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Public Safety Communications Advances, The 3 Flavors of 5G and Amateur Radio

With Advent of FirstNet Nationwide Broadband Public Safety Network, and now 5G

IS THERE STILL A NEED FOR AMATEUR RADIO? YES!

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What Is FirstNet, How Did it Come About?

- Public Safety has had interoperability issues with disparate Land Mobile Radio (LMR) systems for more than 40 years
- 9/11 and Hurricanes Katrina and Sandy brought this into public view for the first time
- 9/11 Commission Report listed 10 recommendations, the last was to solve the lack of communications interoperability
- Ham Radio has always played an important role in providing emergency communications for multi-agency incidents

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Looking for Solutions

- 2006, Morgan O'Brien, Nextel co-founder, gave a Keynote speech calling for a Public Safety broadband network
- 2008, FCC authorized some 700-MHz spectrum for Public Safety
  - Some for 12.5-KHz channels for Land Mobile Radio (LMR)
  - Some for 50-KHz channels for data services
- It did not take long for Public Safety to arrange for reallocation of the 50-KHz channels for broadband resulting in a nationwide Public Safety 5 MHz X 5 MHz (5X5) broadband license
- The Public Safety Spectrum Trust, headed by (Ret.) Chief Harlin McEwin, was awarded this license

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How Much Spectrum Was Needed

- An adjacent 5X5 portion of spectrum was to be auctioned to a commercial network operator that would be required to build its network for Public Safety
  - However, bidding did not reach the minimums
- This “D Block” spectrum was therefore in play during the 700-MHz spectrum auctions
- The Public Safety community spent the next four years lobbying Congress, the Executive Branch, and the FCC to re-allocate the D Block and combine it with what Public Safety had already been awarded
- In 2011, real-world capacity tests were run on a system installed in the East Bay North of San Francisco (https://ecfsapi.fcc.gov/file/7021709918.pdf)
  - This report proved 5X5 MHz of spectrum would not be sufficient

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Congressional Bills to Create the Network

- Bills were introduced in the Senate by Sen. John McCain (AZ) and Sen. Joe Lieberman (CT)
- Another bill was introduced in the House by Rep. King (NY)
  - King bill asked for return of ALL 150-512-MHz Public Safety spectrum
- Additional bills introduced by others
  - None passed
- In 2012, Congress introduced The Middle Class Tax Relief Act of 2012
  - Section VI called for creation of the Public Safety Nationwide Broadband Network
  - Passed and signed into law late February 2012

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Bill Creating FirstNet Signed into Law

FEBRUARY 22, 2012
(PUBLIC LAW 112-96 (TITLE VI)

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FirstNet Was Created

- Title VI brought both good and bad news for Public Safety
  - Public Safety was awarded the D Block, 5X5 MHz of 700-MHz spectrum
  - Resulted in Public Safety Band 14, 10X10 MHz of 700-MHz spectrum
  - $7 Billion in funds committed to Public Safety (but only after a future auction)
    - A few million for NG9-1-1
    - A few million for research and development
  - FirstNet The Authority was formed
  - Board members include Public Safety, industry, and federal department heads
- Public Safety's use of the T-band (470-512 MHz) to cease in 2022
  - T-band is widely used in eleven major metro areas and surrounding communities
  - There is no other spectrum where these agencies can be relocated
  - And there are no funds to cover costs to relocate these agencies
- There are ongoing efforts to convince Congress to reverse this give-back
- No certainty as to the outcome

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FirstNet Contract Award

- There were three bidders, two were disqualified
  - One disqualified bidder took FirstNet to court and lost
- Bid awarded to AT&T March 30, 2017
- States and territories had right to opt out of FirstNet by December 2017
  - Opting out meant organization must build its own portion of the network and meet interoperability goals of the nationwide network
- December 30, 2017, ALL fifty states and six territories had opted into FirstNet
  - Does not mean individual agencies within the state have to opt in

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AT&T Surprises Public Safety

- We expected successful bidder to build out a totally new network using only Band 14 (Public Safety spectrum)
- AT&T saw it differently
  - Offered up ALL its existing LTE spectrum for Public Safety
  - Use of this spectrum would include full pre-emption and priority access for entire LTE network
  - It would build Band 14 to augment its own spectrum in some areas
  - It would build out Band 14 in areas where where it did not have spectrum
- Huge bonus for Public Safety, more broadband spectrum almost everywhere
- Network build-out is in full development mode
- New handheld devices capable of all AT&T spectrum plus Band 14 are available
- AT&T has augmented network build with Cows, Colts, and UAVs
  - (cells on wheels, cells on light trucks, cells on drones)

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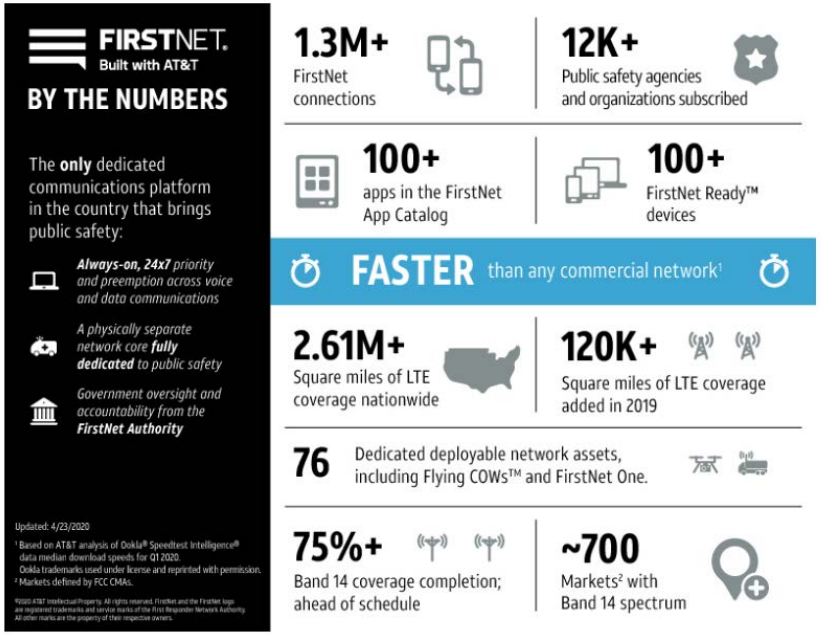
Where FirstNet Is Today

Most Recent FirstNet Report



FirstNet (Built with AT&T)

- Is the official name of the network
- FirstNet The Authority is its governing body
- FirstNet (Built with AT&T)
  - Is ahead of every milestone in the RFP
  - Has already collected $Billions from FirstNet The Authority
- Network will cost more than $30 Billion at end of initial five-year build-out
- It will never be finished!

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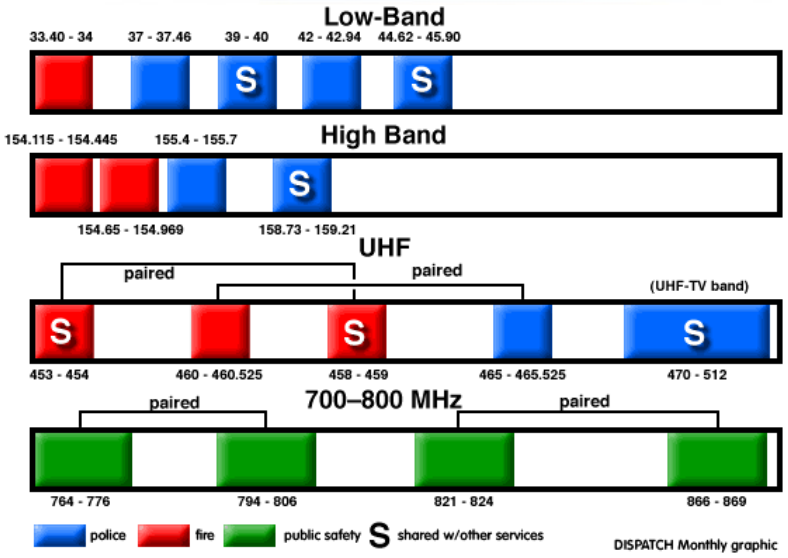
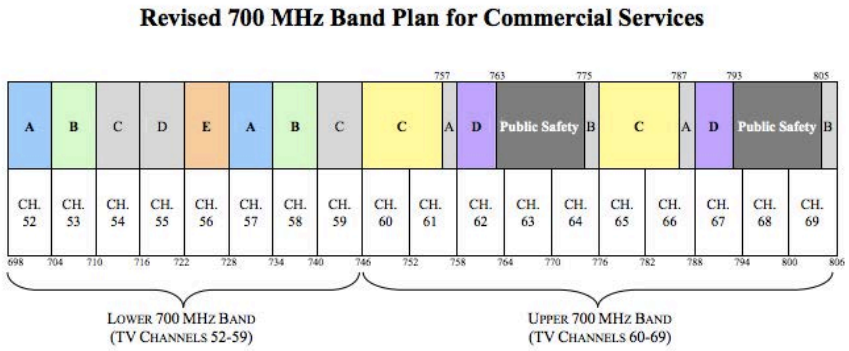
Public Safety Spectrum





None of this spectrum is "safe" from being re-assigned and auctioned!

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What's Next

FIRSTNET, LAND MOBILE RADIO, NEXT GENERATION 9-1-1, ALL-IP WIRELESS WORLD

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Public Safety Communications Upgrades

- First upgrade was the new nationwide broadband network approved by Congress in 2012
  - Known as FirstNet, it is like a commercial broadband network
  - HOWEVER, it provides Pre-emption and Priority for all first responders
- Land Mobile Radio systems being upgraded from Analog FM to Digital
- 9-1-1 Public Safety Answering Points (PSAPs) being upgraded to Next Generation 9-1-1 (NG911)
- These upgrades will have an impact on communications tools available to Public Safety and aid in identifying what may still be needed during major emergencies

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Public Safety Coverage

- Public Safety needs are different from commercial broadband customers' needs
- Public Safety needs lots of bandwidth and speed even for small incidents that may be covered by only one or two cell sectors
- Public Safety needs seamless connectivity between FirstNet and any and all LMR systems (P25, Analog, DMR, etc.)
- FirstNet is nationwide
  - Even so, LMR remains the voice technology of choice
- LMR and FirstNet are both needed today and into the future

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Land Mobile Radio and FirstNet: Both are Needed

- FirstNet now offers what is mistakenly called Mission Critical Push-To-Talk (MCPTT)
  - It should be called Public Safety Grade Push-to-Talk
  - However there are 4 or more approved PTT vendors on FirstNet, none of which are compatible with the others.
  - Big push for FirstNet to LMR PTT integration but now a simple or inexpensive task
    - LMR comes in Analog and Digital formats FirstNet it Digital
    - There are bridges to cross connect LMR and FirstNet but not easy to do
  - Mission Critical PTT includes off network or simplex PTT HOWEVER:
    - Pro-Se as it is call will NOT provide the type of simplex range needed for public safety
    - At the moment to people several hundred feet apart can yell at each other and be heard when Pro-Se won't.
- LMR PTT provides much better off-network range
- This is where area where Amateur radio can be of assistance during multi-agency incidents

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PTT Integration for LMR/LTE on FirstNet

- There is a critical need TODAY!
- This integration will enable an agency handling the incident to coordinate with incoming units regardless of where they are from (as long as they are using FirstNet)
- Interoperability between local, state, and federal agencies is vital to providing better, more reliable communications
- There are ways to accomplish this
  - However, there are some pitfalls!

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Interoperability Goal

- A common or several common, open-standard, inexpensive ways to provide LMR/FirstNet integration
- Agencies using digital (P25) systems may need a different solution than agencies using Analog FM systems
- Various organizations are working to solve this problem
  - 3GPP Standards Body
  - PSTA (Public Safety Technology Alliance)
  - Vendors
  - Others

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Tasks Public Safety Needs to Complete

FirstNet is a great PTT platform for providing multi-agency interoperability. The following are needed to meet the interoperality goal

- Integration of Next Generation 9-1-1 with FirstNet
  - For vetted pictures and videos to be distributed to those responding to an incident
- Rural Broadband Coverage
  - FirstNet has a mandate
  - Multiple federal agencies offer more than 25 different grants
  - Should be under a common organization to combine all grants for rural coverage
- Upgrade Land Mobile Radio to IP back-end so all 3 networks share IP
  - FirstNet will not replace Land Mobile Radio systems any time soon
- Integration of LMR systems with FirstNet Push-to-Talk
- One or more simple, easy-to-implement open standard is needed for interconnecting LMR to FirstNet
  - My crystal ball says we should have a standard by end of 2019

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The Next Six Months

- DFSI should be reviewed further for adaptability
- RoiP+ should be tested and compared to DFSI results
- 3GPP interoperability standard should be reviewed
- There does not have to be a single choice for interoperability
  - However, ALL choices must be an open standard, easy to implement, and delivered as a tested, working solution or solutions as soon as possible
- Interconnectivity between LMR and FirstNet is vital to Public Safety

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The Next Big Things

5G AND INTERNET IN THE SKY

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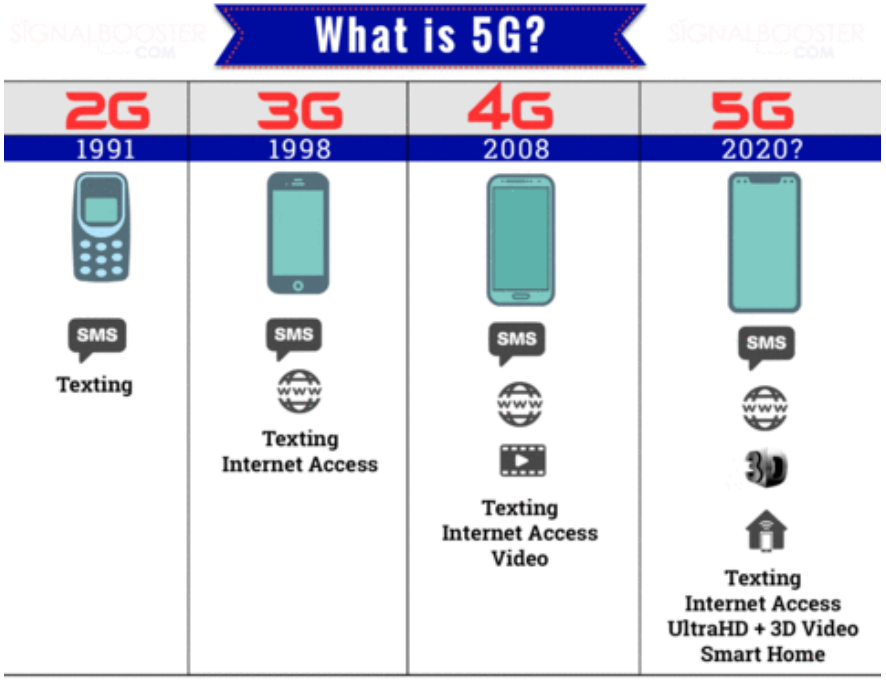
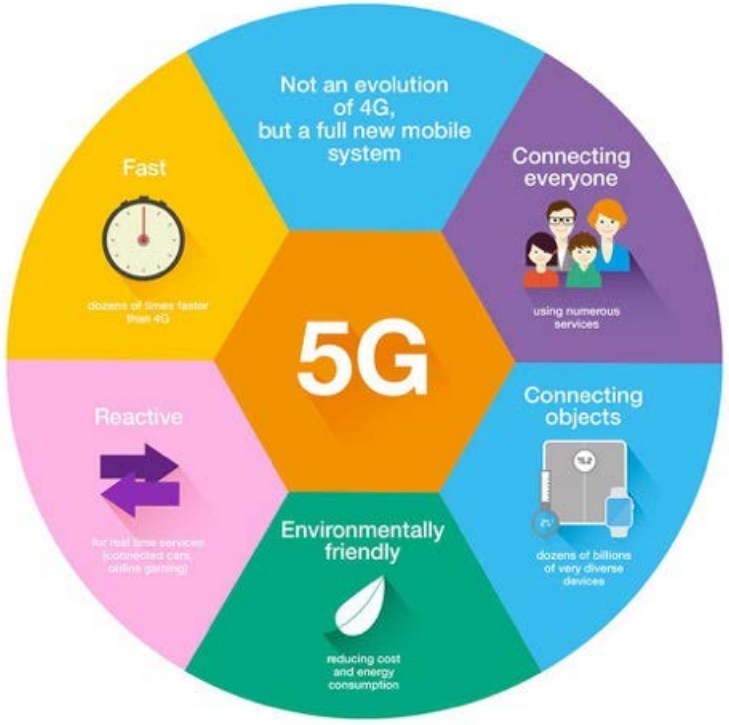
Exactly What Is 5G?





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There are 3 Flavors of 5G

- Think of 5G like a wedding cake:

The 3 Flavors of 5G

Low Band (600/700/800 MHz) A little faster than existing LTE
Mid-Band (2.5 GHz to 6 GHz) Faster than LTE lower latency
Mmwave band (24 GHz to 99 GHz Gigabit speeds small range

Mmwave small cell coverage area is measured yards not miles!

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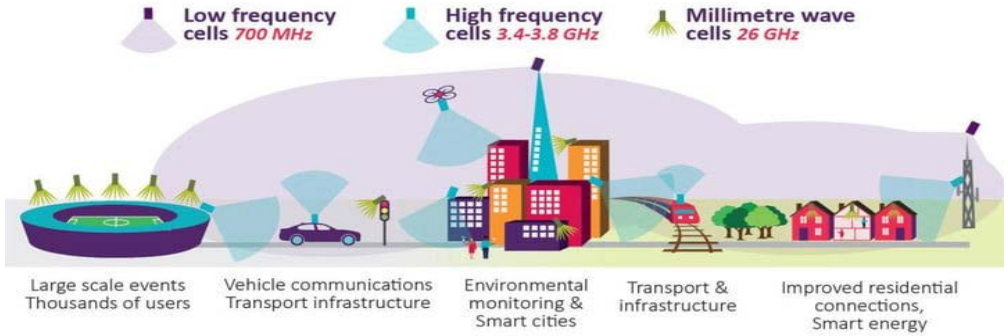
5G Began as Small Cells Using GHz Spectrum

- Original 5G was to use spectrum in the 20 GHz-to-higher range
- Many small cells located close to where the service is needed
- Data speeds in the Gigabits
- HOWEVER
  - 5G will be used by T-Mobile on 600 MHz
  - It will be faster than LTE - At 600 MHz, speeds will be in the 100-300 Mbps range
  - Then it will be used in mid-band (3.5 to 6 GHz)
  - And finally in the high-band (24 GHz and higher)



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Real 5G

- Small cells
- Lots of bandwidth
- Lots of capacity per cell
- Used for point-to-point or to cover small areas well
- Early 5G seems to be about replacing cable and DSL with 5G services to the home
- A number of issues still need to be resolved
  - If spectrum bidders will share their bandwidth with other networks in an area
    - Known as network slicing
  - If each community will end up with multiple poles in rights-of-way every block or two
  - When 5G will be ready for prime time including devices

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Typical Small 5G Cells Sites Today

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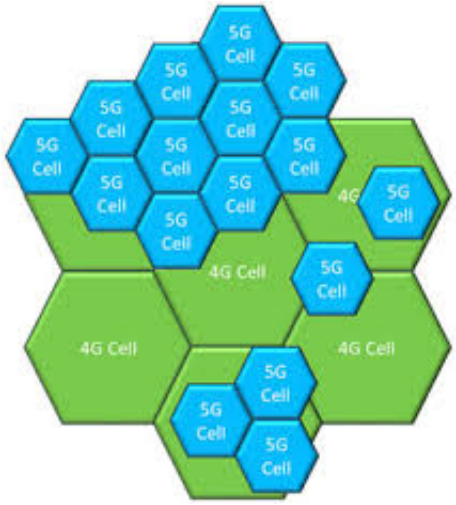
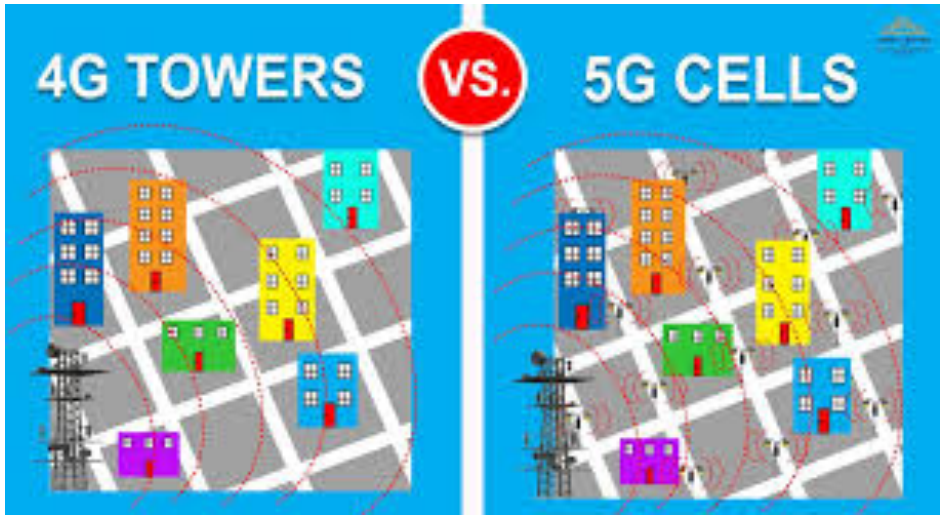
5G Cells Closer Together





Smaller cell size, more bandwidth, shorter range, better capacity, lower latency, and faster data services

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5G Not Only for Cities

- T-Mobile using 5G for larger cells on 600 MHz
- 5G fits into rural broadband picture
  - Fiber, microwave, and/or satellite backhaul
  - LTE wide-area distribution to small cities, villages, farms
  - 5G for denser population centers
  - Perhaps WiFi for final indoor coverage
- 5G is coming but is not yet ready for prime time
- Vendors, networks pushing 5G to gain more network capacity
- Once we have more bandwidth and speed we will use it
- Never-ending battle between what can be provided and what is available

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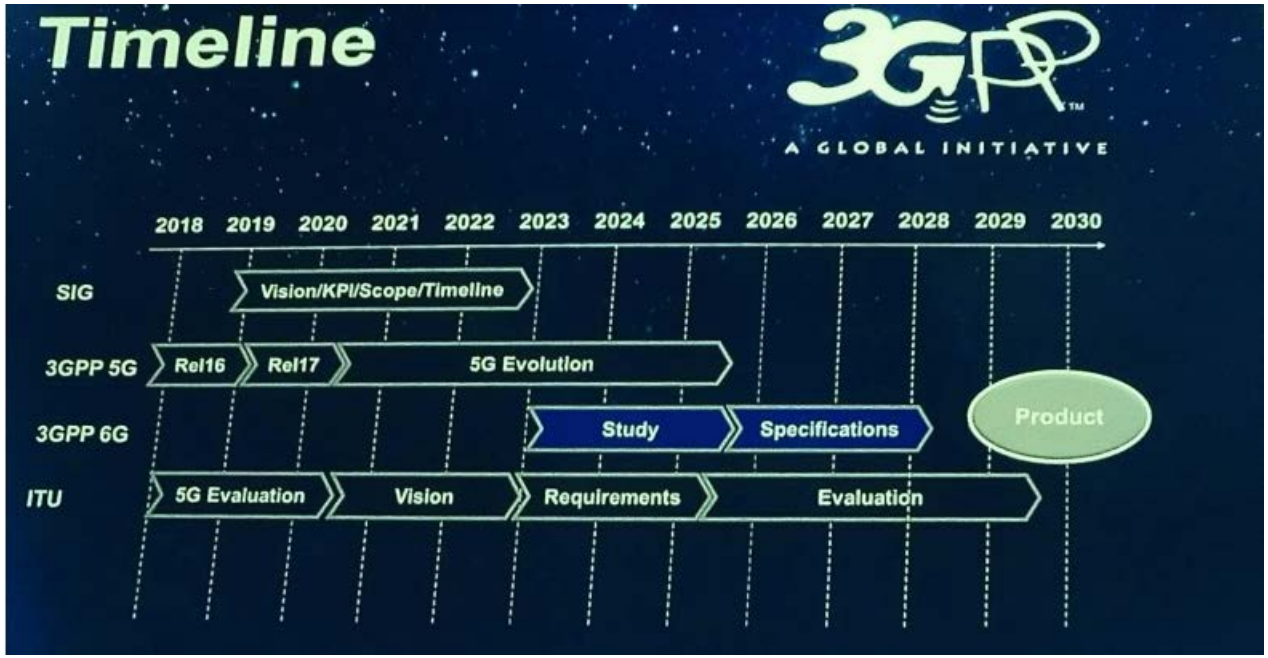
As We Watch 5G, Hang on for 6G

- 6G is exactly like 5G (small, local cells) but in 100 GHz-and-above bands
- Work is being conducted at New York University Lab and other places



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FirstNet is on LTE But wait there's more!

- AT&T provides full FirstNet priority and pre-emption on all of its own LTE spectrum
- AT&T is also building out band 14 which is the public safety spectrum
  - 20 MHz of bandwidth, available ALWAYS for public safety
  - By law it may be used by commercial users not required by FirstNet
- Now ATT has stated that public safety will also be entitled to make use of all AT&T 5G spectrum, again with full priority and pre-emption rights.
- Just to emphasize: Per-emption means they have absolute first priority on the spectrum during incidents.
- FirstNet users share the AT&T Network in normal times.
- FirstNet has it own core (network nervous system) and even though FirstNet users share AT&T LTE spectrum they have a different SIM (called the Black SIM) and their own network ID.

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Coming Soon to a World Near You

Internet In the Sky
Little Leos—Thousands of Them

Will little LEO satellites that are being launched truly provide worldwide Internet access?

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Internet in the SKY Announced

- Amazon - Project Kuiper, plans to launch 3,226 Low Earth Orbit satellites
- OneWeb - Plans for 600 operational, 48 spares launched into low earth orbit
- SpaceX Starlink - Plans to put 12,000 little LEOs in orbit
- Boeing - Two-plus years ago announced plans, now back with new plans for 1,400 to 3,000 little LEOs
- Grand total IF all these small satellites and spares are launched: 18,000+ little LEOs flying around the earth
  - Depending on placement, speeds of these birds will be around 1,000 miles per hour

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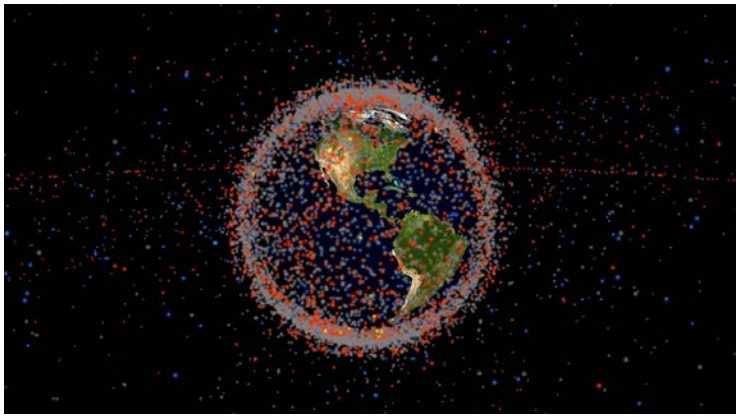
Can Any of these Systems Make Money?



4 Internet in the Sky Providers
$Billions spent by each provider
$Billions in operational costs
Who are the customers?
How much can they afford to pay?

Teledisic, Failed
GlobalStar, Failed
Iridium 1, Failed
Iridium 2, Trying Again

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Several Little Leo Operators have launched

- Some of their satellites
- One has already gone bankrupt
- Could be a total of 14,000 Little Leos in the sky if all of the companies launch all they say they are going to launch
- The average time a little Leo is overhead for use is measured in seconds!
- It will be interesting to see if handoffs really work

- Little Leo's do not provide in-building communications
- Small satellite dishes like Direct TV or Dish Networks will be required

- Claims are coverage over 100% of the world
- Me: I will believe this when I see it!

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Where this Leaves Public Safety and Amateur Radio

PUBLIC SAFETY HAS TO INTEGRATE THREE NETWORKS

AMATEUR RADIO HAS TO ONCE AGAIN FIND ITS NICHE

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Public Safety Has Three Networks

- 9-1-1
- Land Mobile Radio (on many portions of the spectrum)
- FirstNet, Nationwide Broadband
  - Telephony
  - Push-to-Talk
  - Digital Data
  - Video
- ONLY Land Mobile Radio provides off-network Push-to-Talk communications
- It is promised for FirstNet but appears to be dead on arrival (called ProSe)
- No matter how hardened a network is it can fail during emergencies
- Having both LMR and FirstNet helps but there have been and will still be failures
- Public Safety cannot and does not provide communications for shelters and other emergency response locations. Hams typically provide those services.

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When Networks Fail

- FirstNet has 8 points of possible failure from the antenna, site power, backhaul, and onto the network core
- Land Mobile Radio has some “graceful degradation” capabilities FirstNet does not have
  - Trunked/simulcast systems fall back to repeaters then to simplex
  - FirstNet is left with no communications when a cell site is down
- FirstNet (Built with AT&T) provides cows, colts, and flying drones for fill-in but it takes time to transport these assets to a disaster scene
- LMR systems can also suffer outages
- Bottom line is there is no such thing as 5-9s of reliability during disasters
- Ham Radio Operators have always been there when needed and should continue to be prepared to offer their services and bring their own network!
- There will always arise new issues with communications in disasters

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Incident Command in a Broadband World

- Incident Command needs to transition to unified command more often
- FirstNet is shared broadband
  - Law enforcement at an incident
  - Fire at an incident
  - EMS at an incident
  - Emergency Operations Command (EOC)
- All agencies will want video and data sent from the scene and to others on the scene
- Public Safety is only beginning to learn how to allocate broadband resources
  - Can trained Ham operators assist in this task? I think so.
- More Hams should become familiar with and learn from free FEMA classes provided online
- Public Safety personnel want to use communications not learn about them

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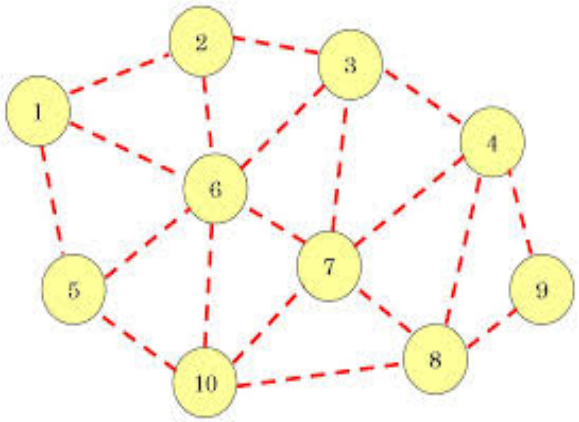
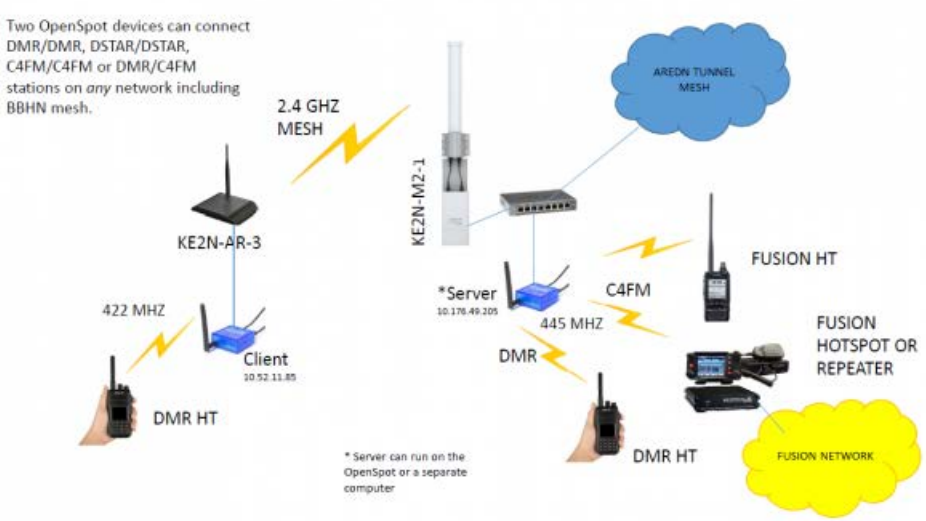
Amateur Radio: Mesh Networks

- Today, many areas already have these mesh networks up and running
- These networks can provide valuable information to and from medical facilities, shelters, and more





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Public Safety and Amateur Radio Differences

Public Safety has both Land Mobile Radio and Broadband networks, however, these networks are in fixed locations

Hams have Repeater Networks, Mesh Networks, and much more, all capable of mobile operations

The Ham advantage is they take themselves, their equipment, and their networks to where they are needed

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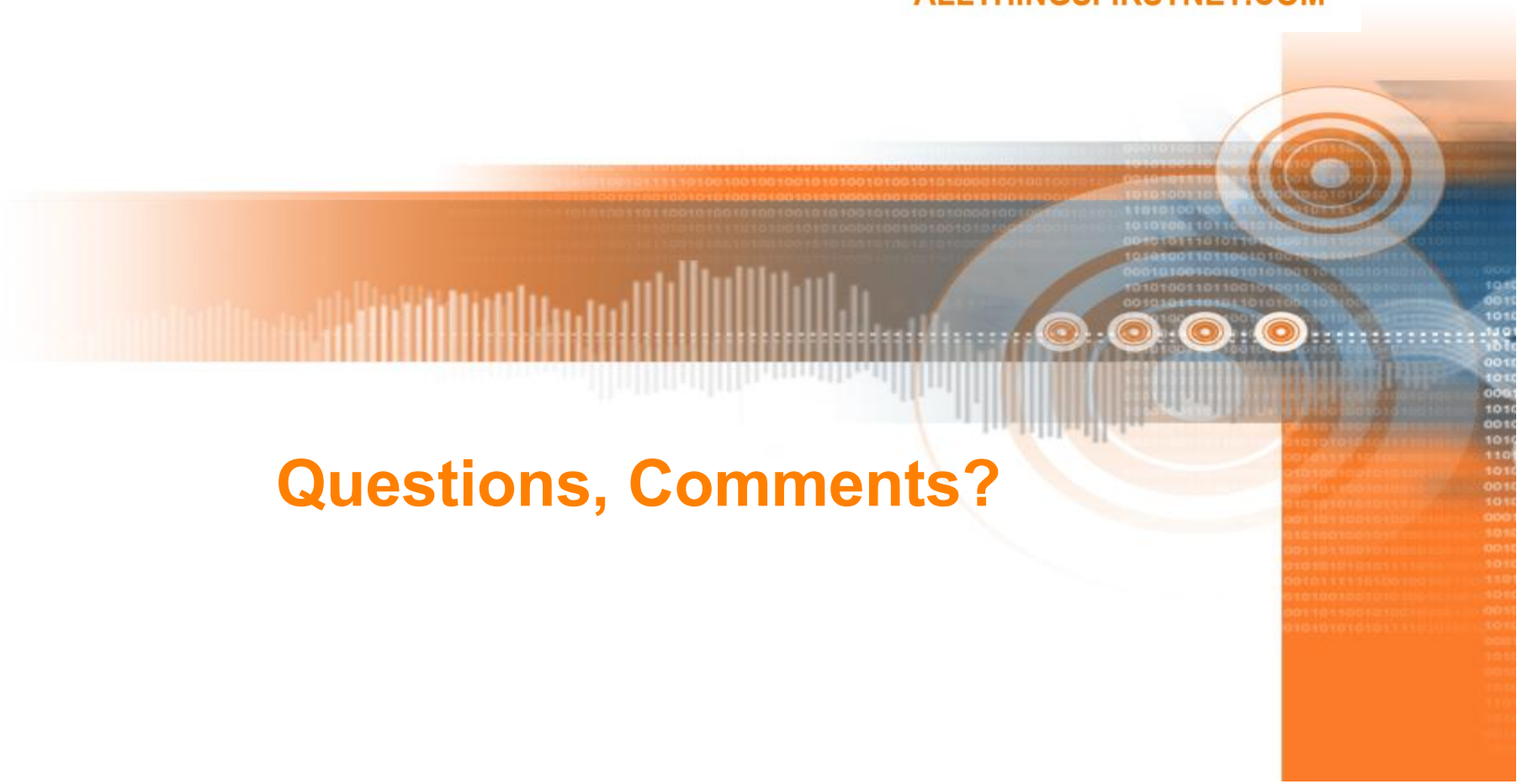

Questions, Comments?