Disaster Communications

Ladimer S. Nagurney PhD, PE
University of Hartford

SCHMGT 597LG
Humanitarian Logistics and Healthcare
March 6, 2018



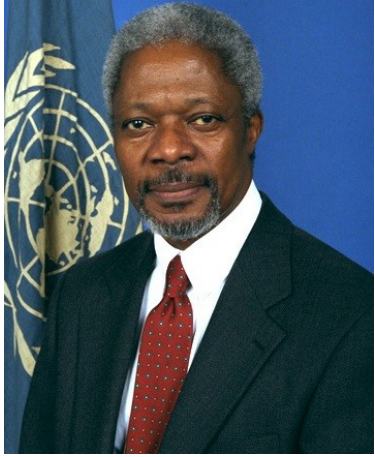








Highlighting the role of Telecommunications for humanitarian assistance, United Nations Secretary General, Kofi Annan said:



Humanitarian work is one of the most important, but also one of the most difficult tasks of the United Nations. Human suffering cannot be measured in figures.....An appropriate response depends upon the timely availability of accurate data from the often remote and inaccessible sites of crises. From the mobilization of assistance to the logistics chain, which will carry assistance to the intended beneficiaries, reliable telecommunication links are indispensable (ICET-98).

Communications Requirements

First 24 hours

Rescue
Command & Control
Disaster Inventory
Humanitarian Calling
News

Second 24 hours

Rescue
Humanitarian Calling
Recovery
News

3-30+ Days

Recovery Operations
Restoration

Communications bandwidth requirements rapidly increase as response extends over time

Trends Transforming Public Safety Communications Motorola Survey 2015

1. An Increased Level of Community Engagement
2. Need to Access Real-Time Data in the Field
3. Need to Increase Communication with Neighboring Agencies
4. Using Collaborative Technologies to Expand Capabilities
5. Need to Manage the Technology Skills Gap

Outline

- Technology for Communications
- Internal Communications
- Communications with other agencies/stakeholders
- External Communication

POTS

Plain Old Telephone Service

Has great security.

Universally available in developed countries.

Slow, but efficient.

However, POTS is

- Dependent on wires being connected.
- Dependent on Central Office operation.
- Subject to local restrictions.

IP (VoIP) phones are not POTS!

2-Way Radio – Conventional – Land Mobile Radio (LMR)

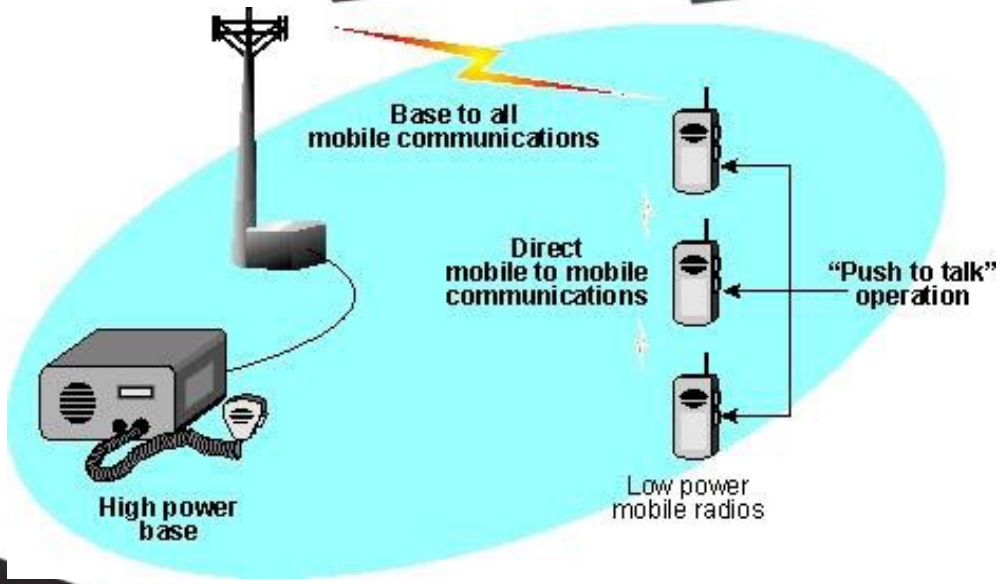
Simplex

Repeated

Trunked

Analog

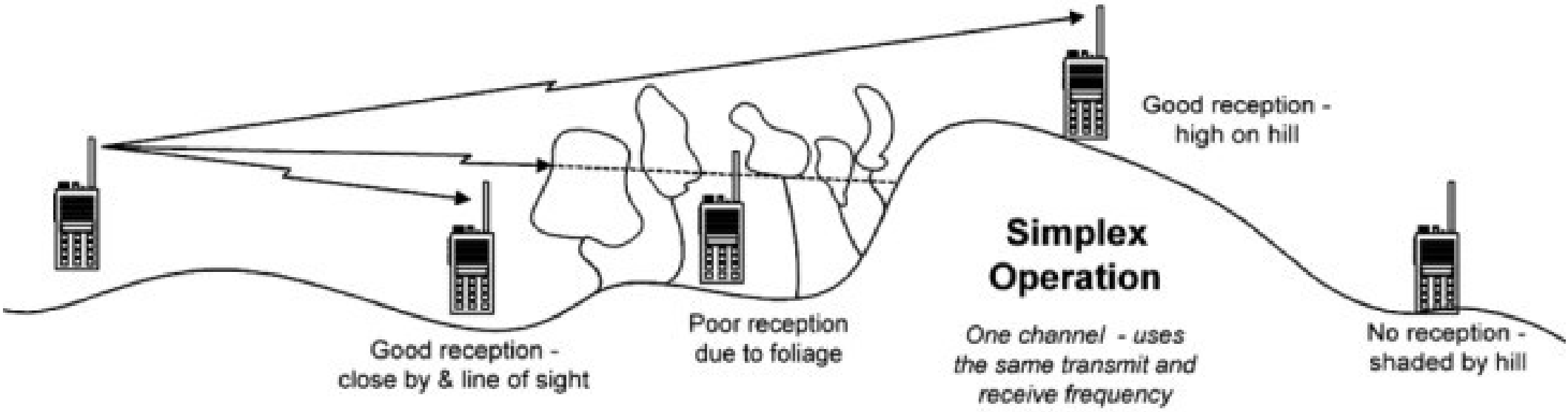
Digital



Simplex Radio Systems

One radio talks to another with no intermediaries.

Generally requires *Line-of-Sight* among radios.

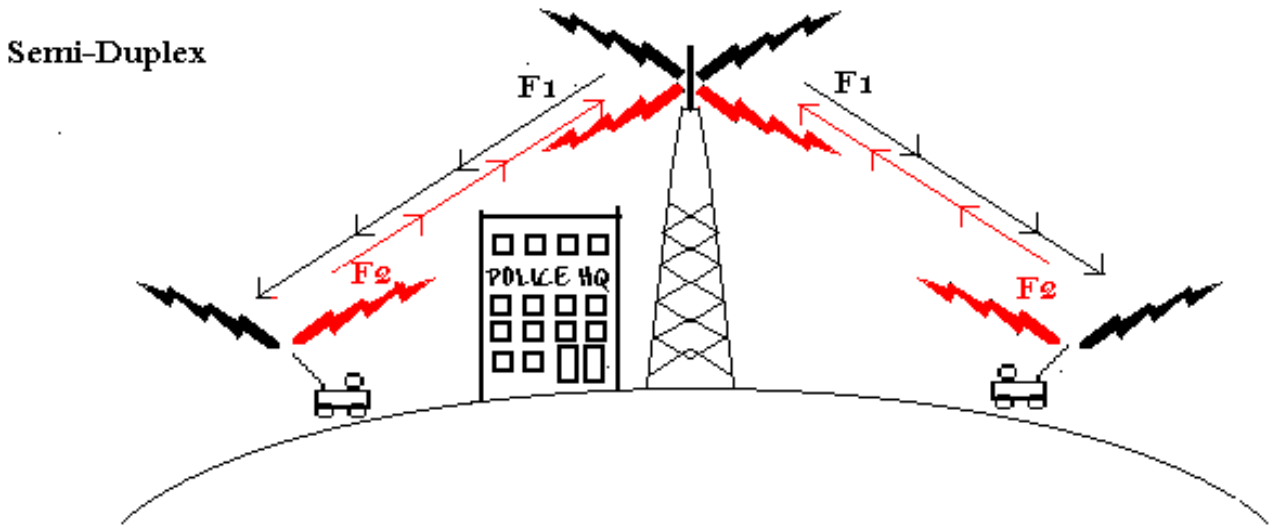


Repeater Radio Systems

All radios receive on frequency F1

All radios transmit on frequency F2

A repeater located at a high location, received the transmission on frequency F2 and retransmits it (repeats) on frequency F1



Repeater Radio Systems

Advantages -

All Users hear all transmissions

Line-of-sight problems are almost eliminated

Portable radios may use lower power

(= longer battery life)

Disadvantages -

Repeater must be operational.

If the repeater fails, users cannot communicate with each other.

Solution: Talkaround

Portable Repeaters that can be rapidly deployed!

Orchard Hill – Saturday, March 3, 2018

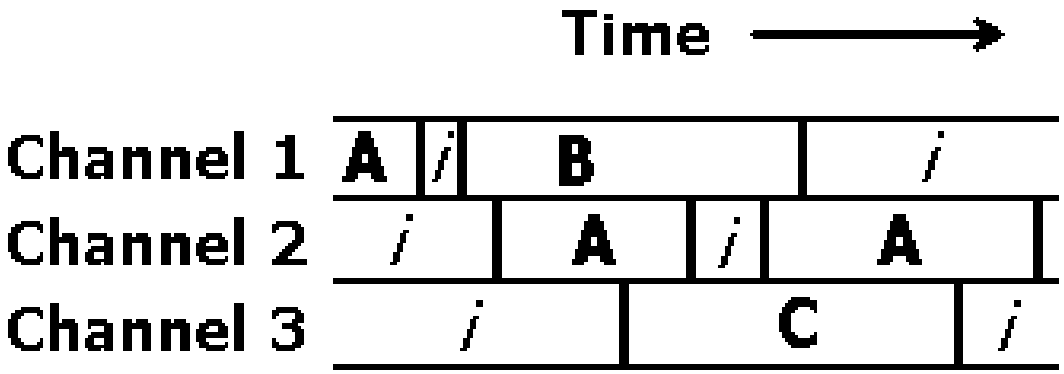
Trunked Radio Systems

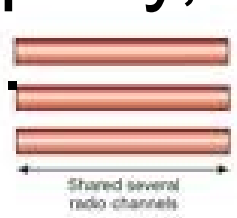
Every group of users does not need the continuous use of a radio channel.

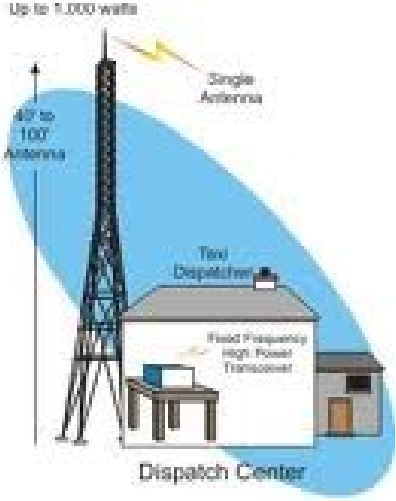
Using a intelligent controller, a pool of several channels can be used by many users.

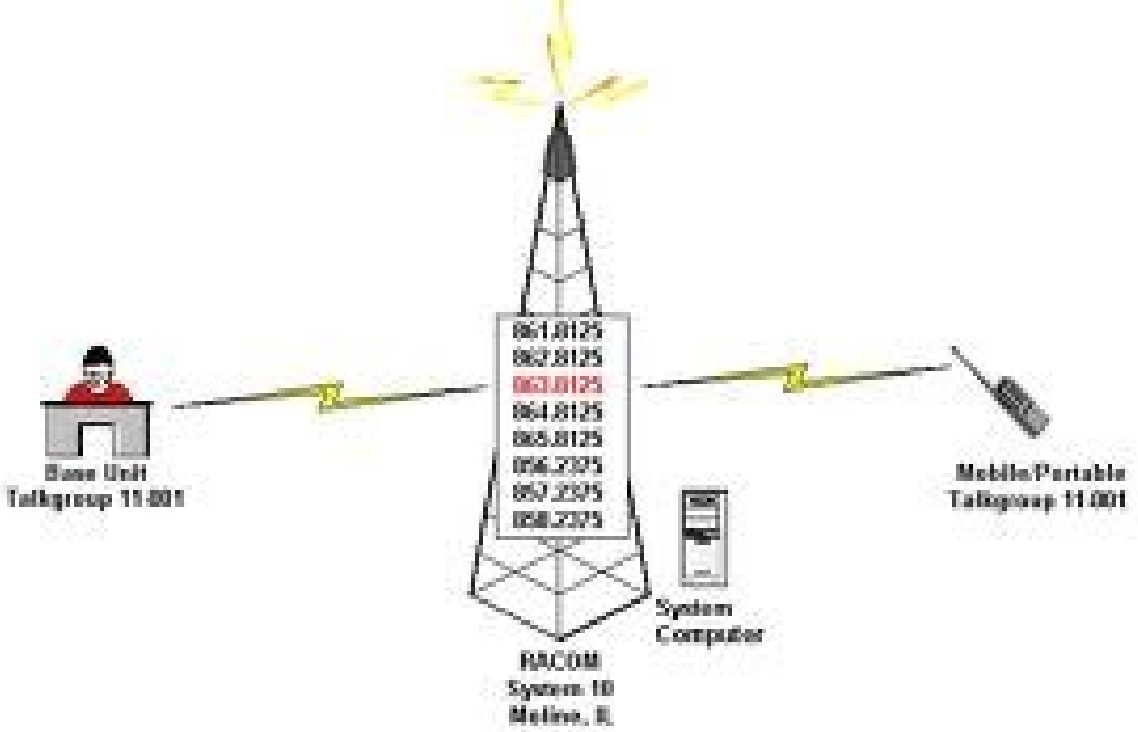
Requires sophisticated hardware at the repeater site.

Unless the system is designed properly, it will not work if the repeater is inoperable.



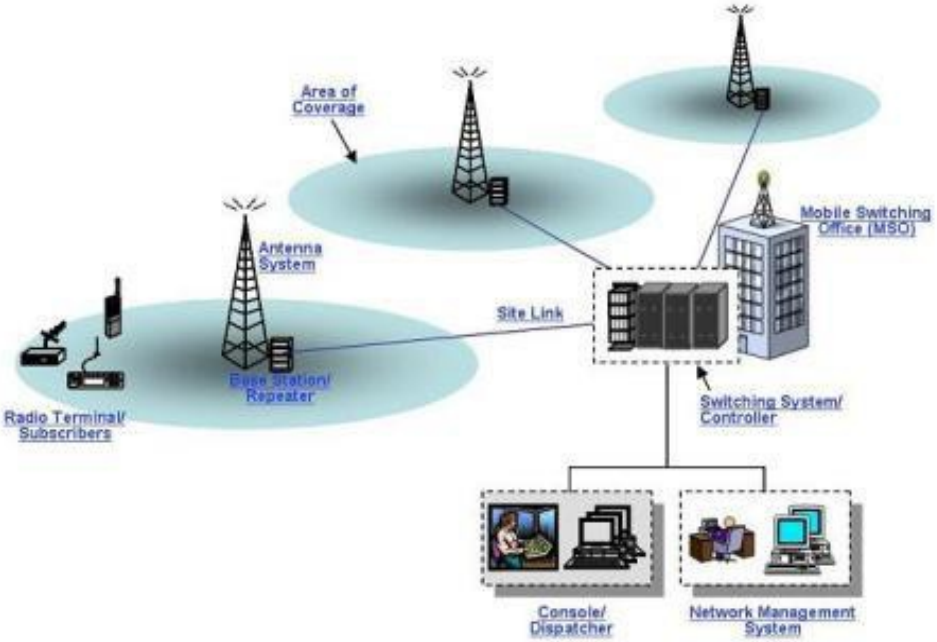






Shares up to 30 channels with a large number of users

* Note: Private IP Network or VPN Tunnels through the Internet with Static endpoints.



Analog vs Digital

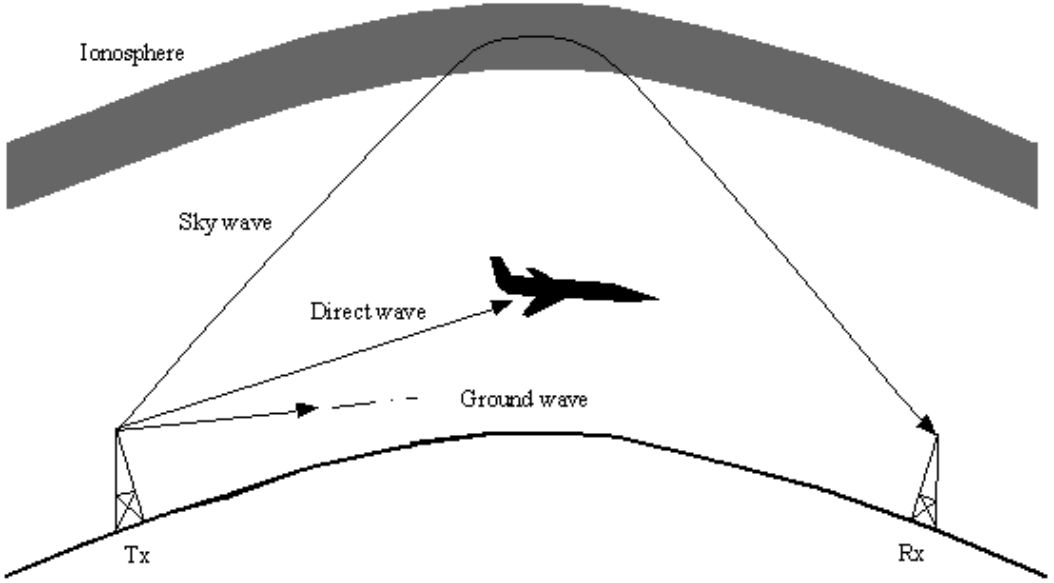
Analog radios use conventional analog technology.

Digital Radios convert analog voice signals to digital and transmit the signal digitally.

Multiple Digital Standards

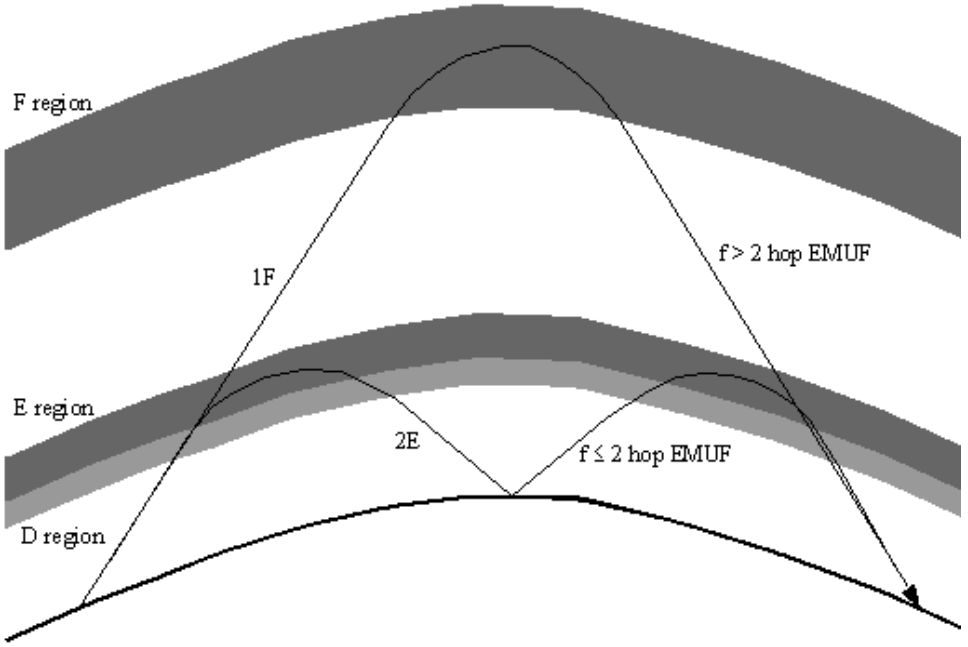
- APCO-25 (P-25)
- DMR
- TETRA

Beyond the Horizon
Non Line-of-Sight Communications



Radio Waves are reflected by the atmosphere.

By appropriate choice of frequencies, reliable communications can be made over ranges from 50 to 10000 miles.



HF Radio in Action

HF Radio at
Yalokole Conservatuion Center

HF Radio

Normal Uses ----- Voice and Data

Aviation – LDOC

Maritime

Point-to-Point

Amateur

Advantages of HF Radio for Emergency Communications

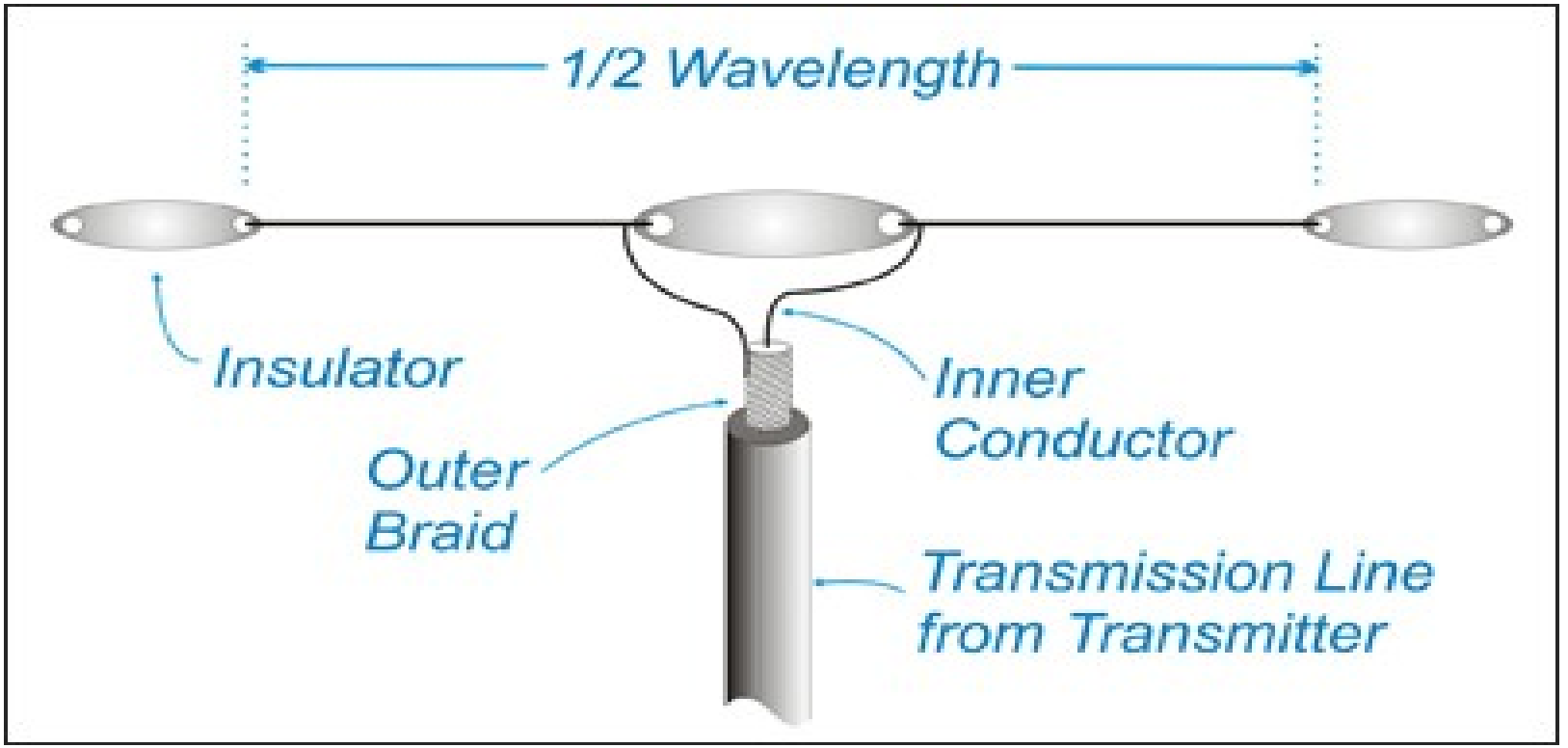
Except for electricity, HF radios do not depend upon any infrastructure. (Can be battery powered)

In most cases, simple antennas, such as wire dipoles can be used. (Even if antennas are destroyed during the emergency, new ones can be easily installed.)

Modern protocols allow a slow connection to the internet for email.

Relatively simple to use, however operators must be trained.

½ Wavelength Dipole
Length in ft = 468/Frequency in MHz)



Disadvantages of HF Radio for Emergency Communications

Trained operators needed at each end.

Usually no automatic connection to networks.

Data rates are slow. (At best dial-up internet at 9600 baud.)

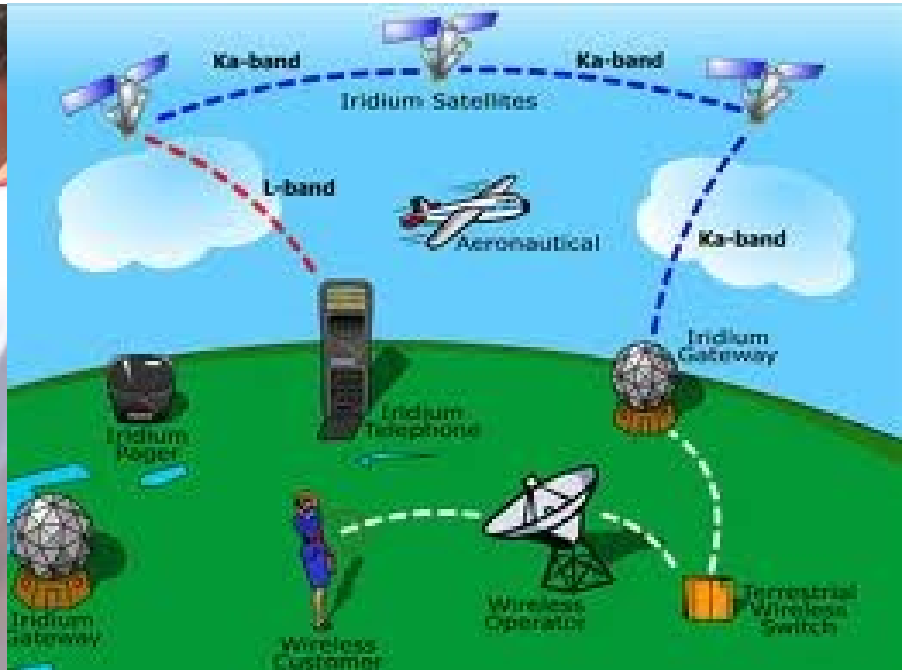
Security is minimal, although that can be an advantage.


Humanitarian Logistics in a Nutshell – Part 2:
Communications Equipment
Democratic Republic of Congo - 2010
http://photodiarist.com/tag/satellite-phones/

Satellite Communications

Low Earth Orbit (LEO)

Geosynchronous Earth Orbit (GEO)



Low Earth Orbit (LEO) Satellites

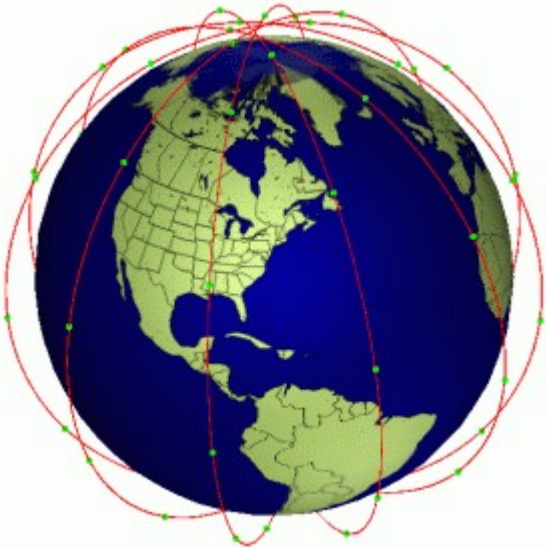
LEO Satellites orbit 100-200 miles above the earth.

Can be accessed with relatively simple equipment.

Handsets look like Cell Phones with Antennas on Steroids.

Require sophisticated networking technology.

Can be used as an Internet Hotspot.



Geosynchronous Earth Orbit (GEO) Satellites

Satellites are 22,000 miles above the equator and orbit the earth in 24 hours appearing to be stationary to the user.

Require dishes antennas to access the satellite.

High bandwidth – Can be used for audio/video/data.

Cell Phones
Voice and Text Messaging

Almost ubiquitous!

Text messages will often get through when voice calls will not.

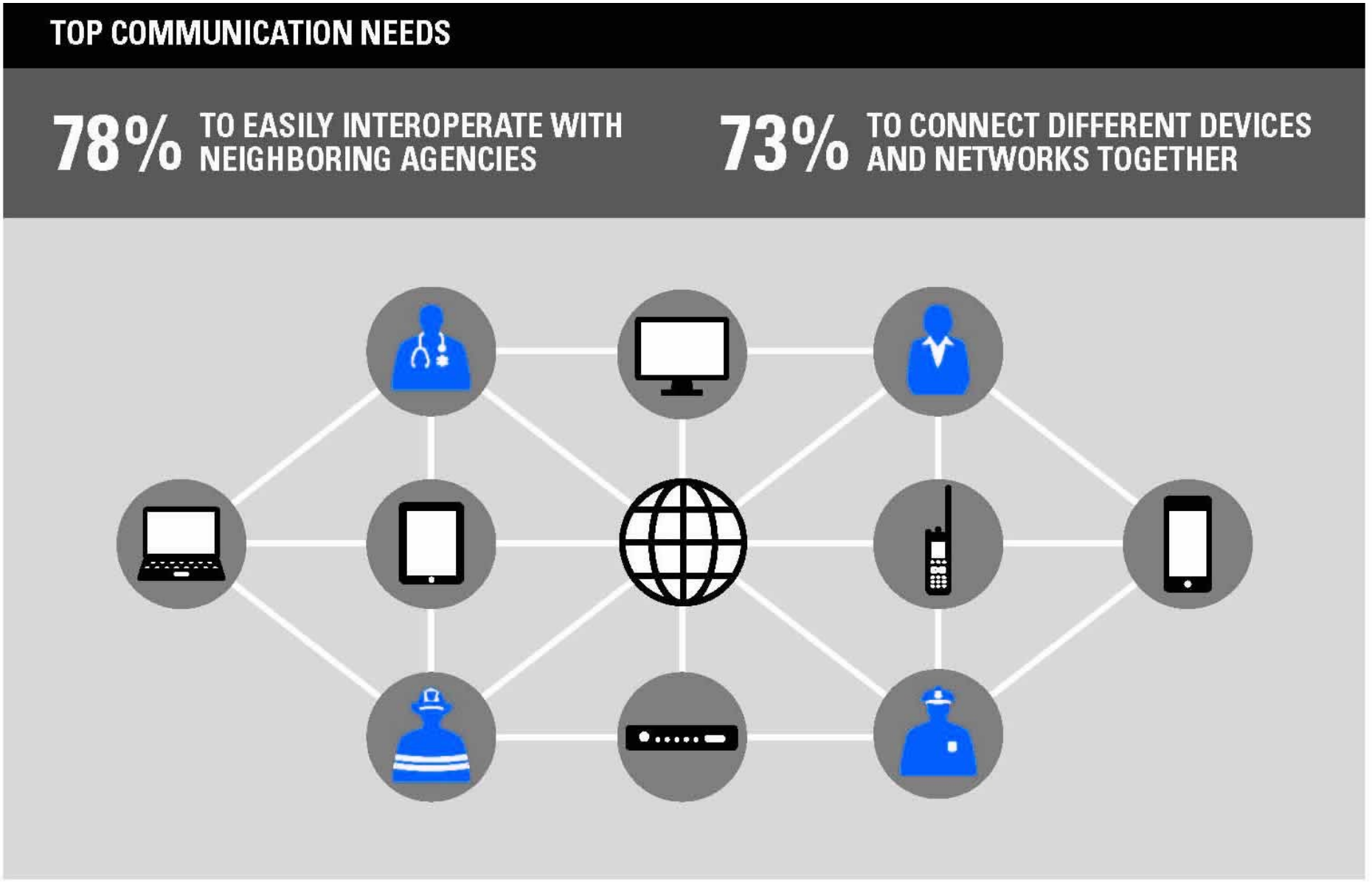
Data services at cell sites are often disabled during an emergency.

Cell sites and associated hardware must survive the disaster.

Broadband for our Smartphones has similar problems!

Rapidly Deployable Cell Sites

Interoperability



Interoperability

Adjoining agencies and stakeholders cannot communicate with another in real-time.

First came to the forefront after 9/11, although it was identified as a problem a decade or more earlier by Communications Professionals.

Major Problem - different agencies use different frequency bands and are licensed separately.

Territorial boundaries limited local government agencies, federal agencies, and non-governmental agencies from having joint radio/communications facilities.

Post 9/11 in the US, a series of interoperability frequencies were allocated that anyone with a primary service license can use for inter-agency operations.

More collaboration among the 3 licensing agencies.

FCC – State and local government, business, non-profit organizations

NTIA - IRAC (Intergovernmental Radio Advisory Committee) – Federal Agencies (non-military)

DoD Frequency Managers – Military Agencies

Key Problems

- Seven frequency bands allocated for public safety.
- Multiple radios cost over $10K per vehicle

Massachusetts Mobile Emergency Operations Center

But what about smart devices?

Public Safety users have quickly embraced Smart Devices.

Chief advantages are simplicity and security.

COTS devices are useful, but lack reliability is harsh environments.

In times of emergency, cell service becomes congested!

Long Term Evolution or LTE

LTE is the standard used by most of our smart phones and devices

Well established in the consumer market, but enhancements are required to the standard to specifically address the needs of Public Safety/Critical Communications.

The driving factor for adopting LTE for Emergency Communications sector is the increased need for broadband data applications.

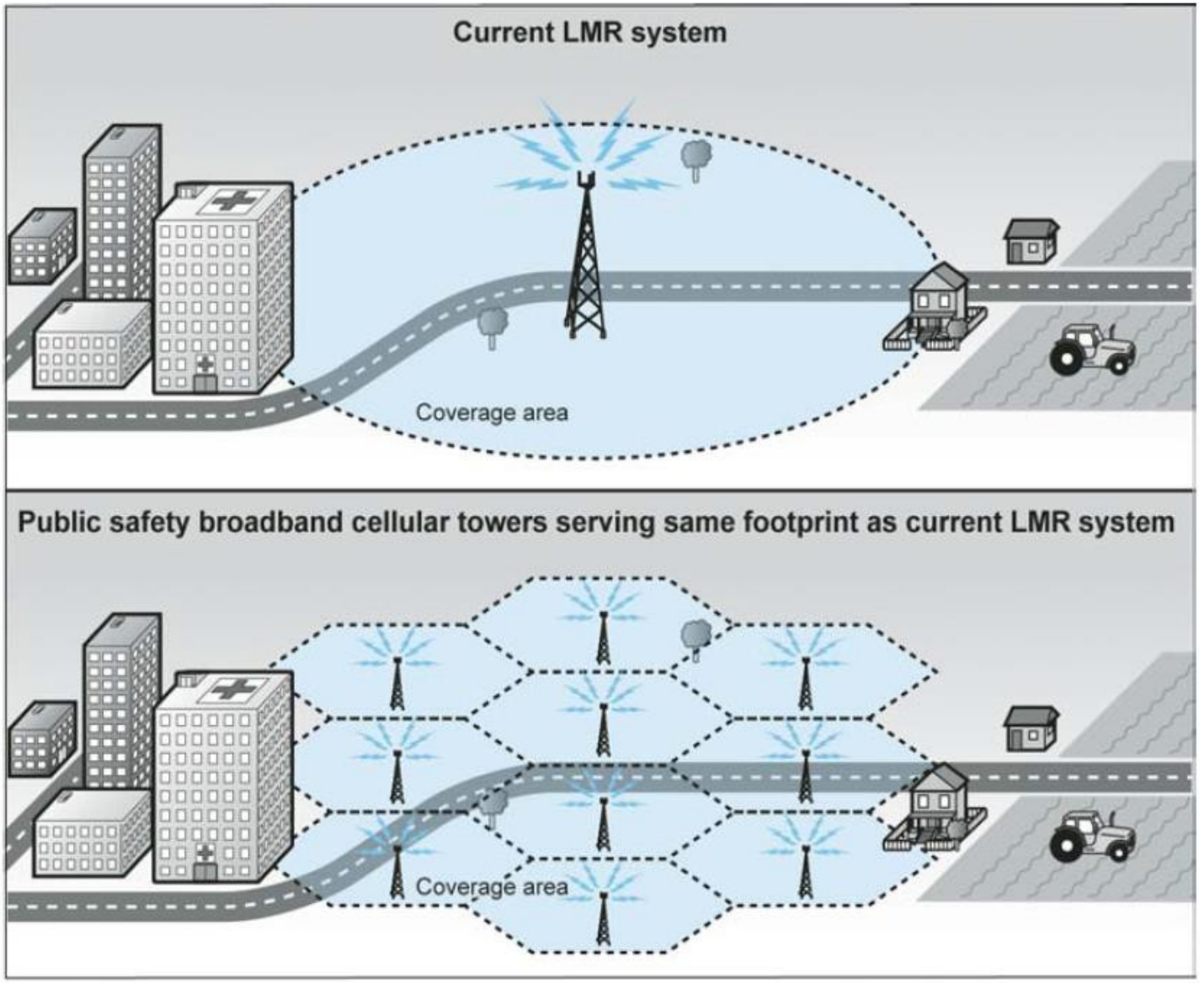
Relation of LTE to LMR

Exactly how LTE will affect a public safety user will depend on that user's role.

Mission Critical Uses, such as fire and police dispatch, will probably not care about LTE all that much. Their main concern is reliability, not the underlying technology, such as LTE, P25, TETRA, or analog.

Mission Critical Users need a communications system that will be there when their safety is on the line.

Differences between LMR and LTE systems



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

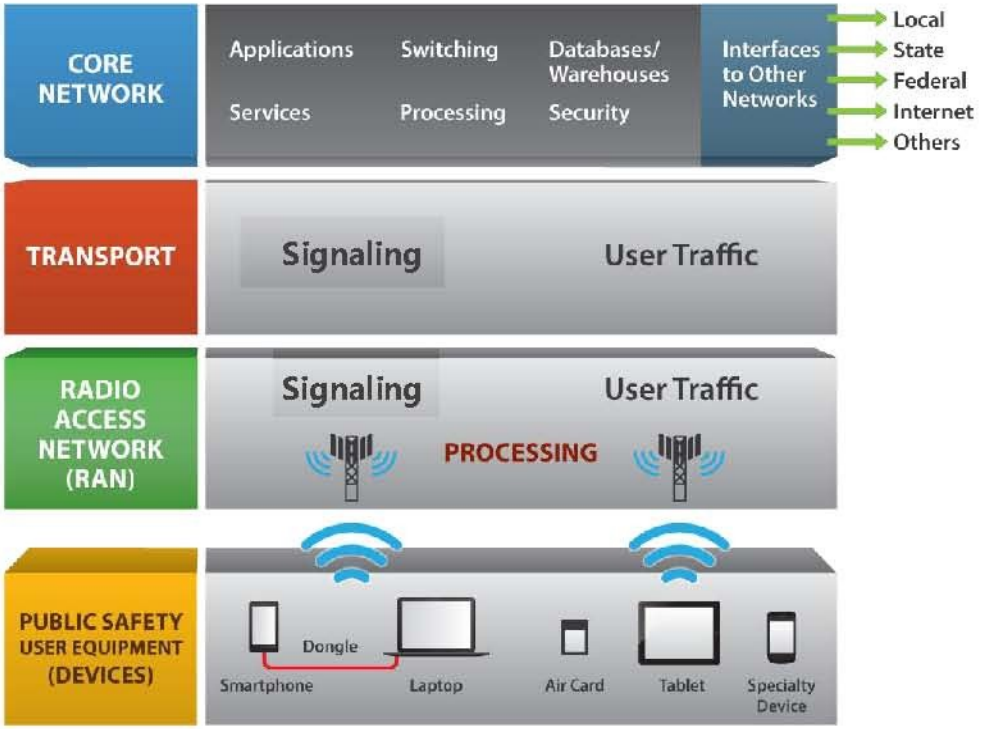
- All sites operate on same frequency thus overlapping coverage needs to be minimized
- "Channels" managed dynamically at each site
- Bandwidth determined by need and availability *minimizing congestion concerns*
- One large data "pipe"
  - *Up to* 74 Mbps capacity near cell tower
  - Capacity reduces 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

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"



LTE is not perfect for the Critical Communications Sector, but additional features would help.

Proximity Services to allow mobiles to identify other mobiles in physical proximity and enables Direct Device-to-Device calls allowing communication among users 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 to access to network services.

User equipment to user equipment relay, allows one mobile to act as a relay point among users and allows network-free communications.

LTE is not perfect for the Critical Communications Sector, but additional features would help.

- Key feature ***Mission Critical Push-To-Talk (MCPTT)*** allowing radio-like communication over LTE.
- Security features to protect the system from unauthorized users, eavesdropping, denial of service attacks, and other security risks.

Mission Critical PTT over LTE

Standard first responder radios are Push-To-Talk

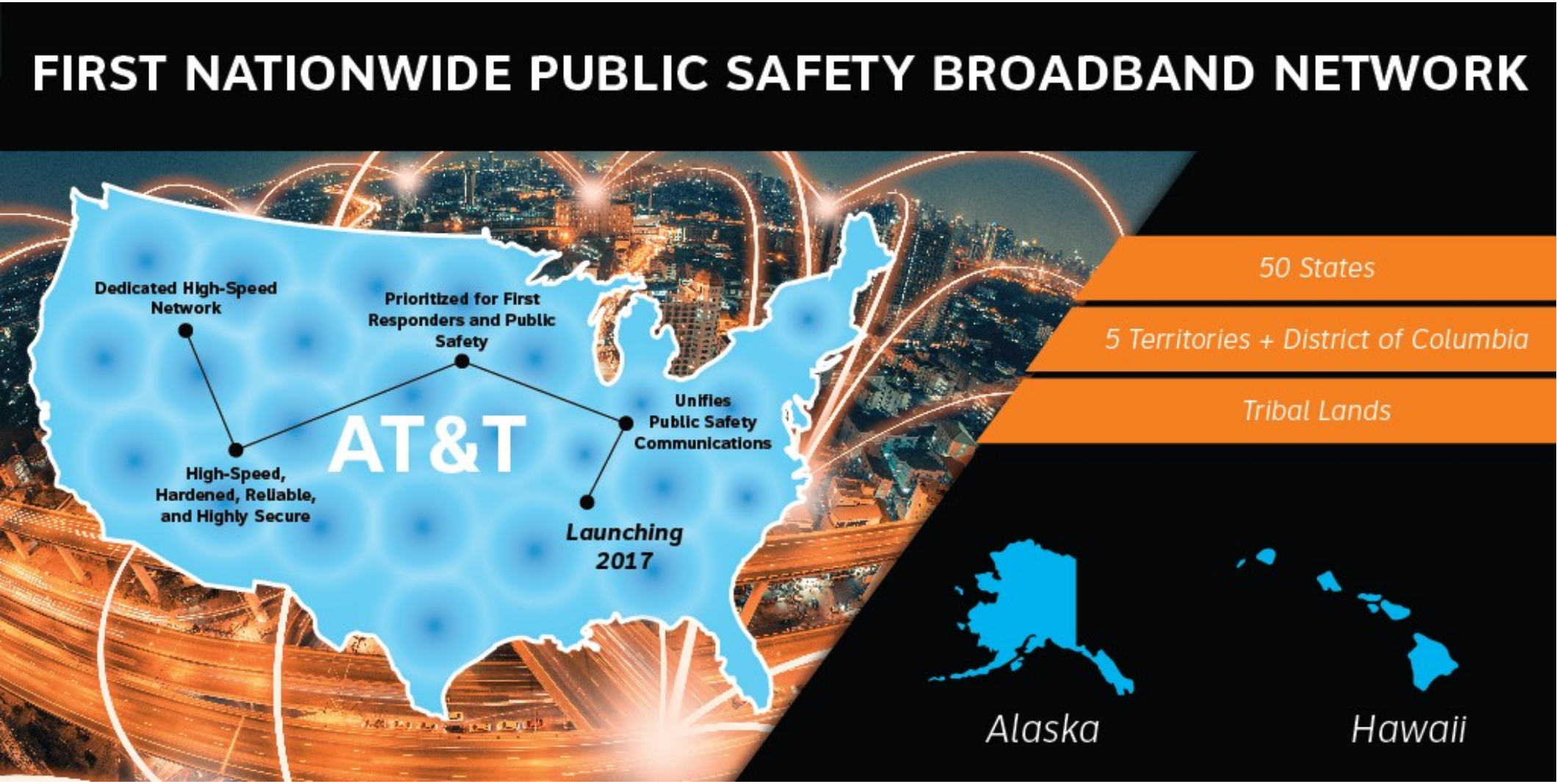
Because of Latency, PTT over LTE is still in it's infancy.

LMR-LTE full-featured interoperability has been demonstrated – Latency tolerable (almost not-noticeable)

Non-mission critical demos - Band 14 public-safety LTE system

Rose Parade

Super Bowl



Purpose is to provide a Broadband Network for public safety that will work even during emergencies!

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. Typically, only one or two cell sectors will be used

Real-time network management will be required to give Public Safety users *pre-emptive priority*.

FIRSTNET

WHAT

The First Responder Network Authority

Build, operate and maintain the first high-speed, nationwide wireless broadband network dedicated to public safety

WHY

Born from recommendations by the 9/11 Commission

End the history of public safety communications challenges to help keep our communities and emergency responders safer

First Responder Communications Challenges

10,000+ individual radio networks

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

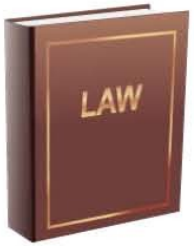
Commercial networks congested during crises

70k+
Public Safety Agencies

3,100+
Counties

550+
Recognized Tribes

FirstNet Beginnings



THE LAW

2.22.12

FirstNet becomes law
PL 112-96

FUNDING

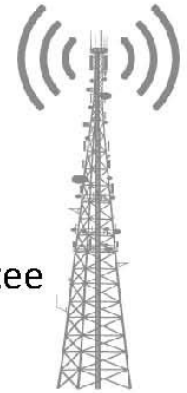
$7B authorized to build the FirstNet network. Funded by spectrum auctions through 2022.

GOVERNANCE

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

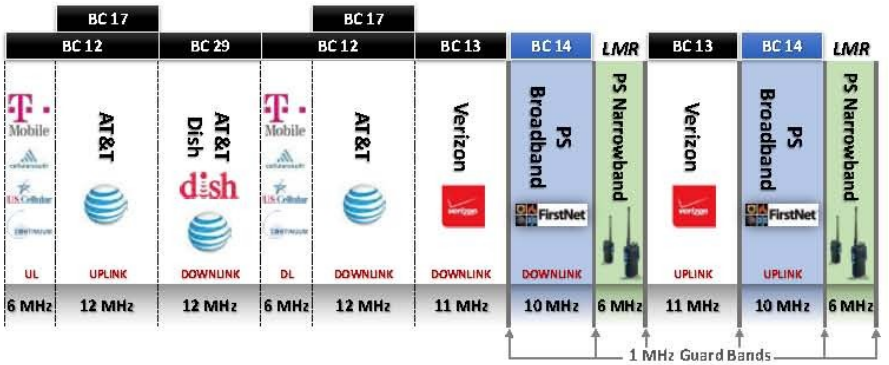
Each Governor appoints **1** Single Point of Contact (SPOC) and governing body to represent the state's interests to FirstNet.

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



BAND CLASS (BC) 14

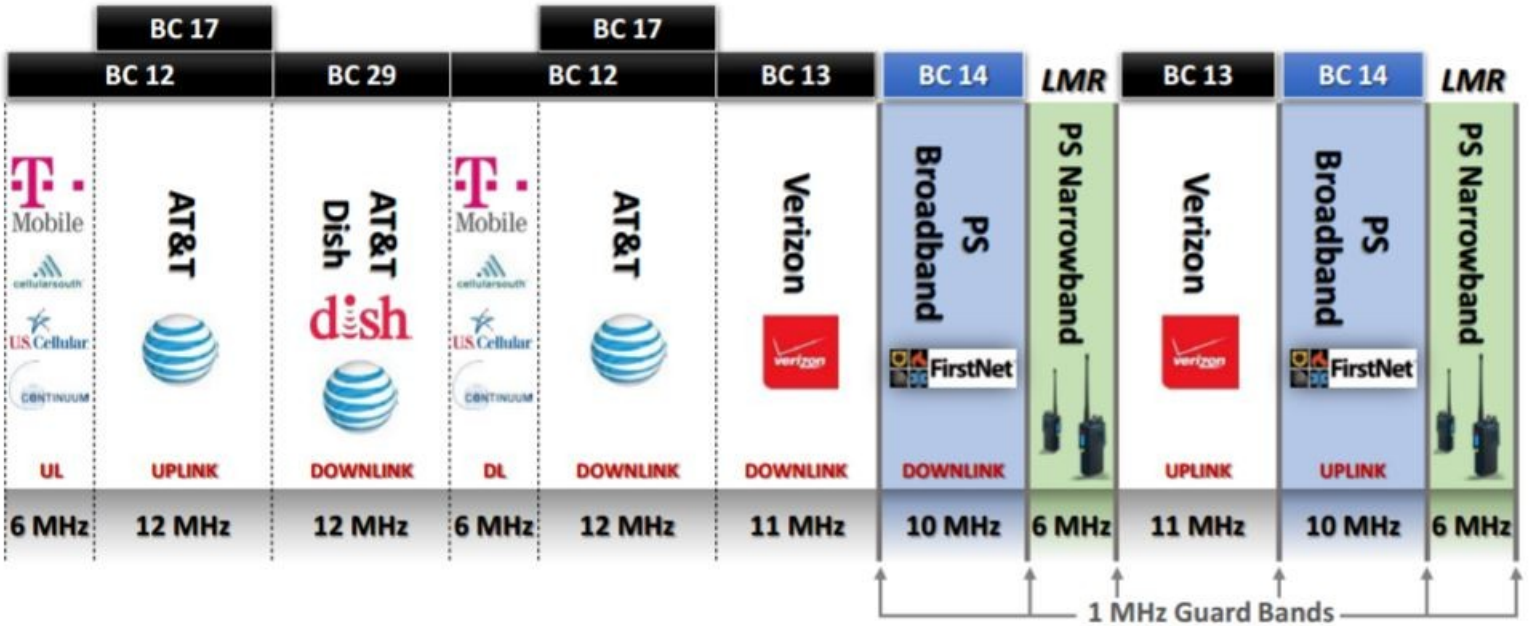
20MHz of bandwidth has been dedicated to public safety in the prime upper **700MHz** frequency range.



FirstNet LTE Band 14

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

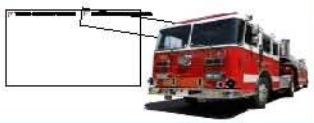


The RAN will be a Combination of Terrestrial, Satellite, and 'Deployables'

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

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

Non-Mission Critical | The Current State | Mission Critical

Commercial LTE Service / Devices

Data | Voice

Land Mobile Radio (LMR) for Public Safety

Voice

Non-Mission Critical | The Near-Term Vision | Mission Critical

FirstNet™ LTE Service / Devices

Data | Voice

Land Mobile Radio (LMR) for Public Safety

Voice

FirstNet announces technology partner to deploy innovative mobile network for public safety

FirstNet™ | AT&T

March 30, 2017

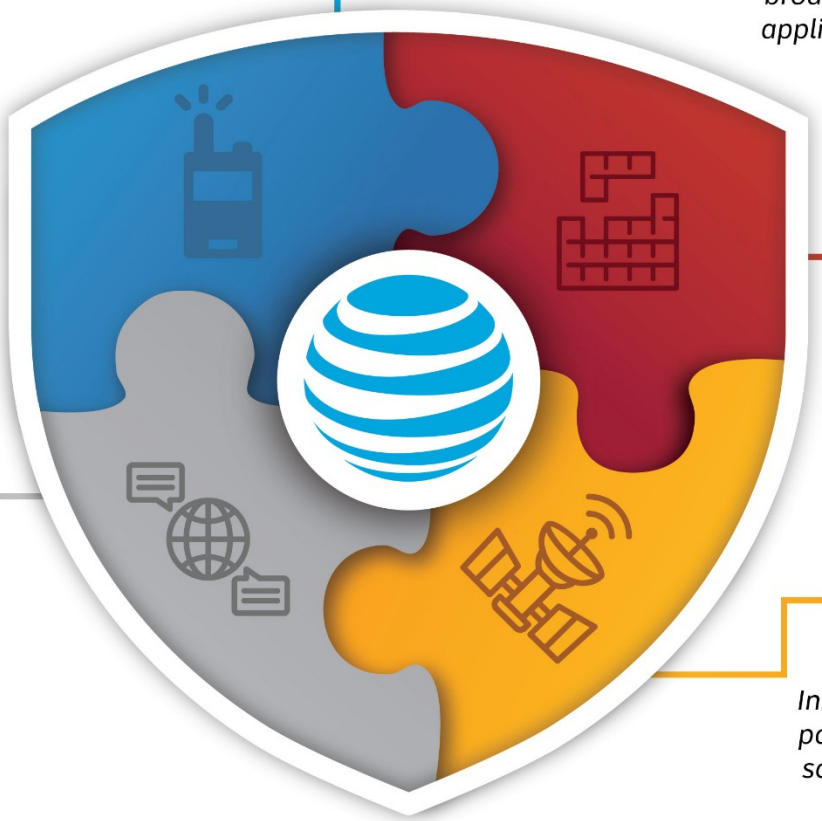
AT&T's Team for FirstNet

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

The Public-Private Partnership approach will lead to a fully-funded, self-sustaining Network with a business model is built upon the efficient use of resources, infrastructure, cost-saving synergies, and incentives, including:

- FirstNet provides 20 MHz of spectrum and $6.5 billion in initial funding to the partnership; and in return 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 together with FirstNet will help to 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.

Devices for First Responders

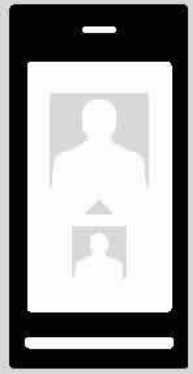
Combination Radio/SmartPhone

Complications

- Today's smartphones (smartdevices) are not one-handed devices
  - Require two hands to operate
- Most use touchscreen - Touchscreens not conducive to use when wearing gloves
  - Not a problem when first responder is patrolling or sitting in a vehicle BUT it is a problem when on an incident
  - Not designed for harsh environments
  - Need built-in Card Readers, Barcode Readers, etc.

Public Safety usually cannot use both hands on a device!

How Agencies Plan to use Data Networks



75%
WANT LTE MISSION CRITICAL VOICE AND DATA

73%
CONTINUE TO INVEST IN THEIR LMR NETWORK
MORE THAN DOUBLED
FROM 2014

45%
WILL USE LTE WITH THEIR CURRENT LMR SYSTEM

400% INCREASE
FROM 2014

54%
USE OR WILL HAVE A DIGITAL P25 PLATFORM

The US is not alone in implementing broadband networks for first-responders

England – Will be operational by mid-2020 (recent schedule slip by 9 months).

South Korea – Operational for the 2018 Olympics

Canada - Will use same technology as the US.

Other countries are planning broadband networks for First Responders.

Many interoperable network plans in progress.

First 911 Call
February 16, 1968
Haleyville, Alabama.

Next Generation 911

In 2014 more than 170 million emergency calls were made to 911

76% of 911 calls come from cellular devices

21% are made from landline phones.

In General location of Cable-based phones cannot be determined by 911 center

In 2014 there were 1,121 text-to-911 communications. This number is expected to skyrocket in the future.


27%
OF AGENCIES ARE ABLE TO RECEIVE TEXT-TO-9-1-1
ALMOST 300% INCREASE
FROM 2014
9-1-1
9-1-1
9-1-1
9-1-1

Internationally Interoperability is limited by Licensing and Equipment Shipment

Each country licenses and regulates communications with guidance from the International Telecommunications Union (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.

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 another.

Tampere Convention


The "Tampere Hall" in Tampere, Finland, where the treaty on Telecommunication for Disaster Mitigation and Relief was signed on 18 June 1998.

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.

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

Status of the Tampere Convention

Signed in 1998 by 68 countries.

Came into force in 2005 after it was ratified by 30 countries.

Currently 44 countries have ratified the treaty.

Major countries that have not ratified the treaty

USA, Russia, Brazil, Chile, Germany, Italy, Portugal

Getting the Word Out to the Public

AM and FM Radio (includes Shortwave Radio in less developed regions)

Constraints

- Not all stations are *local*. Stations may not have a local news/features staff.
- Currently most stations do not have a resident engineering staff. Thus during a disaster if the station is forced off the air, repairs may not quickly be made.
- In many countries AM radio is non-existant and FM is in a state of flux!

Several manufacturers have developed hand crank radios, where a crank can be turned to generate electricity for several hours use.

More sophisticated types include a flashlight and a cable that can be used to recharge ones cell phone.

Getting the Word Out to the Public

Television

- Station must stay on the air. Most have backup power, antennas, and transmitters.
- Many (most) of us receive our television via Cable, thus if no cable, no TV.
- Digital TV makes reception of just TV audio nearly impossible.

NOAA Weather Radio

- Originally designed for marine weather, now has expanded to all hazards.
- Receivers are available but not universally used.

But, now, who listens to the radio or watches over the air TV?

We're glued to our smartphones and tablets!

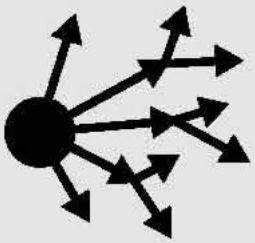
Social Media

FORGING A PUBLIC ALLIANCE

The number of agencies relying on data-driven communications to engage with their communities is growing rapidly. Of respondents, 55% share information with their community via social media, and nearly 30% receive information directly from the public through Facebook and Twitter.

The prevalence of social media in everyday life is driving the need for greater adoption and engagement by public safety agencies. The actions of first responders are routinely recorded by citizens on mobile devices and instantly uploaded to social media sites.[1]

Social media is an essential platform for building community relations. It enables agencies to share information quickly, as events unfold. It helps increase transparency by having an open conversation with the public. It informs citizens on a regular basis and encourages their feedback. This valuable exchange deepens the partnership with local government.



Public safety leaders underscore how essential technology is for building a stronger public alliance. The number one reason for law enforcement agencies to implement new technology is to "improve community confidence and support."[2]

Social Networking Sites

Twitter is universal!

- Social Networking sites, such as Facebook are popular with Emergency Managers to get information out but not as efficient!
- Constraint is that the Internet must work.

Emergency Text Messages

- Can be used to text a large group of people quickly.
- Assumes cellular network is up and running.

Reverse 911

- Can notify wide area by telephone (but usually not cellphones)

Priority – In addition to restoring power, water, clearing roads, broadband service must be restored!

In some areas non-profit local organizations are assisting in wi-fi restoration.

Companies are also assisting

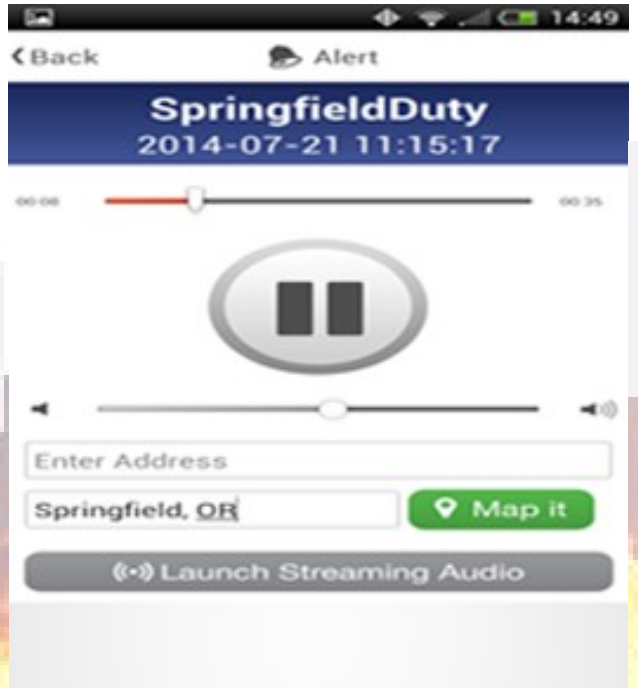
Cape Cod
Sunday
March 4, 2018

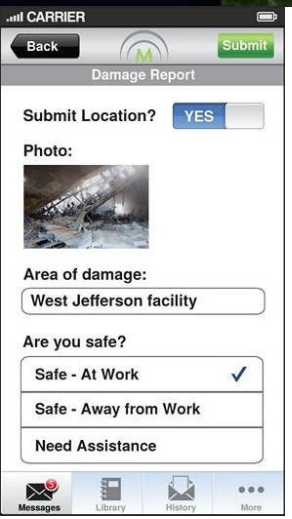
Enterprise Based EOC Systems

intermedix
em systems
WebEOC

veoci
The Virtual EOC

eDispatches – Dispatch to Cell Phones





Disaster Apps

http://www.missionmode.com/15-disaster-and-crisis-apps-for-iphone-and-ipad/

Questions?