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Fixed Wireless Access & Network Approaches Today's Technology, Funding and Contrasts

June 14, 2023

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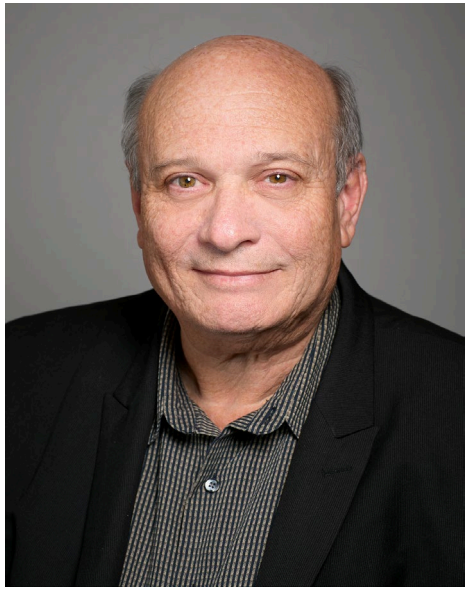

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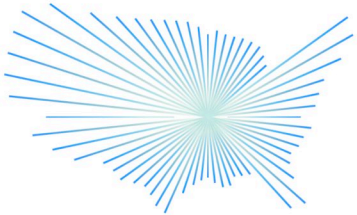

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Presentation for the Tennessee Broadband Accelerate Program

Agenda:

a) Introduction and Overview of Fixed Wireless Access (FWA)
b) Basics of Wireless Technologies that should be Considered when Approaching Community Broadband Planning
c) Understanding the use and choices in FWA
d) Technology Approaches & Types
e) Utilization of Spectrum Bands, Understanding the Difference in Spectrum Choices; and Hybrid Solutions
f) Emergence of Different Wireless & Wired Delivery Choices
g) Backhaul and Last Mile Choices
h) Funding Programs and Types of Requirements

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Today's Agenda Continued:

h) Fiber, Wireless, Satellite (Geosynchronous and LEO), Traditional Wired, Cellular, and Hybrid Networks

i) Backhaul and PTP

j) Wireless Internet Service Providers (WISPs) & Rural Deployments

k) Working in and around rural communities – mapping and importance of good network choices

l) Conclusion and Q&A & Resources

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Let's Begin the Diverse Journey of Making Choices in Broadband Services Delivery

- Billions of Wi-Fi enabled devices and uses globally. Millions of locations served with a wide-variety of sources
- Services to almost every location, except…the unserved (somewhere between 8M-30M households depending on the data)
- But even the served aren't all served competitively – Many still have antiquated services or no competition – sometimes these are under-served (presently the FCC defines these as not getting at least 25/3 Mbps)
- Digital Access remains a national priority that is not yet met. Same with digital diversity. - There are choices to change this.

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Introduction and Overview of Broadband and FWA – Today we will mostly cover Fixed Wireless, but Mobile Wireless is Vital as Well – A mix is critical :

Now, more than ever, broadband services are a ***necessity.*** It benefits the user and community; and, in many cases is the basis of being competitive.

Having reliable broadband services means:

a) Providing consistent services with regular availability and with operational speed, latency, and functionality to achieve most normal uses;

b) Available to each location with support and sustainability.

Choices, Choices, Choices…Use the Best tools for the Situation. But Understand the Situation and Expertly Plan before Choosing the Best Solution for the Need.

Fixed Wireless Access:

Choosing to remove the wires and utilize networked transceivers. Access broadband signal by Point-to-Point (PTP) and Point-to-Multipoint (PtMP).

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Understanding Fixed Wireless Access (FWA) Choices and Use

Point-to-Point (PTP): Point-to-Point services provide for moving broadband signal (upload/download) from a designated fixed location to another location. That can be backhaul which brings the signal to the area (kind of like the highway) or it can be from an Access Point to the final (last mile) location (kind of like the exit). Example: Tower or pole to houses or business.

Point-to-Multipoint (PtMP): Point-to-Multipoint services take broadband signals (upload/download) from a fixed Access Point (sometimes called an eNode B or Base Station) to multiple fixed locations (last mile). Example: Tower or pole to house(s), business(es) or multiple locations emanating from a single radio location.

Technology Approaches and Hybrid Solutions

Backhaul or Middle Mile: Getting to the offramp – Taking the signal from the commercial source to the local area for distribution. Done by PTP radios "hopping" between locations – sometimes in redundant rings. Backhaul can also be by fiber, cable, or copper wire.

Last Mile or To the Premises/Client/End Location: With Fiber only solutions, its known as Fiber to the Home (FTTH) or Fiber to the Premises (FTTP); but FWA can emanate from fiber to the AP then use wireless solutions to the end-point (clients). This can be in a wide-variety of delivery methods: PTP, Mesh, rooftop-to-rooftop, AP-Client, and more.

Propensities of Spectrum Band (Frequencies) Choices

Low Band, Mid Band, High Band (mmWave)

a) **The Laws of Physics** apply to all bands…Sorry, can't magically change this…☺

b) **Lower Bands** are more forgiving of clutter, terrain, and atmosphere; but carry less data and generally operate at lower speeds. Can handle low line of sight.

c) **Middle Bands** provide the comforts of some flexibility in distance carried – goes further, more clutter interference (line of sight), but afford greater throughput.

d) **Higher Bands & mmWave** carry tons of data at high speeds but only do so for relatively short distances and are very sensitive to clutter, terrain and line of sight. – Great for rooftop to rooftop or as a "bridge" between buildings

e) **Terahertz and Beyond – the Future**… using light and very high frequency to transfer huge amounts of data at very very high speeds.

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What are the differences in choices of Fixed Wireless Access approaches to providing broadband services in your community? – Not all the same…

- What are the **conditions in the area**?
- Is the service for **indoor, outdoor or both**? Is this for backhaul or last mile?
- What is the localized **geography and terrain**?
- How much **clutter**? (think buildings, poles, fences, things in-between radio signals)
- **Competitive radio/wireless signals (noise)?** – Harmful interference (in band or out of band) – Density of populations (users) and Radios in Use
- **Weather, atmospheric and/or other conditions?** (fog, snow, rain, dust, water reflection, etc.)
- **Critical Use**: Near and airport, base or sensitive area/protected area?

Types of Uses and their Regulation & Spectrum Sharing: Dynamic Spectrum Access Solutions

Strictly Commercial or Bands with No Government Use: Regulated by the Federal Communications Commission (FCC)

Bands only Used by Government Entities and Organizations/Uses: Regulated by the NTIA, a United States Department of Commerce Agency

Bands which can/or are Shared Between Government and Non-Government Use.

Examples (non-exhaustive) of Spectrum Sharing

Government Primary User – Commercial Secondary User – Secondary Use must protect primary use from harmful interference.

Government Primary User – Auctioned Licensed Spectrum for Secondary Use: Coordination or Database Recordation (e.g., ULS) protects both entities from Harmful Interference of the Other.

Shared Primary Use: Government and Commercial: Uses different methods to monitor and sometimes control uses to provide protections: Dynamic Spectrum Sharing – (e.g. CBRS uses a Spectrum Access System, 6 GHz licensed primary with 6 GHz Part 15 unlicensed uses an AFC System or Automatic Frequency Control Sytsem to protect the licensed users).

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Choosing Fixed Wireless Access Options – Outdoor Deployment

Spectrum options (Band Choice) – choose one a hybrid (non-exhaustive list):

- **Unlicensed Bands** – Available to all applicable users (e.g., 900 MHz, 2.4 GHz, 5.8 GHz, 6 GHz Part 15 (pending), 60 GHz band) – Generally governed by FCC Part 15.
- **Licensed by Rule** – No license must be purchased, but rules must be followed (e.g., CBRS 3550-3700 MHz) and TV White Space – and **Priority Access License** (PAL also found in CBRS) – CBRS is governed by FCC Part 96.
- **Nationwide Non-Exclusive License** – Must apply for a license and follow the applicable method to protect incumbents or other users (60 GHz band)
- **Exclusive Use Licenses** (Generally obtained at Auction or via a Secondary Market) (e.g. 2.5 GHz, 3.45-3.55 GHz, 3.70-3.92 GHz (C-Band), 24 GHz licensed and more. Often licensed bands are governed by FCC Part 101.

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What's up with speeds, amounts of data, latency, upload/download (synchronous or asynchronous)…other?

Speed: Generally measured in megabits per second (Mbps) for the download (from the Internet to device) and upload (from the device to the Internet)

Synchronous v. Asynchronous: If the speed of upload and download are the same, they are said to be "synchronous" – if they diverge, they are "asynchronous"

Latency: The amount of "delay" between the time something is sent to when it is actually received.

Bandwidth: The amount of spectrum allocated for channels of operations (e.g., 10 MHz, 20 MHz, 40 MHz, etc.)

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How much speed, latency, etc. is needed to use broadband at home or in the office?

Speed: FCC defines broadband currently at 25/3 (25 Mbps download and 3 Mbps upload) and is looking to change that metric to around 100/10.

What Works: Most households can effectively use broadband for homework, entertainment, normal remote-work, and Internet of Things (e.g., monitor your heater/AC, etc.) at speeds between 25-50 Mbps download and 3-20 Mbps upload). Some uses may require more, but that can be purchased or allocated. – FWA can easily provide even multiples of these speeds. You can watch Netflix, play games, do homework, work on Zoom, and buy online at these speeds.

Latency: A latency of between 3 ms (milliseconds) and 10 ms is normal & even higher may not be perceived. Shorter latency is generally for commercial uses.

Synchronous or Asynchronous: Almost all broadband uses favor download by multiples of 7x-15x the demand for upload. If you have to balance and provide synchronous speeds, its fully possible in most cases, but you must consider spectral efficiency and waste of unneeded bandwidth for uploads which are not common uses in normal cases.

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FWA Broadband Service Providers…Who are they?

ISPs (broadband) are a varied bunch and include:

- Cellular Mobile and Fixed Wireless Carriers such as AT&T, Verizon, T-Mobile, DISH and others (MNOs)
- Cable Providers such as Comcast, Charter-Spectrum, Cox and others (MSOs)
- Wireless Internet Service Providers (WISPs)
- Geosynchronous Satellite Providers (such as Hughes)
- Low Earth Orbital Providers (LEO) (such as Starlink)
- Wired and Wireless Ground Based Providers (ILEC/CLEC)
- Co-Ops, Municipal and County Providers; Utilities; Specialized Providers
- Private Network Providers and
- Others…

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Wireless Internet Service Providers (WISPs)

WISPs provide services throughout the world. They often provide reliable and tangible broadband services and a range of connective services in rural, suburban (ex-urban) areas – often serving PTP and PtMP FWA services as well as hybrid broadband services in traditionally underserved areas.

For more than two decades, WISPs have often been the only source of reliable broadband services to communities across the nation and globe. See more information about them at: http://www.wispa.org

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Working in and around rural communities – Mapping/Planning and Importance of Good Network Choices

- Density of Population Matters to Choices of FWA
- Rural Communities tend to have Distances and Terrain between Locations
- Line of Sight is not Always Available
- The Signal for the Broadband Access Must be Brought In from Far Away
- Ground Access, Pole Access, Power Access Must Also be Available
- Zoning and Local Rules and Boundaries Affect Cost
- Network Planning Makes all the Difference
- Economic Returns May Be Different

Vertical Markets Covered by FWA Deployments - Examples

Hospitality, Retail, Commercial, Industrial, Ports and Transportation, Mining, Residential – Single Family Dwelling, Residential – Multiple Dwelling Units, Commercial – Multiple Tenant Enterprises, Hot Spots, Sporting Locations, Prisons & Courts, Public Buildings, Airports, Venues, Entertainment, Financial Sector, Security and Surveillance, Education K-12, Education – Higher Ed and Dormitories, Campuses, Communications and Telecom, and many many more.

Fixed Wireless Access Choices Indoors - WLAN

- WLAN – Wireless Local Area Networks
- Using wireless technology indoors is very different from using wireless technologies outdoors. Walls, reflective surfaces (mirrors and windows), doors, metal objects, radio frequency emitting equipment, concrete, microwave ovens, and baby monitors affect radio signals (including Wi-Fi) indoors.
- Choice of Indoor FWA WLAN equipment, frequencies and layout are critical.
- Indoor deployments can affect outdoor deployments; Outdoor deployments can affect indoors.

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Emergence of Cellular Broadband Services in the Home Wireless Broadband Market

Some forms of delivery can be from signals that traditionally were only for mobile cellular services. Now, signal can emanate from small cells localized in neighborhoods and provide broadband service either through the walls (outside to inside) or via a fixed client device.

Noise and interference abatement methods, use of PTP small cells, close by receivers, and specialized antenna technology (e.g., beamforming, MIMO, directional antennas) and other technologies provide better and better platforms for this use.

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Funding Opportunities in the United States Today – Options and Impediments

- Federal Infrastructure Funds: IIJA BEAD NOFO (Administered by the States via the U.S. Department of Commerce NTIA – Infrastructure Investment and Jobs Act – Broadband Equity , Access and Deployment, Notice of Funding Opportunity)
- Federal Communications Commission: Community Access Funds (CAF), Rural Development Opportunity Funds (RDOF)
- United States Treasury Broadband Funding
- United States Department of Agriculture – Rural Utility Service or RUS Funds
- State Economic Development or Broadband Development Funds
- Private Grants and Matching Funds, Public-Private Funding
- Tribal Lands Funds, Special Needs, Schools & Libraries and more…

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Costs, Time to Deploy, CapEx/OpEx Networks, Resiliency

- **Deployments of FWA, Fiber, Hybrid, and Other Networks Vary in Cost and Upkeep:**
- **The Network**: Network equipment deployment, network/software, commercial broadband connection, APs & Clients, Network backbone and more.
- **SG&A (Costs):** Billing, marketing, overhead, employment/personnel, insurance, installers, engineering, benefits, equipment, real-estate, access, filing/registering, legal, accounting, and more.
- **CapEx (Capital expense - the hard costs of deploying your networks); OpEx (Operating expense** -the ongoing cost of maintaining, growing, and sustaining your network on a day-to-day basis)
- **Resiliency:** The ability to grow. The ability to sustain damage (man made and natural) and recover. The ability to be competitive in all ways. The ability to make a business successful.
- **Return on Investment and ARPU**: The ability to sustain the business or operation on its own income and/or funding and the Average Revenue per User.
- **Ability to Adequately (or more) Serve the Market**: Long term viability.

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Regulatory Environment, Politics of Broadband and Spectrum; and Spectrum Policy

- Politics plays a role in every aspect of broadband deployment and use of the Internet.
- Choice of Tactics/Technologies/Spectrum/Fiber etc. driving the means to deploy is often politically motivated.
- There are limited resources. There is also limited time to make things available. A National Spectrum Policy is coming. Will your state be ready?

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Training, Maintenance, Growth, Flexibility, Durability, Reliability and Sustainability

- Know how to plan a network: Determine the right tools – What can be done where – Network planning tools look at Fresnel Zones and Line of Sight to provide a basis for types of services needed.
- What type of gear is needed/technology to Serve a Location.
- How will Growth in the Area Impact the Network – Planning for the Future
- How is equipment effected by the elements – durability
- How can an ISP service and maintain the network?
- What makes the network sustainable and maintainable?

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Perception and challenges around grant and regulatory rules that affect the fixed wireless industry – Some Questions – Not all the answers…

- Is FWA Reliable? Future proof? Sustainable? Flexible?
- Is Fiber everywhere better? Should governments dictate technologies of broadband providers, no matter the cost?
- Should there be better accountability of all providers?
- How do you actually serve the unserved and better serve the under-served?
- Should funding be dependent upon grants, federal or state funding, credits (tax or otherwise)
- Should there be build-out requirements?

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Politics of Broadband Deployment & Broadband Mapping & Reporting (FCC Broadband Data Collection or BDC Initiative)

Reporting Requirements: Transition from traditional required FCC Form 477 to the new Broadband Data Collection methodology – Location Based Reporting

Use for Funding: Mapping is supposed to ID where un-serve and under-served areas are and allow for service to be filled in where it is not present.

Accuracy and Upkeep: What will guarantee the accuracy and methodology of reporting so government funds, private party funds, and public funds are not wasted in broadband deployment?

Privacy Protections: How do you protect providers from predatory practices and loss of business if too much data is provided? How do you assure a good program if too little is available?

What's Next? …

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What's the Future Look Like?

Mobile Technology Standards: 3G LTE, 4G LTE, 5G (5G NSA, 5G SA, 5G NR, 5G Nru), 6G…Third Generation Partnership (3GPP).

Fixed Wireless Access Standards: Proprietary, 5G, Wi-Fi, Wi-Fi 6, Wi-Fi 6e, Wi-Fi 7…and on.

New Approaches: Using Ultra high frequency, light, and more.

Better Propagation Modelling.

Better Spectrum Sharing with Dynamic Spectrum Control.

More Spectrum Reuse, Approved Sharing & More Spectrum and Spectrum Options.

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Conclusion – Take Aways

- In solving for today and tomorrow's broadband deployment needs, consider everything. What is the situation on the ground. What works best for the needs of a particular area. Consider that one choice may not be the best, many different approaches may be needed.
- Cost is not the only factor, getting broadband to all American's is vital and not in the distant future.
- Fixed Wireless Access is diverse and symbiotic with fiber, cellular, satellite, cable and other sources. Diversity of providers and technologies is important in the competition and advancing technologies and service for tomorrow and long beyond.

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Questions and Answers?

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Who is WISPA?

WISPA is a trade organization that represents the interests of more than 600 internet service providers that deliver broadband internet connectivity services to approximately nine-million consumers, businesses, first responders and community anchor institutions around the country.

The majority of WISPA's operator members provide fixed broadband access as a standalone service, though many do offer interconnected VoIP where there is consumer demand or where required by the Federal Communications Commission ("FCC") under its universal service program rules.

To provide their services, WISPA members often use unlicensed, licensed-by-rule, and exclusive-use licensed spectrum at low-band, mid-band, and high-band frequencies, predominantly in rural, unserved, and underserved areas, as well as fiber optics where it makes economic sense to do so.

Often, WISPA's members will deploy both a hybrid of wireless and fiber technologies, either as middle-mile or last-mile connections, in the same network, making their choices based on the **"right tool for the right job."**

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Thank You. Some Random Resources.

Federal communications Commission (FCC): http://www.fcc.gov

United States Department of Commerce National Telecommunications and Information Administration (NTIA) Office of Spectrum Management: https://ntia.gov/office/office-spectrum-management-osm

NTIA IIJA Bead NOFO: https://broadbandusa.ntia.doc.gov/sites/default/files/2022-05/BEAD%20NOFO.pdf

CBRS FCC Part 96: https://www.ecfr.gov/current/title-47/chapter-I/subchapter-D/part-96

Wireless Innovation Forum CBRS Standards: https://cbrs.wirelessinnovation.org/

6 GHz Part 15 WInnForum Standards: https://6ghz.wirelessinnovation.org/

Wi-Fi Alliance – Wi-Fi Information and Standards: https://www.wi-fi.org

WISPA (Wireless ISPs Association): http://www.wispa.org