Management, Applications Deployment, Service Operations

FirstNet™

Services	Location	Multimedia	Applications	• Content
	Messaging	User ID Management	Provisioning	• Local Control
	Presence	Push-to-Talk	Voice over LTE	• NOC, SOC

EPC	Mobility Management		Policy and Charging	• Interconnect
	Home Subscriber Register		Serving Gateway	• QoS, priority, preemption
	Packet Gateway		Diameter Routing	

Transmission	Routers	Transmission Facilities (Fiber)
	Firewall	Dense Wave Division Multiplexers
	Border Gateway	

Data Centers	Hardened Facilities	Power Backup
	Redundant Transport	HVAC
	Security	

Security

FirstNet Network Architecture

FirstNet™

Partner Networks — Internet | PSTN IPX | NG-911 | Agency (Local Control, Local Apps/Data) | State (Local Control, State Apps/Data)

Security

Operational and Business Support — Billing | CRM | Clearing | Analytics | Experience Device Mgt. | Partner Mgt. | Security Management | Mediation | Charging | Fraud | SIM Mgt. | Provisioning | Network Management

NOC SOC — Managed Service

Application Platform — App Store | Regional Applications | FirstNet Applications | Local Control

Network Service Platforms — PTT | VoLTE | IMS | SDP | MMS | Presence | V-Mail | SMS | Location | CMAS | Identity | EIR | AAA | SDM

Evolved Packet Core — PGW | SGW | PCRF | DRA | HSS | MME

Transport & Datacenter — RAN Access Backhaul | Aggregation Transport | Regional Core Datacenter | National Transmission | National Core Datacenter

Radio Access Network — FirstNet eNodeB | FirstNet Relay eNodeB | FirstNet Small Cell | MNO Partner eNodeB | Roaming Partner eNodeB | Vehicle Router/Hotspot | Deployable (Sat/MW) | Satellite

Devices — Smartphone | Tablet | Modem | Specialty Device | Router | Vehicle Router/Hotspot

Legend:
- User Data
- Local Control Data
- Combined User & Signaling Data
- Signaling Data

March 2, 2015

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FirstNet Will Have Advanced Capabilities

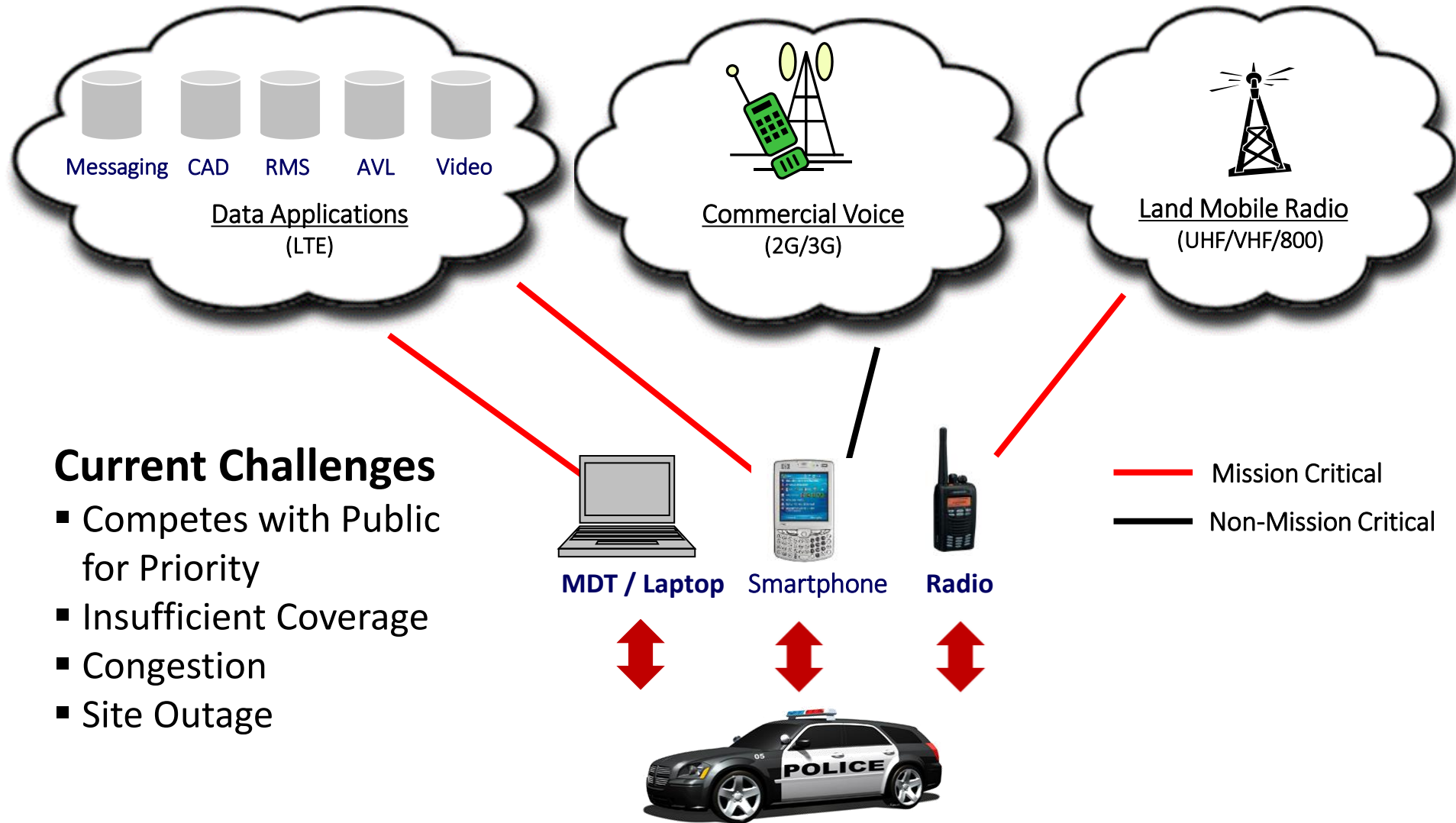- **Key FirstNet Characteristics**
  - Quality of Service Priority and Preemption
  - Local Control
  - Hardening
    - Security - Physical and Cyber
    - Structural Hardening
    - Resiliency

Communication
- Video
- Voice (non-mission critical)
- Messaging
- SMS/Text
- Data (Internet)

Applications
- CAD, RMS, NLETS
- FirstNet applications (e.g., AVL)
- Syndicated applications
- Currently used Agency applications

Services
- Records management
- Data storage
- Audio storage
- Database inquiries

Capabilities
- Network monitoring and status
- Integrated solution and services
- Priority
- Hardened and secure
- Provisioning

FirstNet™

Messaging CAD RMS AVL Video

Data Applications
(LTE)

Commercial Voice
(2G/3G)

Land Mobile Radio
(UHF/VHF/800)

Current Challenges

- Competes with Public for Priority
- Insufficient Coverage
- Congestion
- Site Outage

MDT / Laptop Smartphone **Radio**

Mission Critical

Non-Mission Critical

What is Mission Critical Voice

- National Public Safety Telecommunications Council produced a 7 page document defining mission critical voice
  - http://www.npstc.org/broadband.jsp

- The following requirements were identified:
  - Direct or Talk Around Mode (off network communications)
  - Push-to-Talk (PTT) w/ low latency
  - Full Duplex Voice (commercial/PSTN calls)
  - Group Call (one to many)
  - Talker Identification
  - Emergency Alerting (highest level of priority)
  - Audio Quality

- Definition being used as a reference for standards developments

- No standardized solutions exist today that can meet all of these requirements

Voice Service Evolution

Voice Category	Status	Readiness
VoIP (Telephony)	Demonstrated in several applications	
Voice over LTE (Telephony)	VoLTE preferred solution; just being implemented by some carriers	
Non-mission Critical Voice (Push to Talk)	Standard and proprietary options available	
Mission Critical Push to Talk (Push to Talk)	Standardized approach being worked on within current standards developments	
Direct mode (Peer to Peer)	Also being worked on within standards efforts; includes peer-to-peer data as well	

LTE Security
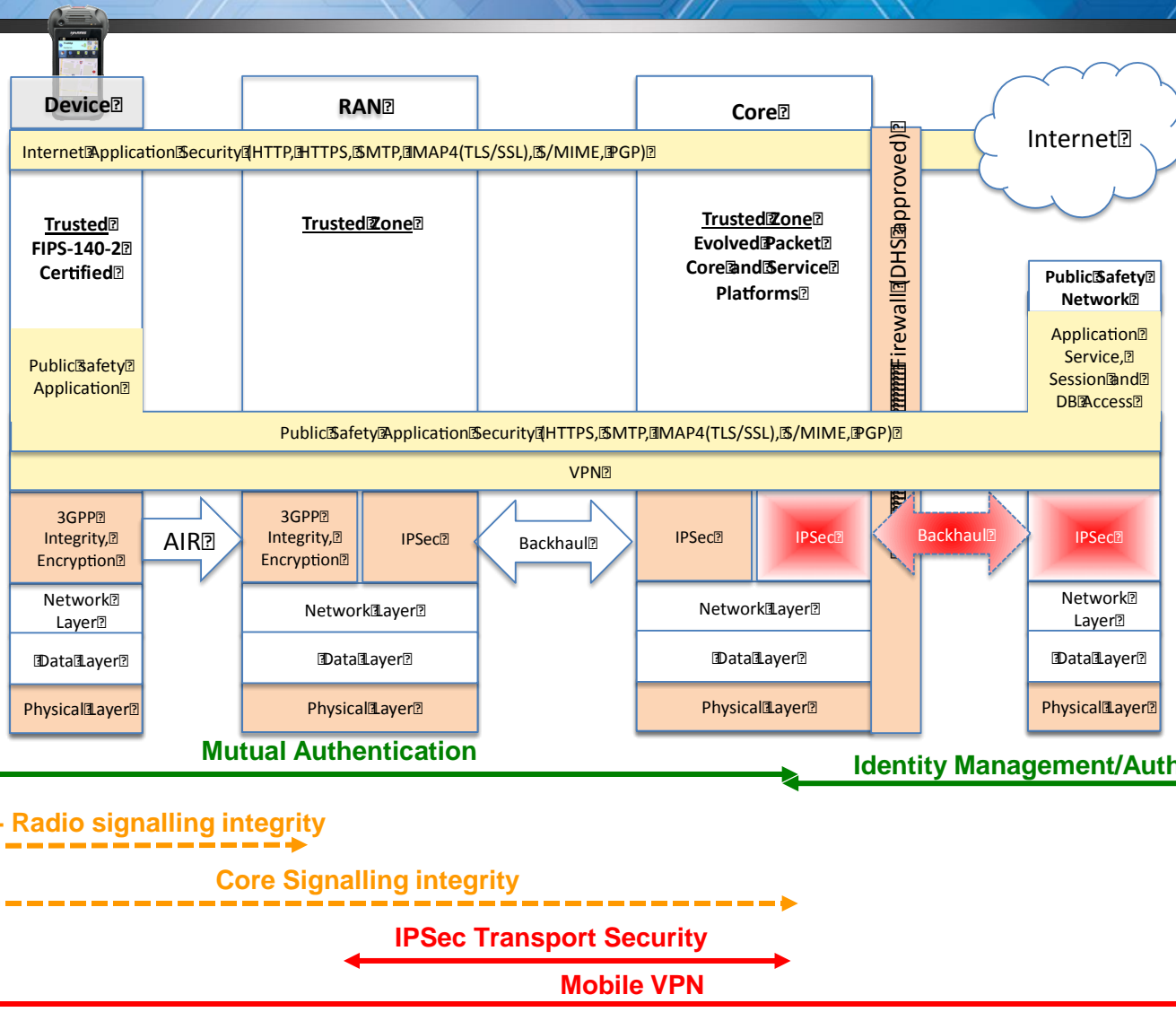
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Thank You