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Advances in Disaster Communications: Broadband Systems for First Responders

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3RD INTERNATIONAL CONFERENCE ON DYNAMICS OF DISASTERS
KALAMATA, GREECE – JULY 5-9, 2017

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Communications Requirements

First 24 Hours	24 – 48 Hours	3-30+ Days
		
Rescue Command/Control Disaster Inventory	Rescue Recovery	Recovery Restoration

Humanitarian Calling and News

Bandwidth Increases

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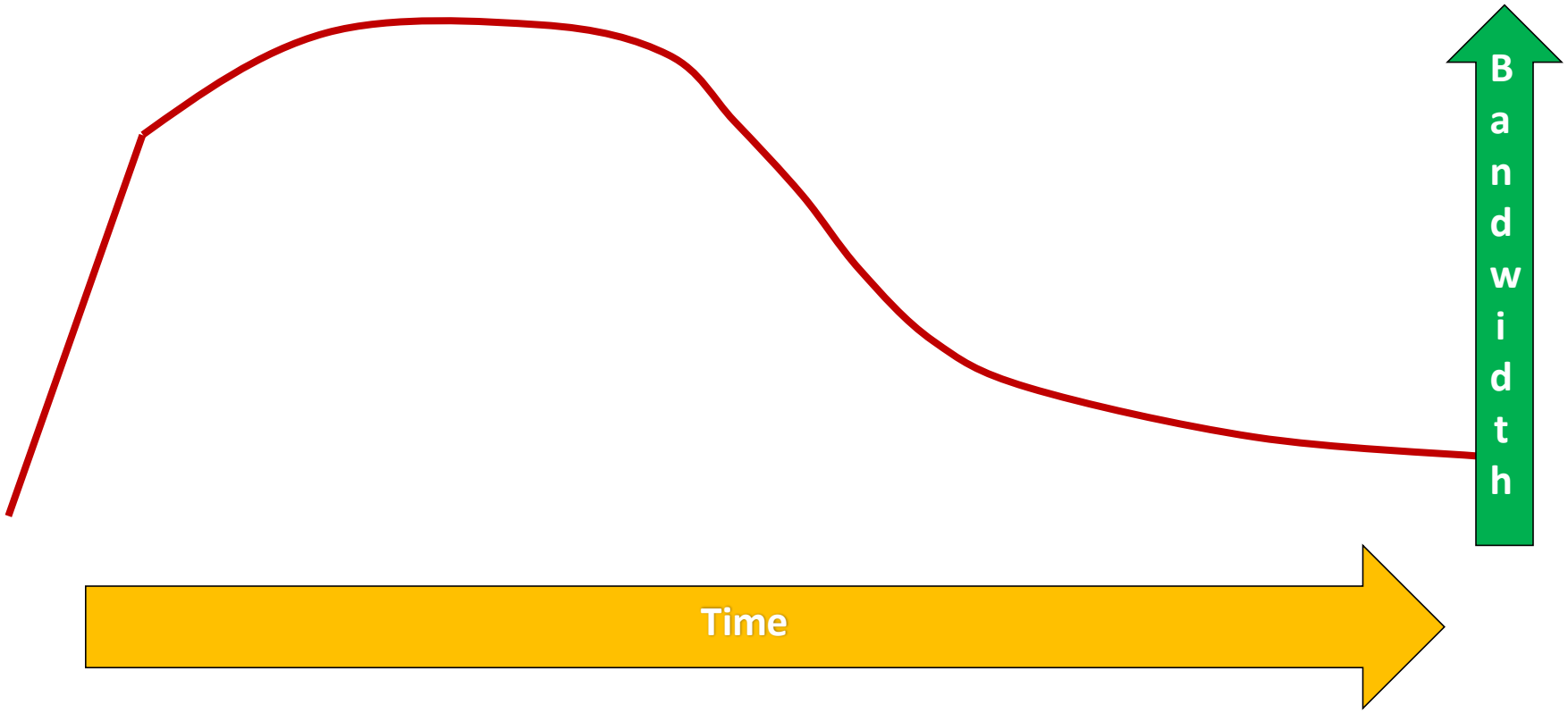
Communications Requirements

First 24 Hours | 24 – 48 Hours | 3-30+ Days



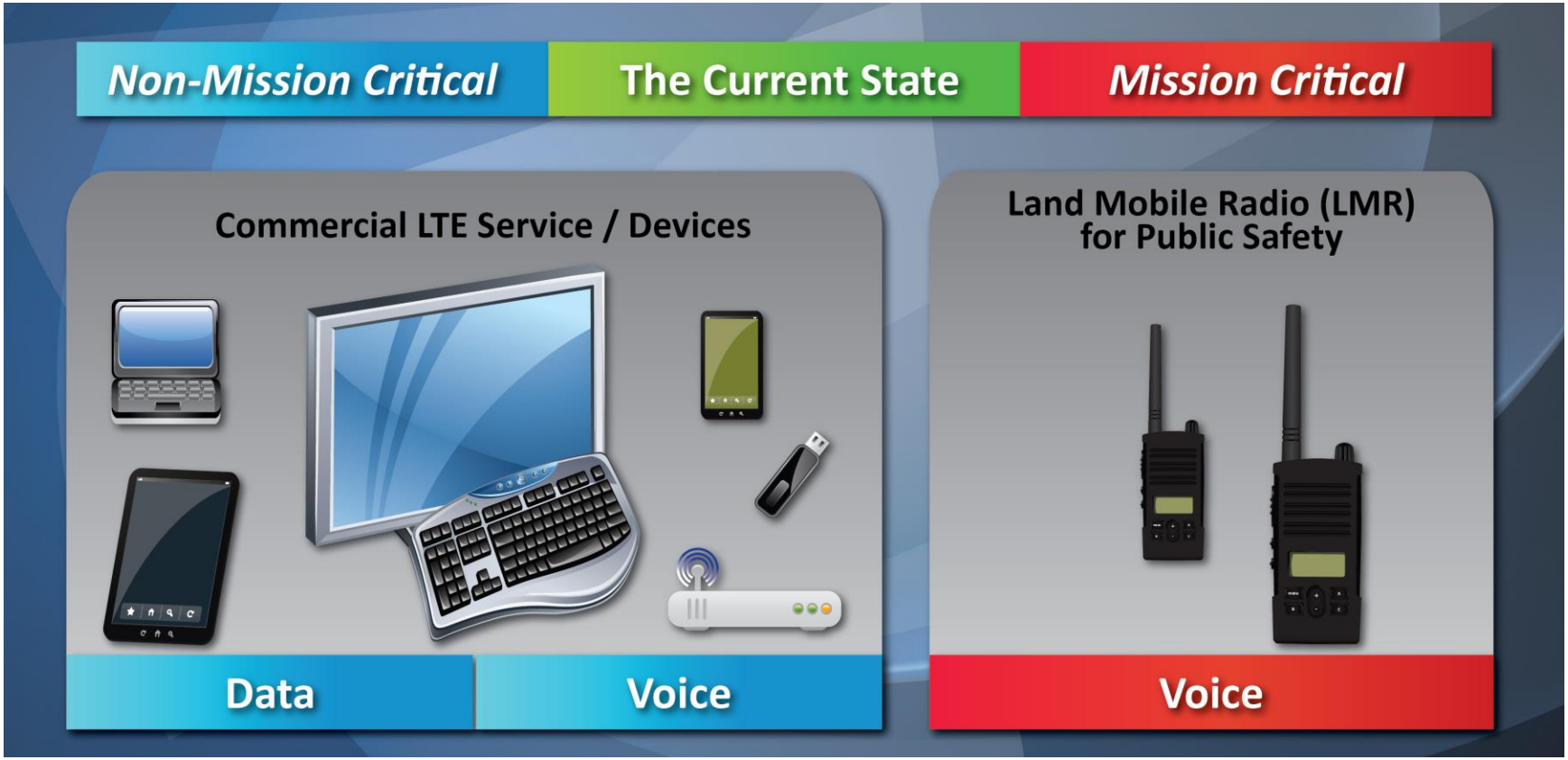
Trends Transforming Disaster Communications

1. An increased level of community engagement
2. Real-time data is accessed in the field
3. Increased communications with neighboring agencies
4. Collaborative technologies are used to expand capabilities
5. Managing the technology skills.

Types of Disaster Related Communications

1. Mission Critical Communication
2. Non-Mission Critical Communication
3. Broadband for First Responders – FirstNet in the US

Current State

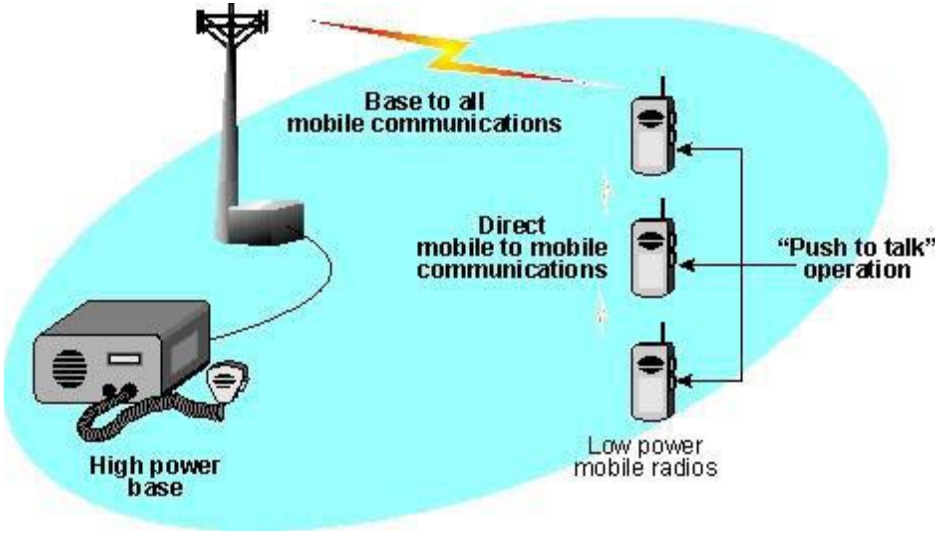


Mission Critical Communications (MCC)

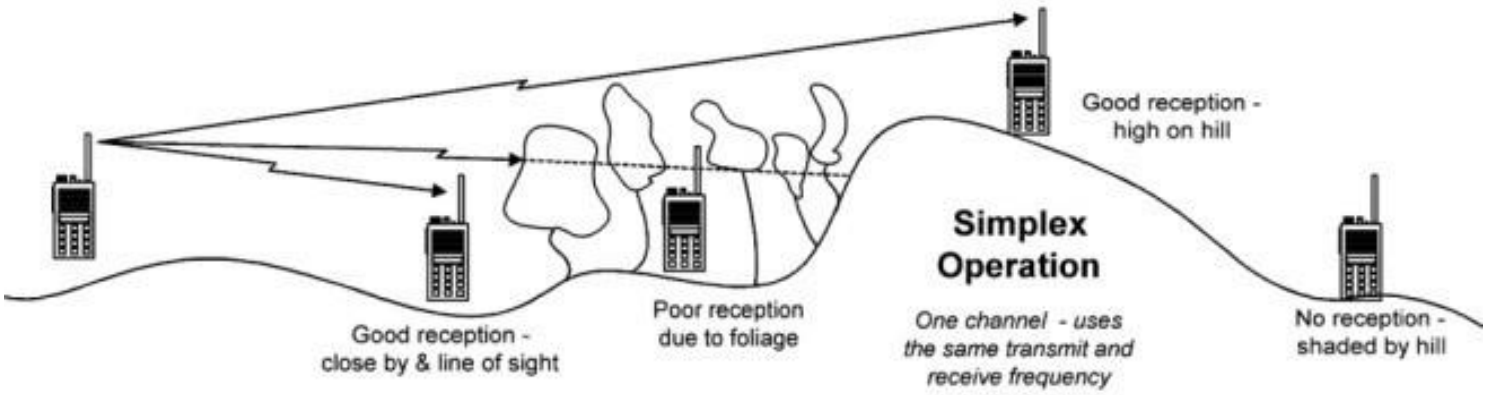
1. Messages (voice/data) must be transmitted immediately (low latency)
2. For situational awareness, usually requires that all involved receive the message(s)
3. Key metric is reliability – for MCC, most first responders just want what works!

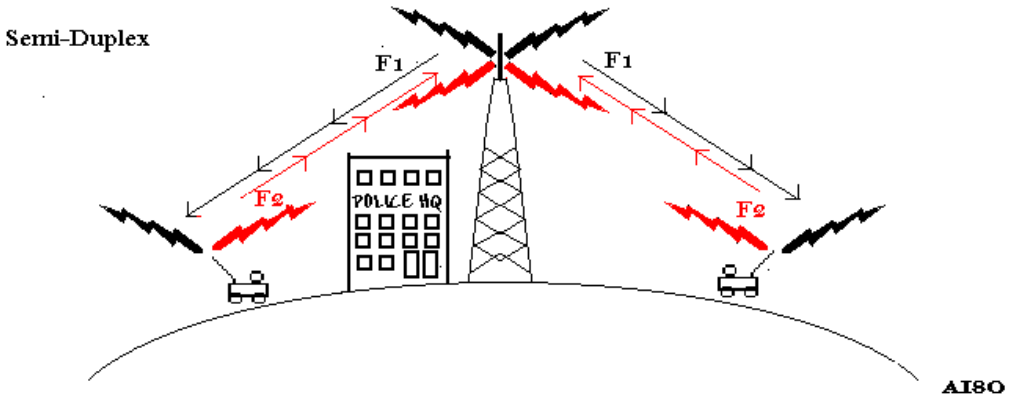
A Brief Background on Communications

- LMR – Land Mobile Radio – Conventional 2-way radio that is ubiquitous in public safety agencies.



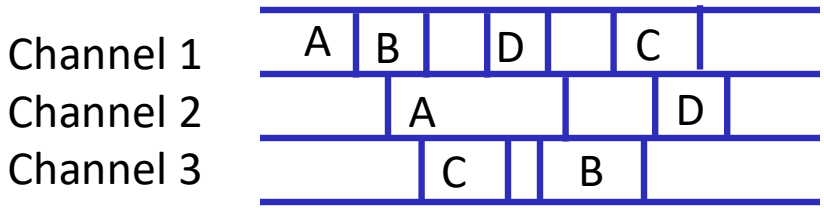
LMR – Simplex vs Repeater

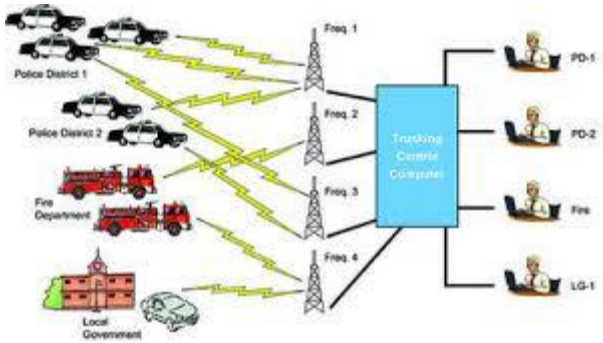




LMR – Trunked

Recognizes that the Radio Spectrum is a scarce resource and that messages are not continuous.





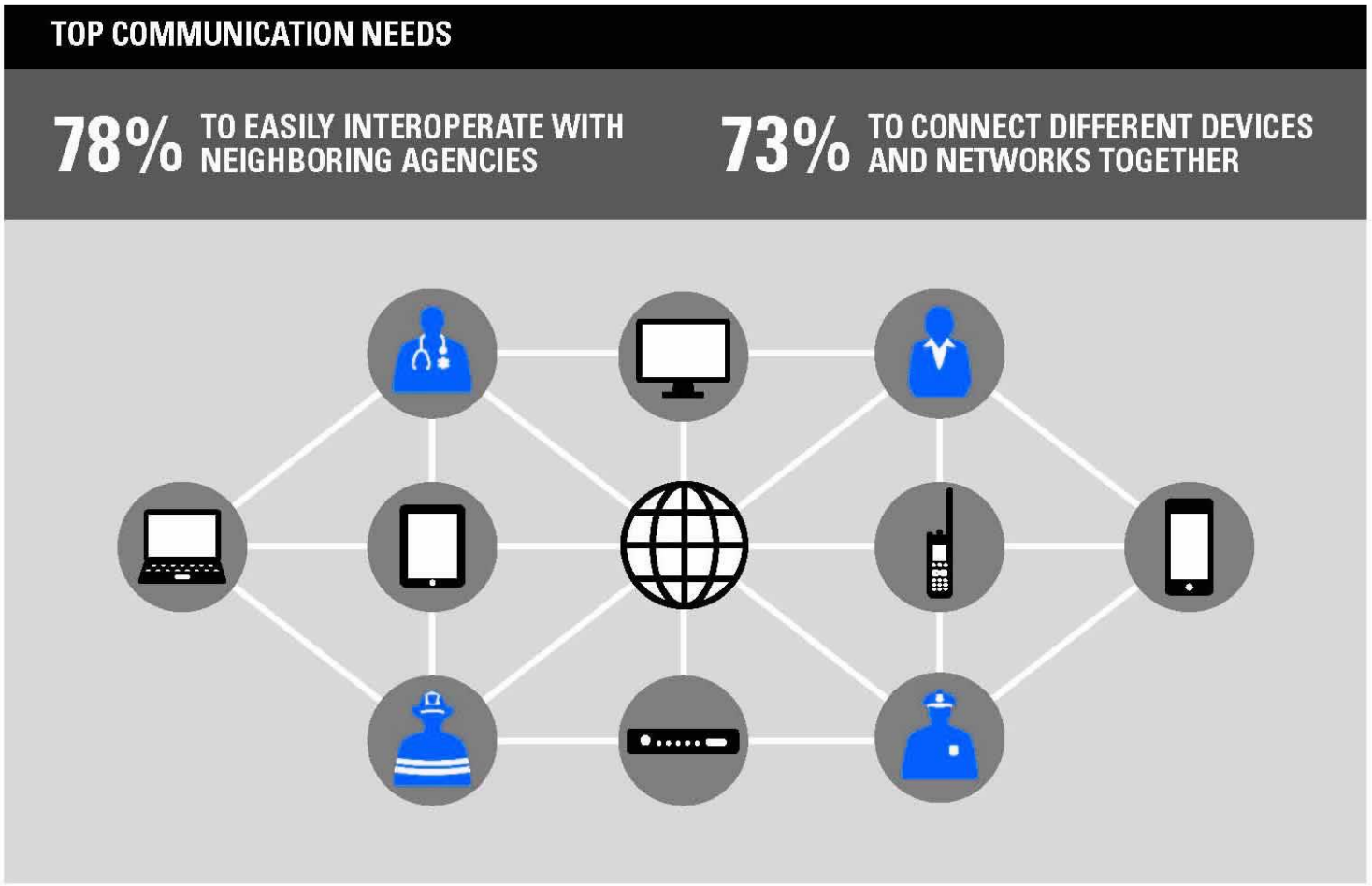
Conventional - TETRA - P25 - DMR

- Conventional – Traditional analog communications systems that have existed since the 1930s.
- TETRA - Terrestrial Trunked Radio - European standard (1995) designed for public safety networks. Also used for transportation networks and the military.

Conventional - TETRA - P25 - DMR

- P25 - Project 25 or APCO-25 – North American standards for digital radio communications for use by public safety organizations to enable interoperation.
- DMR - Digital Mobile Radio - An open digital mobile radio standard defined by ETSI in 2005 and used internationally.

Interoperability



Interoperability

Answer – Broadband!

LTE – Long Term Evolution

- LTE - Long Term Evolution - the standard used by most of our smart phones and devices.
- The driving factor for adopting LTE for the Emergency Communications sector is the increased need for broadband data applications.
- Requires cell sites and infrastructure.
- Well established in the consumer market, but requires enhancements to address the needs of Public Safety/Critical Communications.

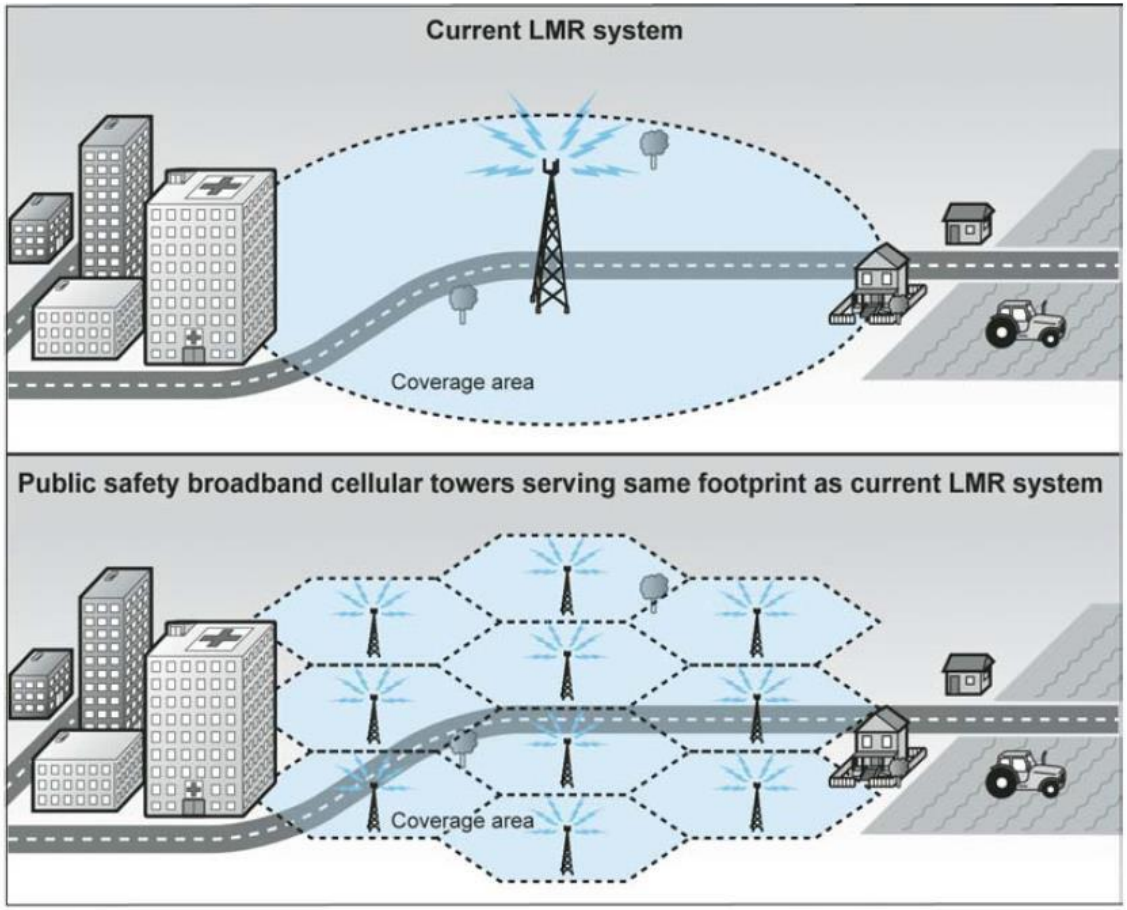
Features needed for LTE for MCC

- ***Proximity Services*** to allow mobiles to identify other mobiles in physical proximity and enables ***Direct Device-to-Device*** calls allowing communication even when the network is down or where no network exists.
- ***User equipment to network relay*** allows one mobile to act as a relay for another and provides access to network services outside the normal network coverage area.

Features needed for LTE for MCC

- ***User equipment relay*** allows mobiles to act as relay points between other mobiles, permitting communication without going via the network even if the mobiles are out of direct range.
- ***Mission Critical Push-To-Talk (MCPTT) allows radio-like communication over LTE.***
- ***Security features*** to protect the system from unauthorized users, eavesdropping, denial of service attacks, and other security risks.

Differences between LTE and LMR



Source: GAO.

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

Each channel supports a conversation

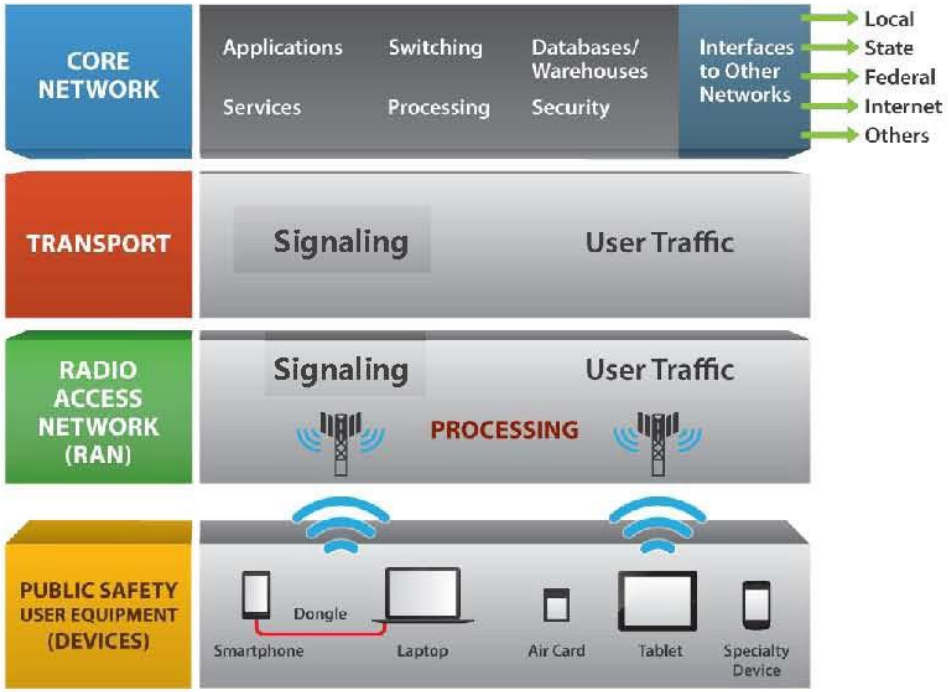
LTE

- 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)

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

4 Basic LTE Network Components

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



Problem

When a disaster occurs, Broadband use (Smart Phone – Tablet) increases to the point that the network becomes congested and throughput essentially goes to zero.

First responders who have immediate need for broadband cannot access the network.

What is needed for Public Safety Broadband!

- Public Safety Broadband using 700 MHz LTE
- Fully interoperable on a nationwide basis
- Bandwidth is not an issue for normal operation
- Bandwidth becomes an issue when a large incident occurs in a confined area, however, only one or two cell sectors will be used
- Real-time network management required with Public Safety having pre-emptive priority.

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First Responder Communication Challenges in the US

10,000+ individual radio networks

No dedicated broadband network to unify communications across agencies, devices or jurisdictions

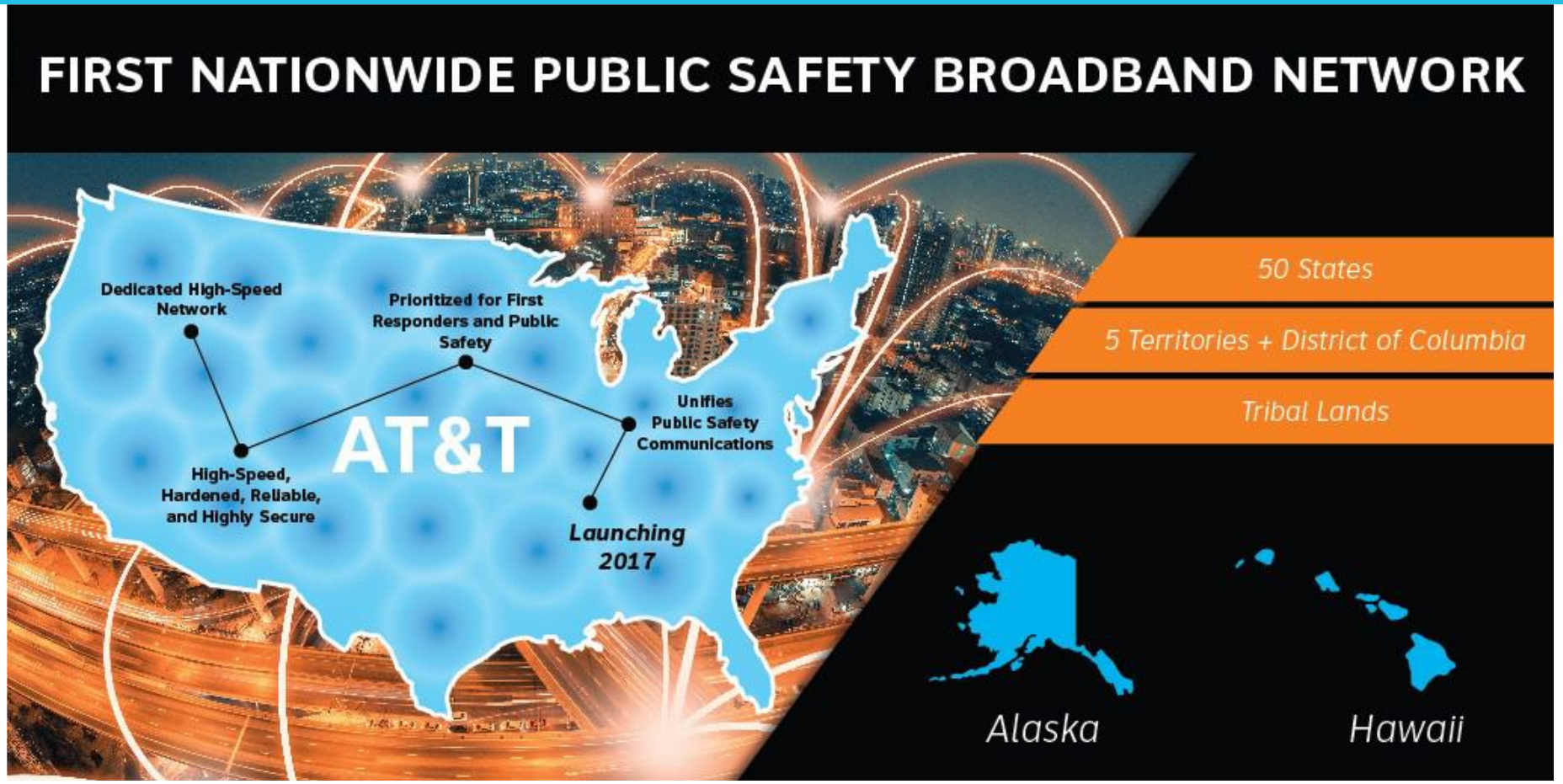
Commercial networks congested during crises

70k+
Public Safety Agencies

3,100+
Counties

550+
Recognized Tribes

FirstNet


FIRST NATIONWIDE PUBLIC SAFETY BROADBAND NETWORK
Dedicated High-Speed Network
Prioritized for First Responders and Public Safety
Unifies Public Safety Communications
AT&T
High-Speed, Hardened, Reliable, and Highly Secure
Launching 2017
50 States
5 Territories + District of Columbia
Tribal Lands
Alaska
Hawaii

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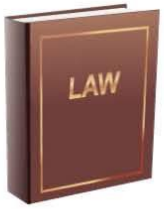
FirstNet Beginnings



THE LAW

2.22.12

FirstNet becomes law
PL 112-96

FUNDING

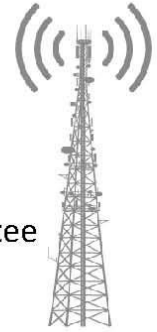
$7B authorized to build the FirstNet network. Funded by spectrum auctions through 2022.

GOVERNANCE

The FirstNet Board has **15** members, including those with telecommunications and public safety backgrounds

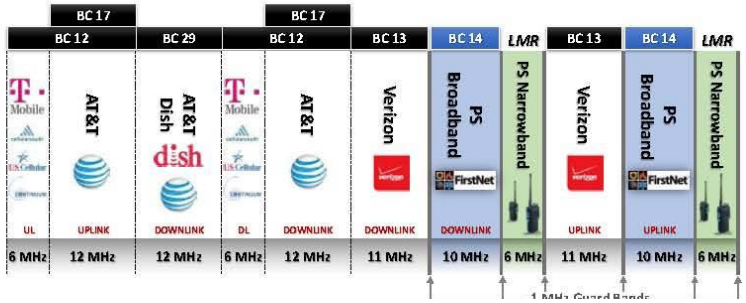
Each Governor appoints **1** Single Point of Contact (SPOC) and governing body to represent the state's interests to FirstNet.

40 member Public Safety Advisory Committee (PSAC) advises FirstNet on public safety intergovernmental matters.



BAND CLASS (BC) 14

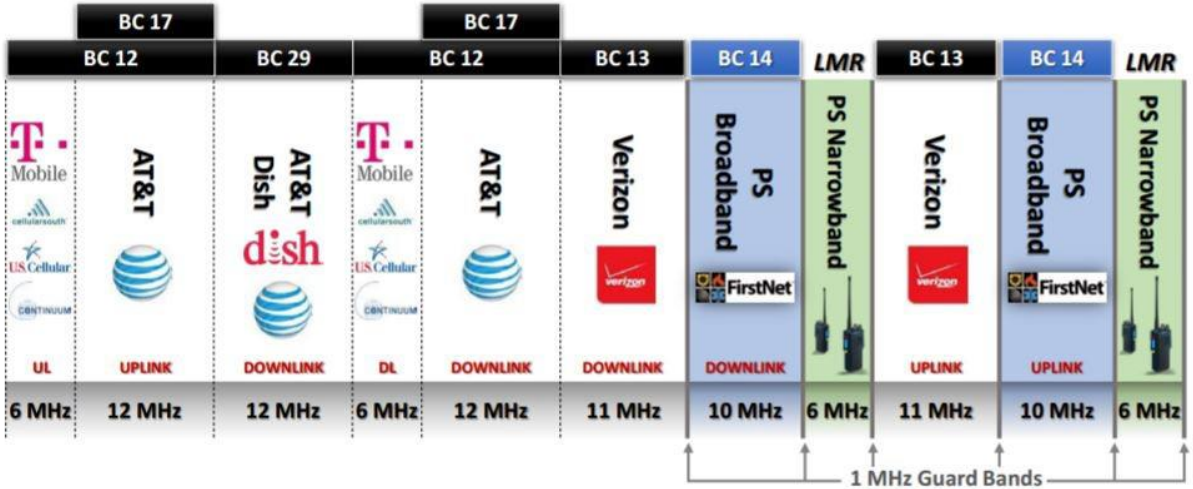
20MHz of bandwidth has been dedicated to public safety in the prime upper **700MHz** frequency range.



FirstNet Band 14 LTE

20 MHz of Spectrum @ 700MHz

- 3GPP standardized as LTE "Band 14"
- 10 MHz Downlink + 10 MHz Uplink
- Entire 20 MHz swath plus guard bands licensed nationwide to FirstNet
- Allows higher power portable/mobile devices – benefit to rural areas
- 3GPP Standards already in place for 1.25W devices



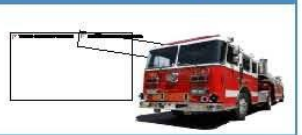
TV Channels 52-69

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

FirstNet

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

FirstNet Will Have Advanced Capabilities

FirstNet™

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

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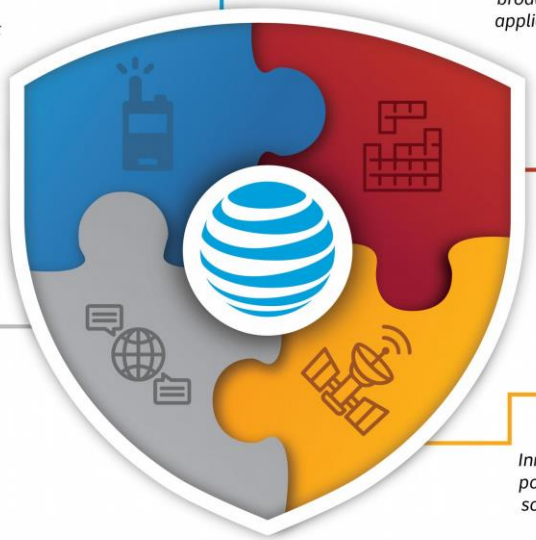
Contract Award – March 30, 2017

FirstNet Band 14 LTE

AT&T's Team for FirstNet



MOTOROLA SOLUTIONS

Motorola Solutions will deliver purpose-built public safety mobile applications, software and services that bridge communications between land mobile radio and LTE to enable public safety agencies to take full advantage of the network's data capabilities.

GENERAL DYNAMICS

General Dynamics brings decades of proven systems integration and program management experience, broadband engineering skills, public safety-focused applications, deployable telecommunications assets and cybersecurity resources.

Sapient Consulting

Sapient Consulting will deliver an innovative application ecosystem for the public safety community and an advanced FirstNet web portal for states.

inmarsat government

Inmarsat Government brings a wide portfolio of satellite communication solutions and value-added services in support of FirstNet.

AT&T also brings access to additional resources including:

- An extensive network of subcontractors and vendors
- 45 U.S. rural telecommunication providers
- Domestic wireless roaming agreements with 25 companies
- 500+ OEM relationships for access to top-of-the-line devices

FirstNet Public-Private Partnership

Public-Private Partnership approach leads to a fully-funded, self-sustaining network.

Business model is built on the efficient use of resources, infrastructure, cost-saving synergies, and incentives.

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FirstNet Public-Private Partnership

- FirstNet provides 20 MHz of spectrum and $6.5 billion in initial funding; AT&T will deploy and operate a nationwide high-speed broadband network for public safety over 25 years.
- AT&T will spend about $40 billion over the life of the contract to build, operate, deploy, and maintain the network, and will ensure the network evolves with the needs of public safety and advances in technology.

FirstNet Public-Private Partnership

- AT&T can use FirstNet's spectrum when it is not being used by public safety for other, commercial purposes. The company will prioritize first responders over any other commercial users on the Network.
- FirstNet will oversee this contract to ensure it delivers innovation, technology and customer care.

FirstNet Public Safety Users Quality of Service and Pre-emption (QPP)

- Public-safety users will be divided into two tiers: Primary and Primary Extended.
- AT&T - FirstNet will be multiband and provide public safety with priority on all bands of the network, not just band 14.

FirstNet: Primary Public Safety Users

- Access class barring - Public-safety users will have a special access class and be exempt from throttling and barring.
- High-priority access flag - Public-safety users will receive priority treatment in various call setup stages.
- Traffic management - Non-public-safety traffic will be offloaded from band 14 during high loads.
- Admission control - Primary users will have a higher priority level and the ability to preempt other users.

FirstNet: Primary vs. Primary Extended

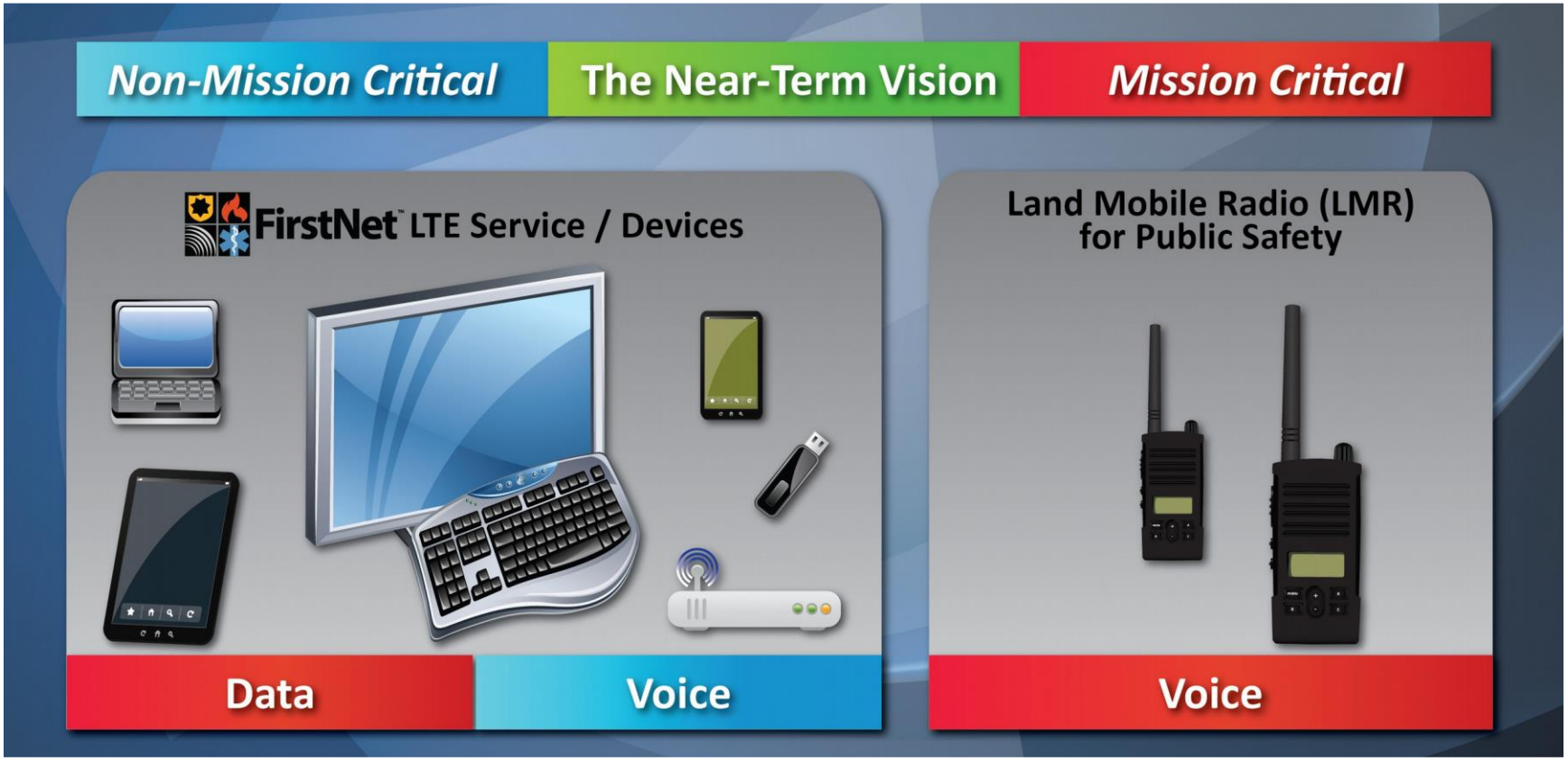
- Primary users will include firefighters, police officers and EMS. They will be the only network users who can actually pre-empt another user on the network.
- While Primary Extended users will not have pre-emption capabilities, they will still have priority status on the network.
- There will be a difference in pricing between the two levels of priority.

FirstNet: Primary vs. Primary Extended

- Special incident management level priority will exist to allow a specific user to be lifted above other traffic for a specific period of time through a manual form of priority that users can provision through an incident management portal.

FirstNet Devices

Near-Term Vision – Transition to FirstNet



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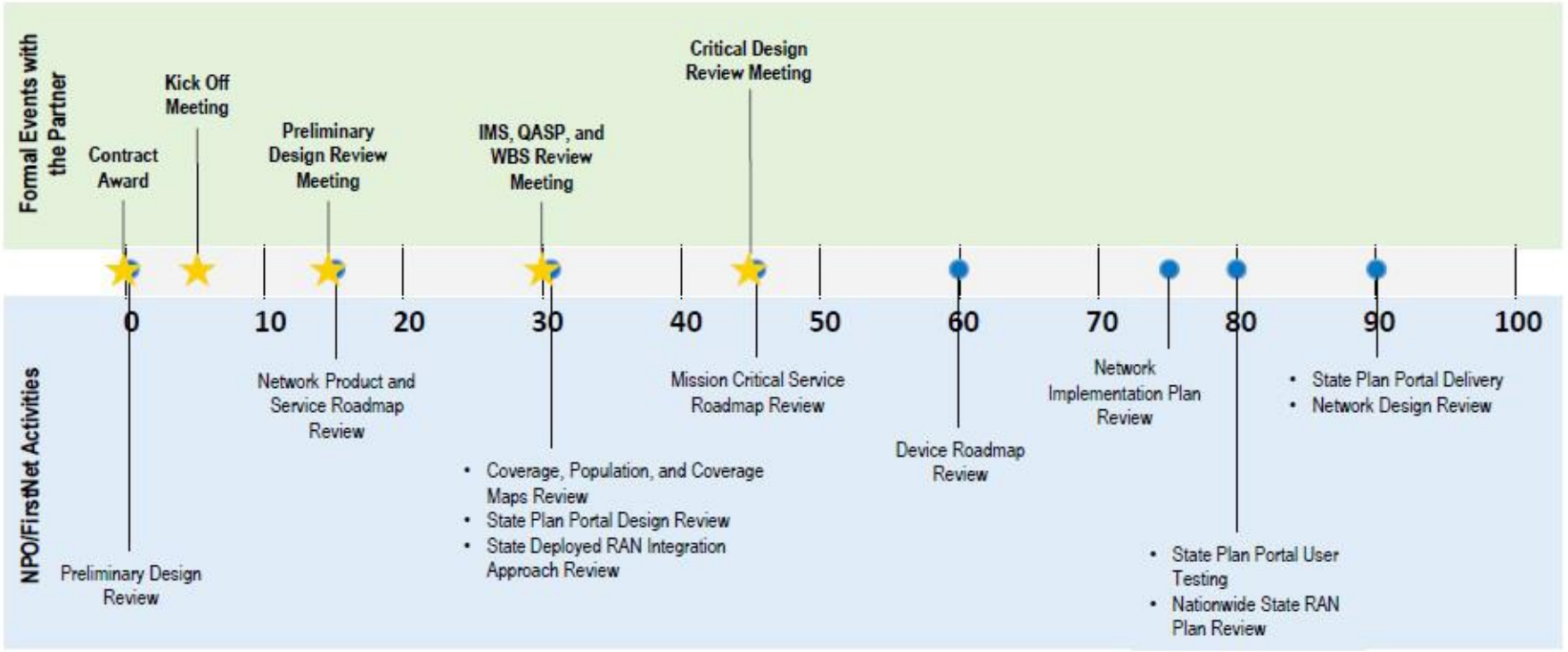
The First 100 Days of FirstNet



Opt-Out Provision of FirstNet

States may opt-out of FirstNet if they can build their own Radio Access Network that will interface with the FirstNet core network.

Not clear what funding these states will receive from NTIA for building the network.

AT&T et al has been playing hardball with states considering opting out.

Opt-Out Provision of FirstNet

New Hampshire has executed a contract with Rivada Networks for an alternative RAN.

Massachusetts, Wisconsin, Michigan, Colorado, California, Rhode Island, and Alabama have released RFPs for alternative public-safety LTE RANs.

International First Responder Networks

- England – Will be operational by mid-2020 (recent schedule slip by 9 months).
- South Korea – Scheduled to be operational for the 2018 Olympics
- Canada – Will use same technology and frequencies as US
- Australia – Different Frequency Bands
- Hong Kong – Testing

International First Responder Networks

- China – Several Operational PS LTE Networks
- Brazil - Using video and data at its police centers on 700MHz LTE.
- Chile - 700 MHz spectrum allocated
- Finland, France – Have unique roadmaps

Will the Tampere Convention have to be updated?

- Each country licenses and regulates communications with guidance from the ITU, a UN agency.
- Except for Shipboard and Aircraft radios that are governed by International agreements, all other communications equipment is regulated country by country.

Will the Tampere Convention have to be updated?

- All transmitters require a station license.
- Equipment that is tuned by frequency requires the operator to have an operators license.
- Certain classes of equipment may be licensed by rule in one country, but not in another.

Will the Tampere Convention have to be updated?

- The Tampere Convention treaty simplifies the use of telecommunication equipment across borders.
- The Tampere Convention calls on states to facilitate prompt telecommunication assistance to mitigate the impact of a disaster and covers both the installation and operation telecommunication services.

Will the Tampere Convention have to be updated?

- Barriers include licensing requirements, use allocated frequencies, restrictions on the import of telecommunication equipment, as well as limitations on the movement of humanitarian teams.

Will the Tampere Convention have to be updated?

- Signed in 1998 by 68 countries.
- Came into force in 2005 when ratified by 30 countries.
- Currently ratified by 44 countries.
- Major countries that have not ratified the treaty include: USA, Russia, Brazil, Chile, Germany, Italy, Portugal

Hardware Challenges

- Mission Critical PTT
- Plugfest June 19 – 23, 2017 – ETSI, Sophia Antipolis, France.
- Focus - MCPTT server to client communications.

Hardware Challenges – PTToC

Hardware Challenges – PTToC

Hardware Challenges
TETRA Radio/Smarphone

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Hardware Challenges
Analog-DMR Radio/Smarphone

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Motorola LEX L10 MISSION CRITICAL LTE HANDHELD – First Certified FirstNet Device

- Defines the broadband experience for officers in the field.
- Coverage on both the Verizon 3G/4G Commercial and Public Safety LTE networks
- Equipped with Google Mobility Services (GMS), offering Google and Android via the Google Play store.

Open Research Questions

- User class prioritization in the field – will it work?
- Will any changes be needed to LTE standards?
- Will Mission Critical PTT work?
- Long Term ***Evolution*** – As we move to 5G, how will FirstNet change?
- What about LTE-U and WiFi?
- Is the political/business model sustainable?

Thanks!

Questions?