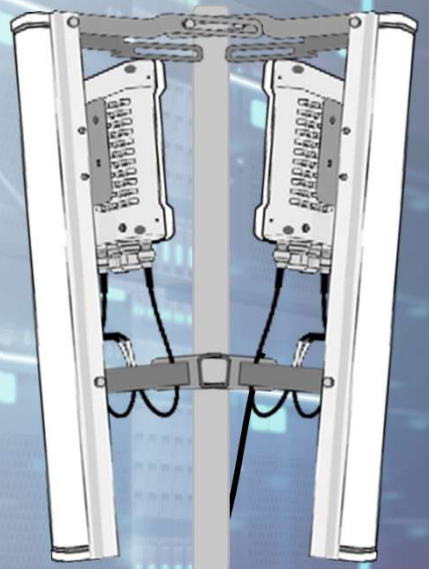
Demystifying Fixed Wireless Access



Presenter: Steve Harris
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February 2023

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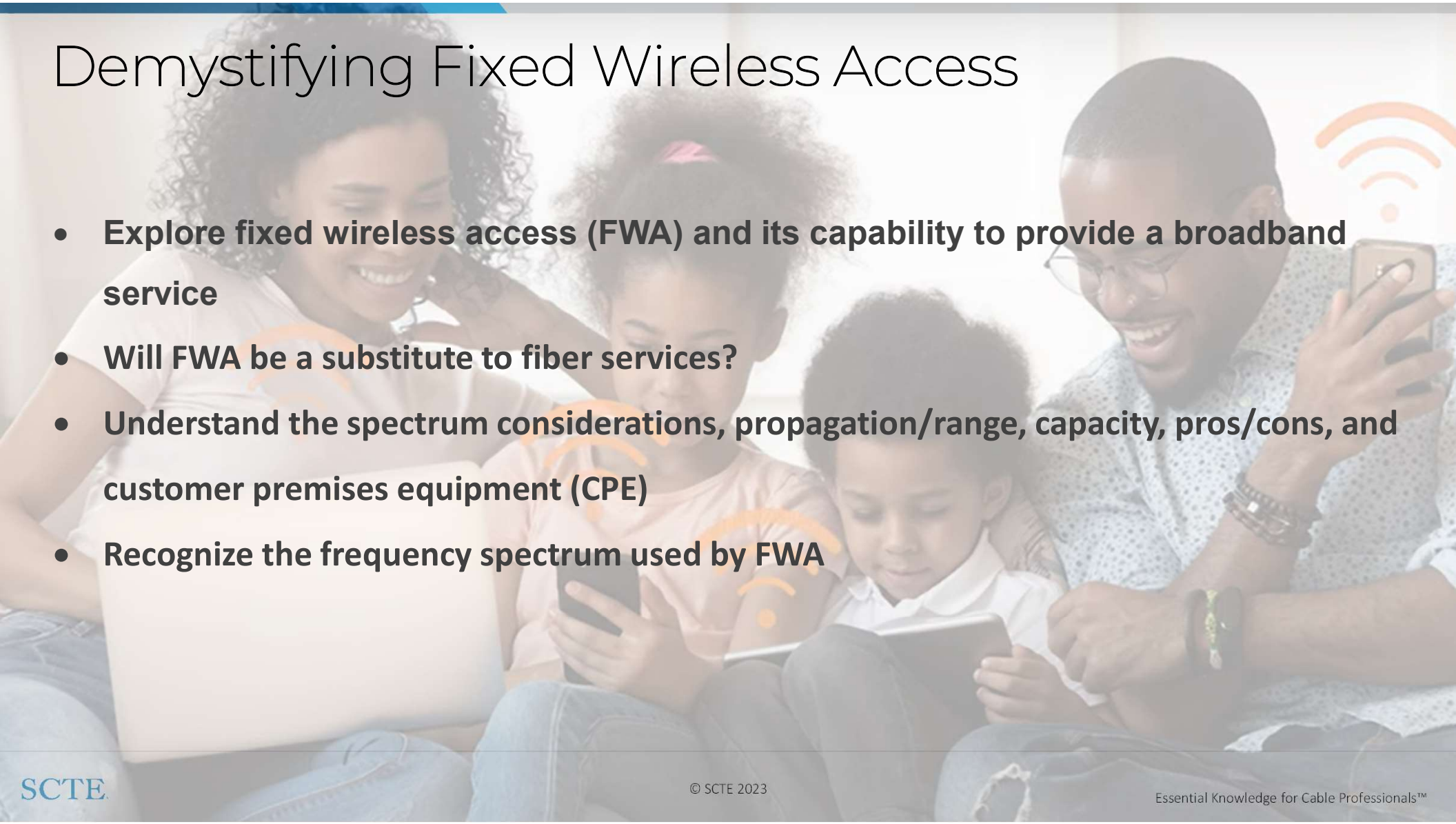
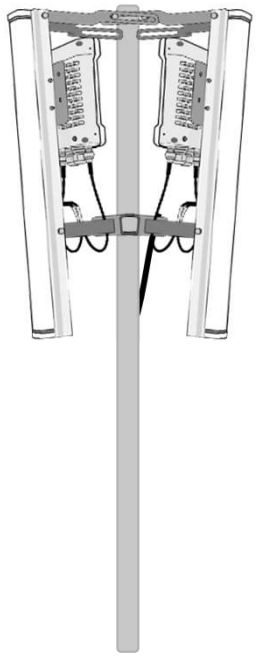
Demystifying Fixed Wireless Access



- **Explore fixed wireless access (FWA) and its capability to provide a broadband service**
- **Will FWA be a substitute to fiber services?**
- **Understand the spectrum considerations, propagation/range, capacity, pros/cons, and customer premises equipment (CPE)**
- **Recognize the frequency spectrum used by FWA**

Explore fixed wireless access (FWA) and its capability to provide a broadband service.



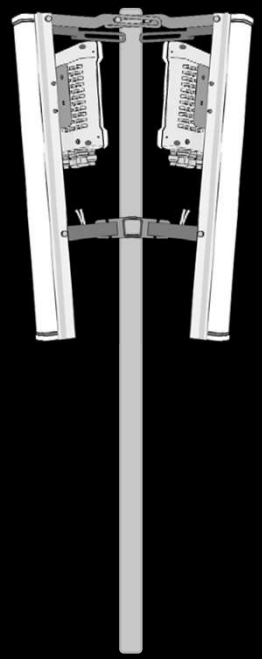
Raise Your Hands….

What is fixed wireless access?

Fixed equipment at the premises that uses wireless signals in the last mile / kilometer to deliver Internet services to connect the unconnected.

Market

- T-Mobile and Verizon are expected to have 11 to 13 million total FWA customers by the end of 2025.
- Global 5G FWA market is expected to be valued at USD 29.4 billion in 2023, projected to reach USD 153.0 billion by 2028.
- New technological advancements in LTE to 5G.
- CBRS-based FWA beats Starlink performance.



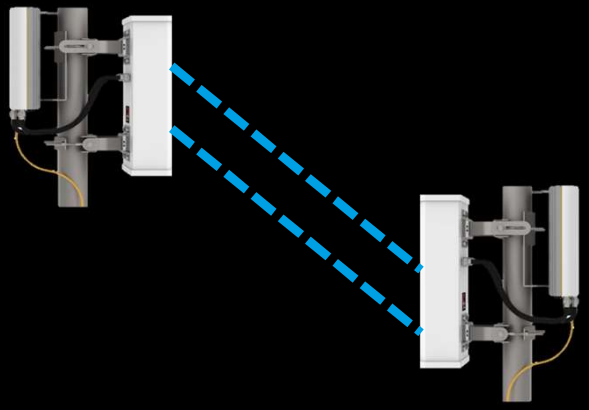
What is Fixed Wireless Access or FWA?

- Fixed Wireless is used to connect some rural and remote areas of a broadband network.
- Different than fixed line access technologies:
  - Fiber-to-the-Building
  - Fiber-to-the-Premises
  - Fiber-to-the-Node
  - Hybrid Fibre Coaxial

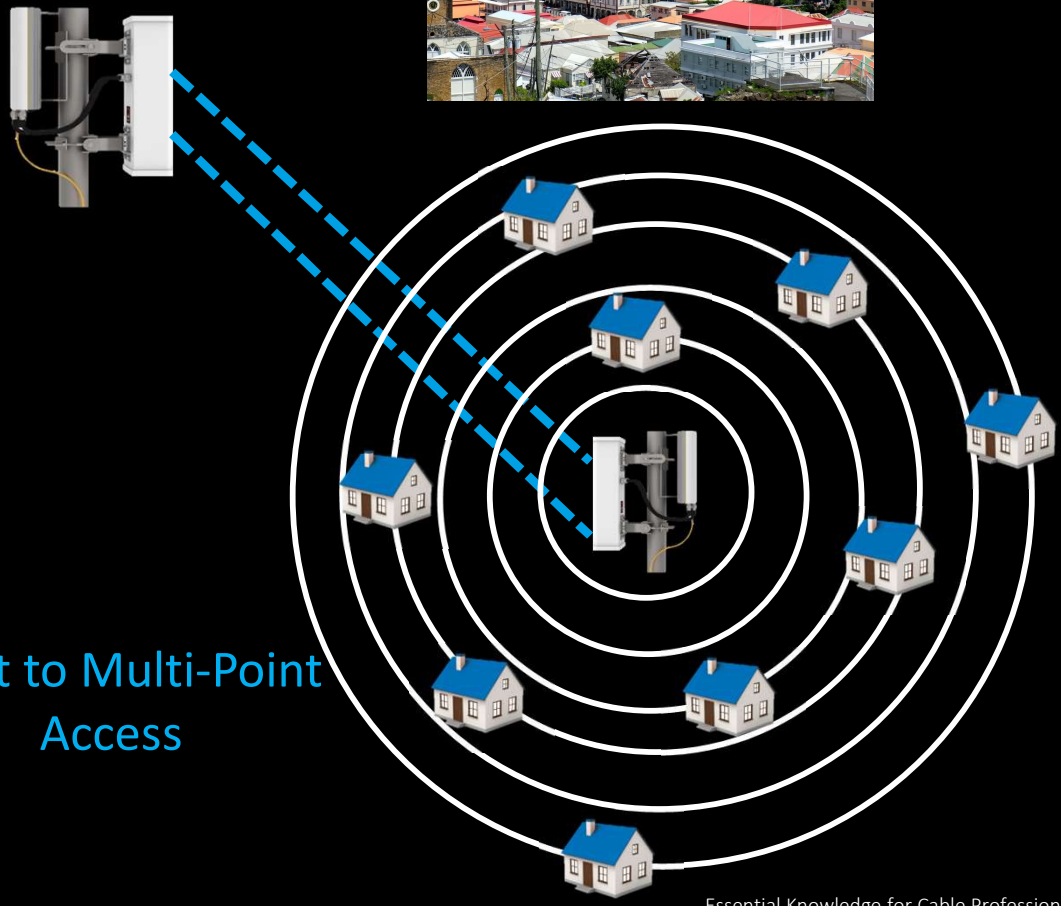
Fixed Wireless Access PtP and PtMP

- FWA service providers may build backhaul (PtP) and last mile access (PtMP) infrastructure in difficult to reach, remote or rural locations.
- FWA is a proven solution for connecting the unconnected.
- FWA will help bridge the digital divide!

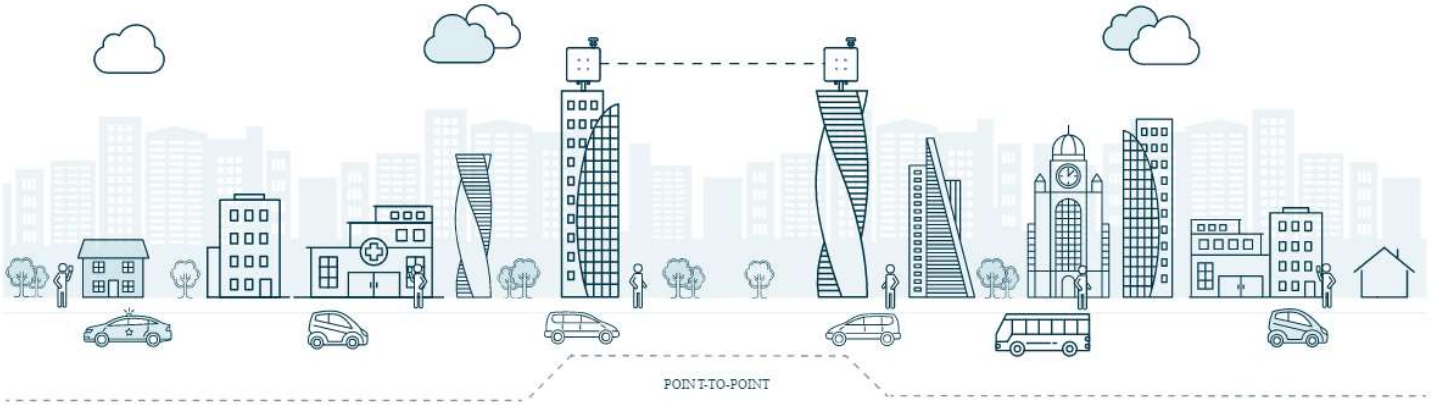
PtP and PtMP Architectures

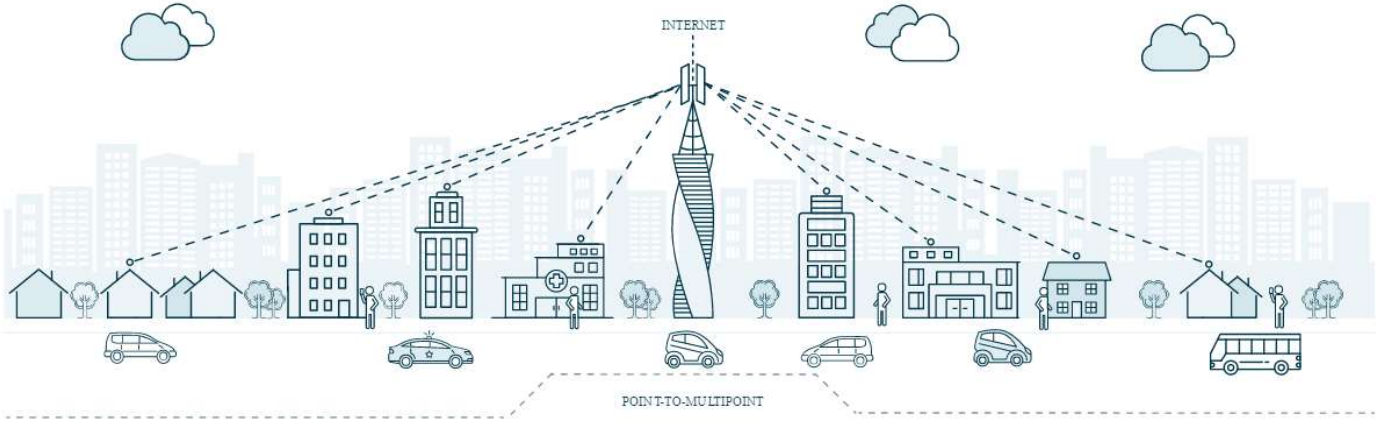


Point to Point (PtP)
Backhaul

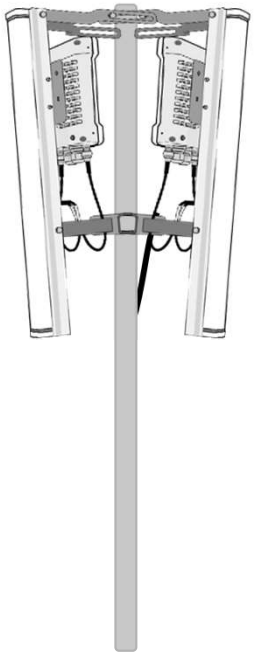


Point to Multi-Point
Access





Will FWA be a substitute to fiber services?



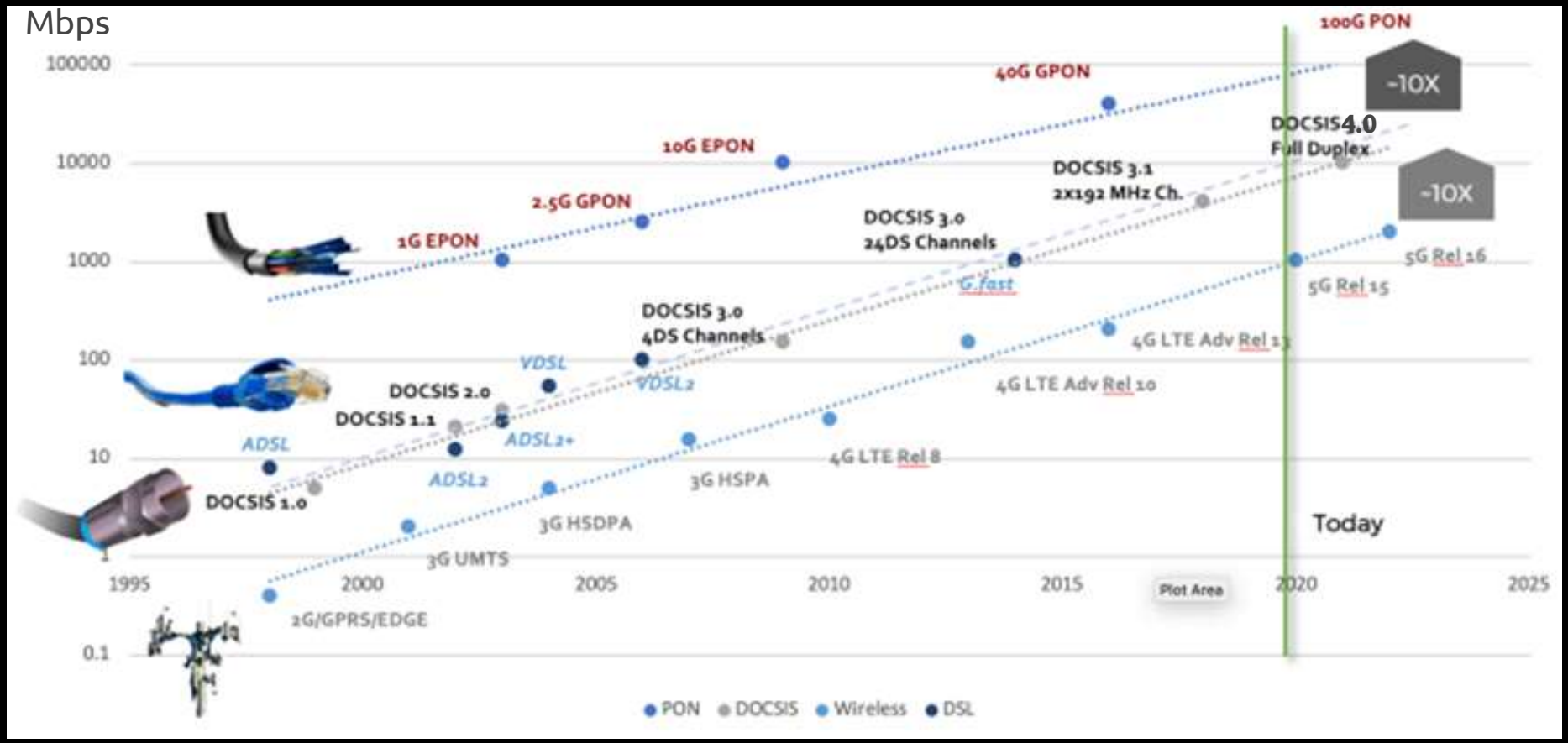
Worldwide Interoperability for Microwave Access (WiMAX)

- There is no specific standard for fixed wireless.
- WiMAX was considered the fixed wireless standard for some time, but carriers got confused about using it for fixed or mobile broadband.
- The failure of WiMAX stalled the deployment of fixed wireless.
- Limited licensed spectrum

How it stack up? Broadband Speed Comparisons

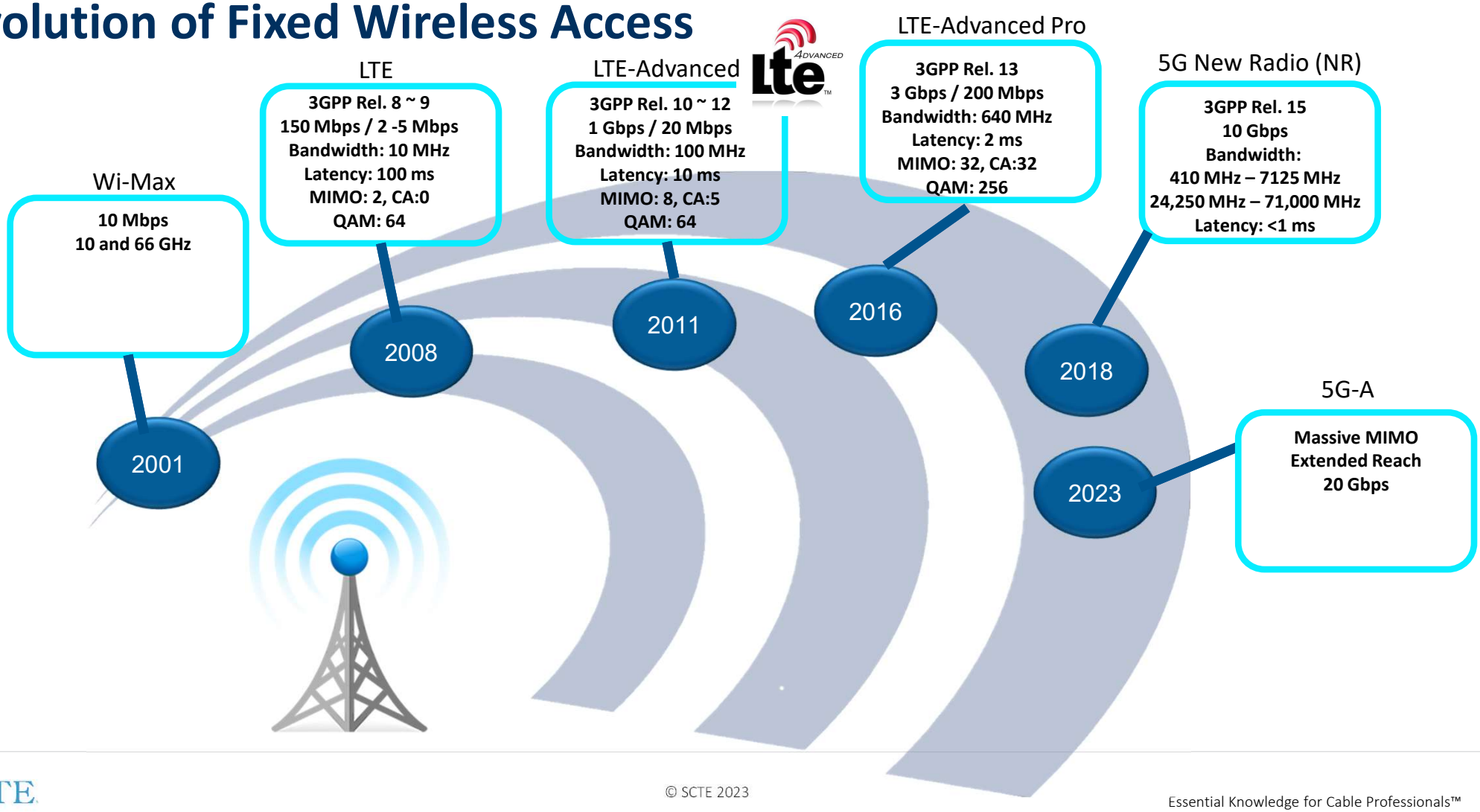
	Technology	Download Speed Range (Average)
DSL	ADSL/ADSL2+	24 Mbps
	FTTC/VDSL2	200 Mbps
	g.Fast	100 Mbps – 1 Gbps
Fiber	FTTP/H	1 Gbps – 40 Gbps
Satellite	Satellite Broadband	50 – 500 Mbps
Cable	DOCSIS 3.1/4.0	10 Gbps
FWA	LTE (4G)	Up to 100 Mbps
	5G	1 – 10 Gbps

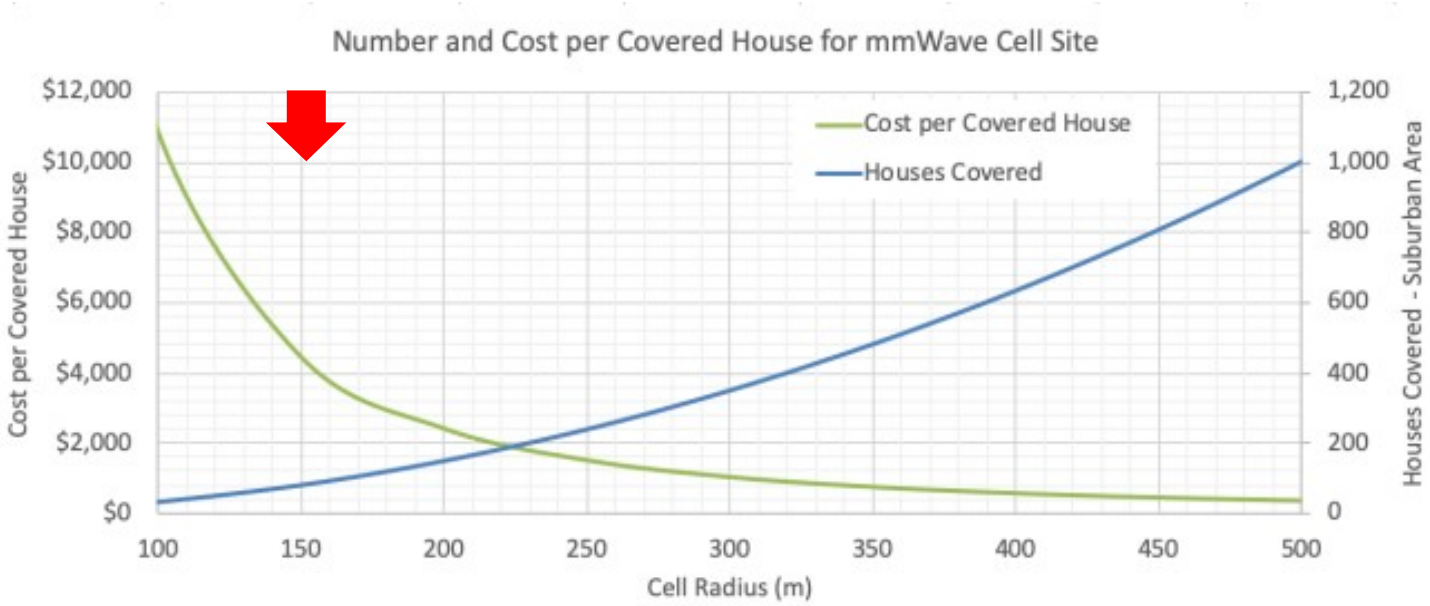
FTTH, DSL, DOCSIS, and Wireless Technology Evolution



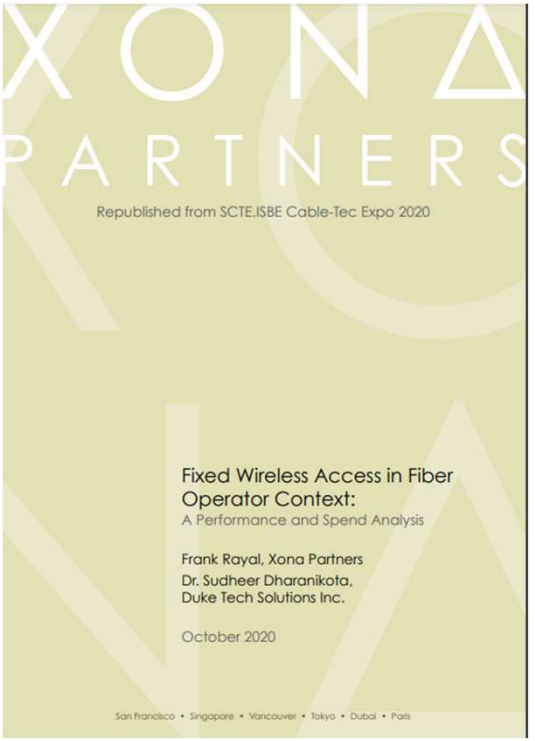
Source: DTS

Evolution of Fixed Wireless Access





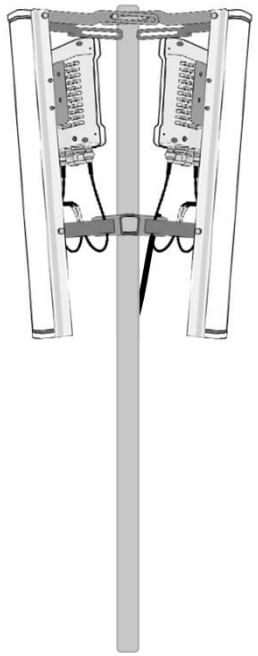
Cost of 28 GHz mmWave FWA. [Source: Xona Partners; DTS]



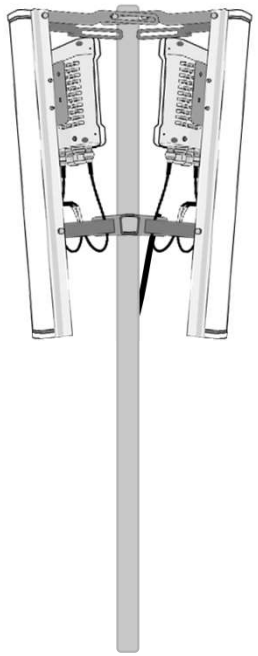
How does Fixed Wireless Access or FWA work?

Category	mmWave Fixed Wireless		Fiber To The Home	
	Pros	Cons	Pros	Cons
Deployment	Quick access to market Could be deployed quickly	Propagation characteristics (foliage, material, clutter) impact on range	Can be deployed in any terrain	Requires advanced planning, permitting
Quality of Experience		Variable depending on location	Constant & predictable	
Throughput		Decreases proportionally to distance, varies depending on obstructions in signal path	Constant & predictable; ~100x more capability than FWA	
Availability		Depends on distance and location of user terminal; foliage and IRR glass reduce availability	Constant & predictable	
Number of users	Cell densification to increase capacity; Roadmap to support greater throughput/# of users	Variable depending on deployment scenario in addition to other factors	Linearly scalable	
Financial Structure	Lower CapEx (scenario specific), quick access to market	High OpEx (scenario specific)	Low OpEx	Initial CapEx investment heavy
TCO	22 Months to breakeven (case dependent)	1. Small coverage range or low sub penetration lead to poor biz case 2. Actual breakeven is longer when factoring cost of core network and spectrum	~ 12 mo. breakeven; Better product offers	

How does FWA work?



Recognize the frequency spectrum used by FWA



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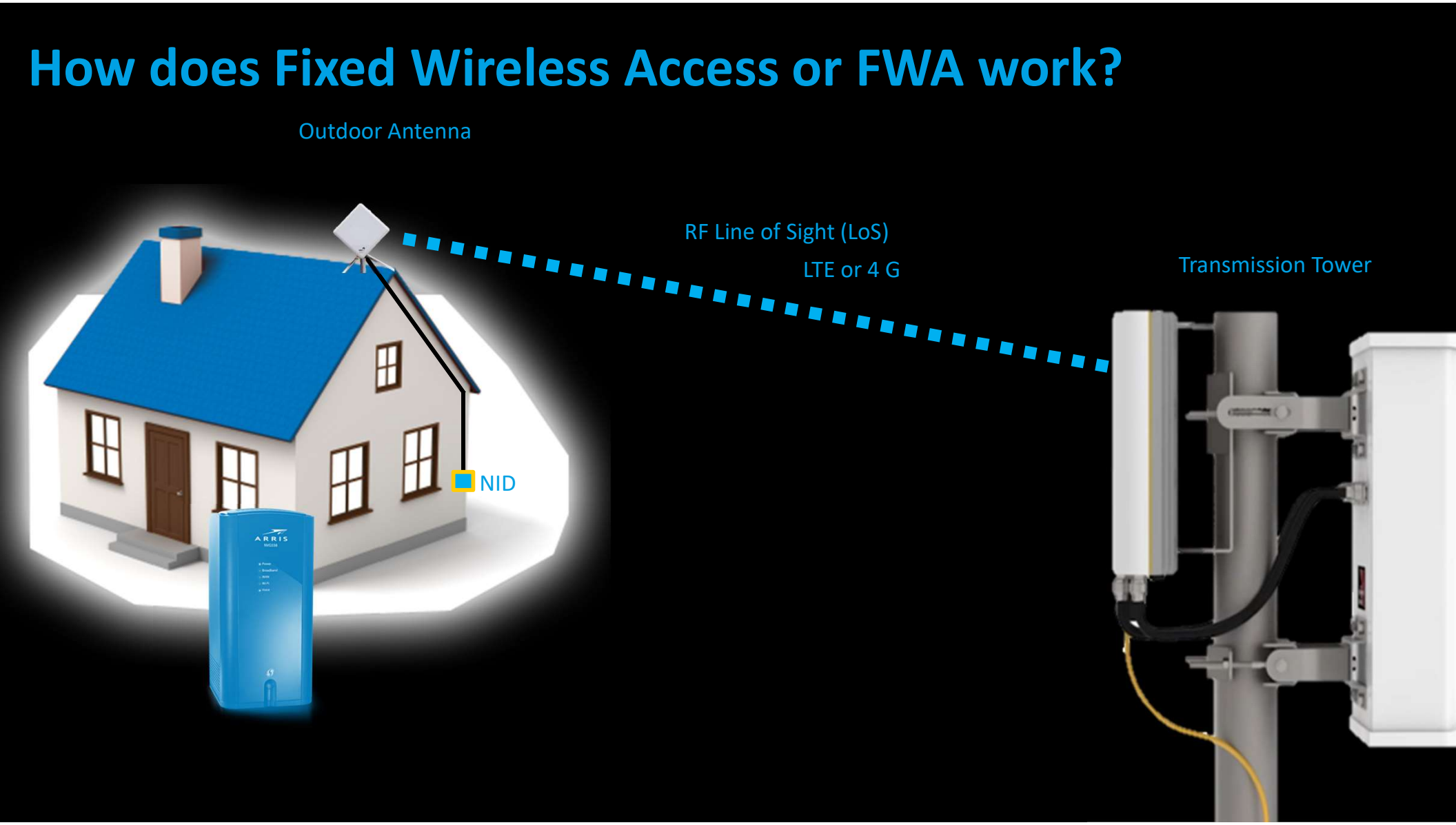
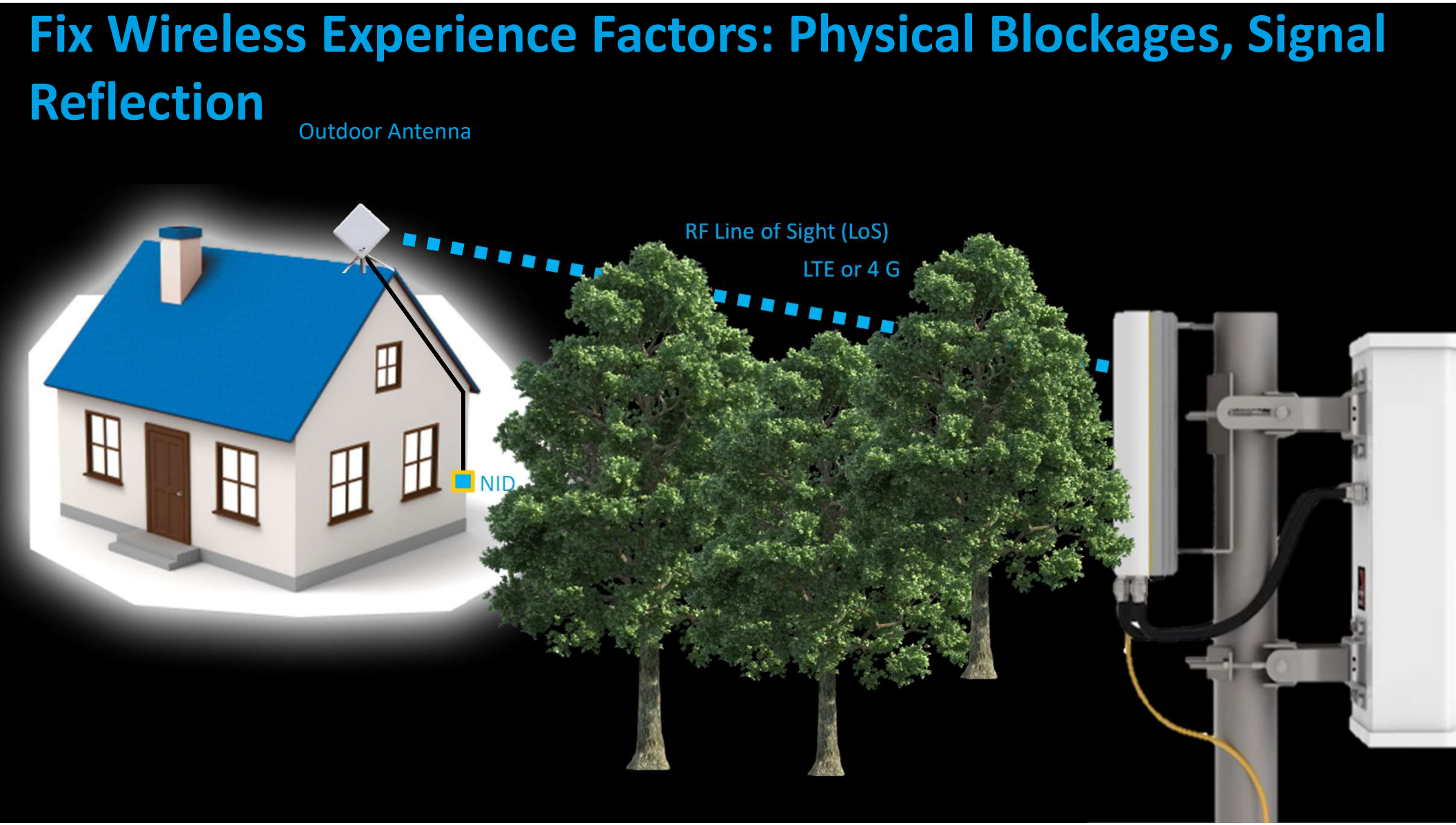


CPE with indoor Antenna Option

Antenna Installation

Outdoor Antenna
Outdoor Antenna

Fix Wireless Experience Factors: Physical Blockages, Signal Reflection

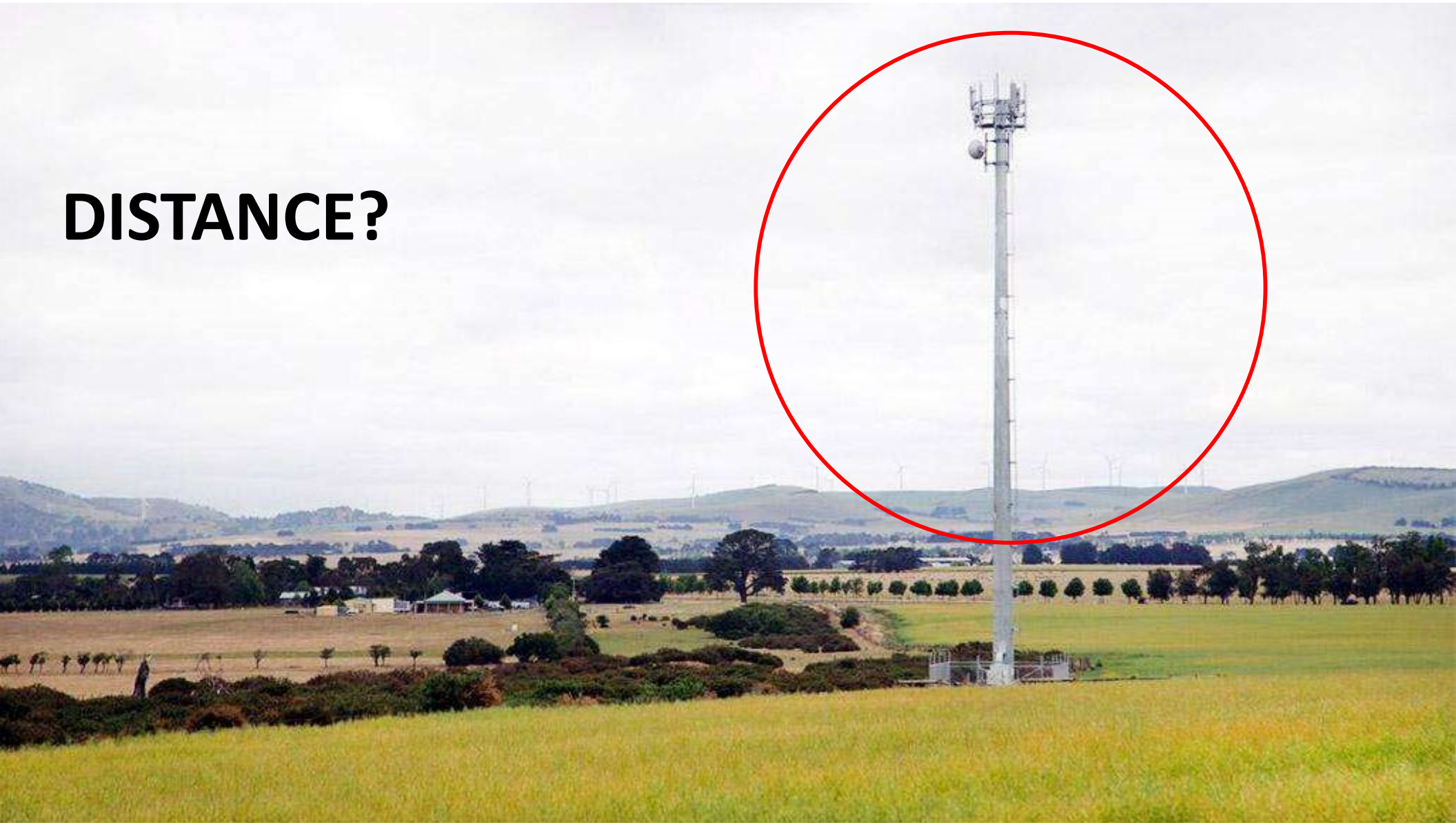


Raise Your Hands….

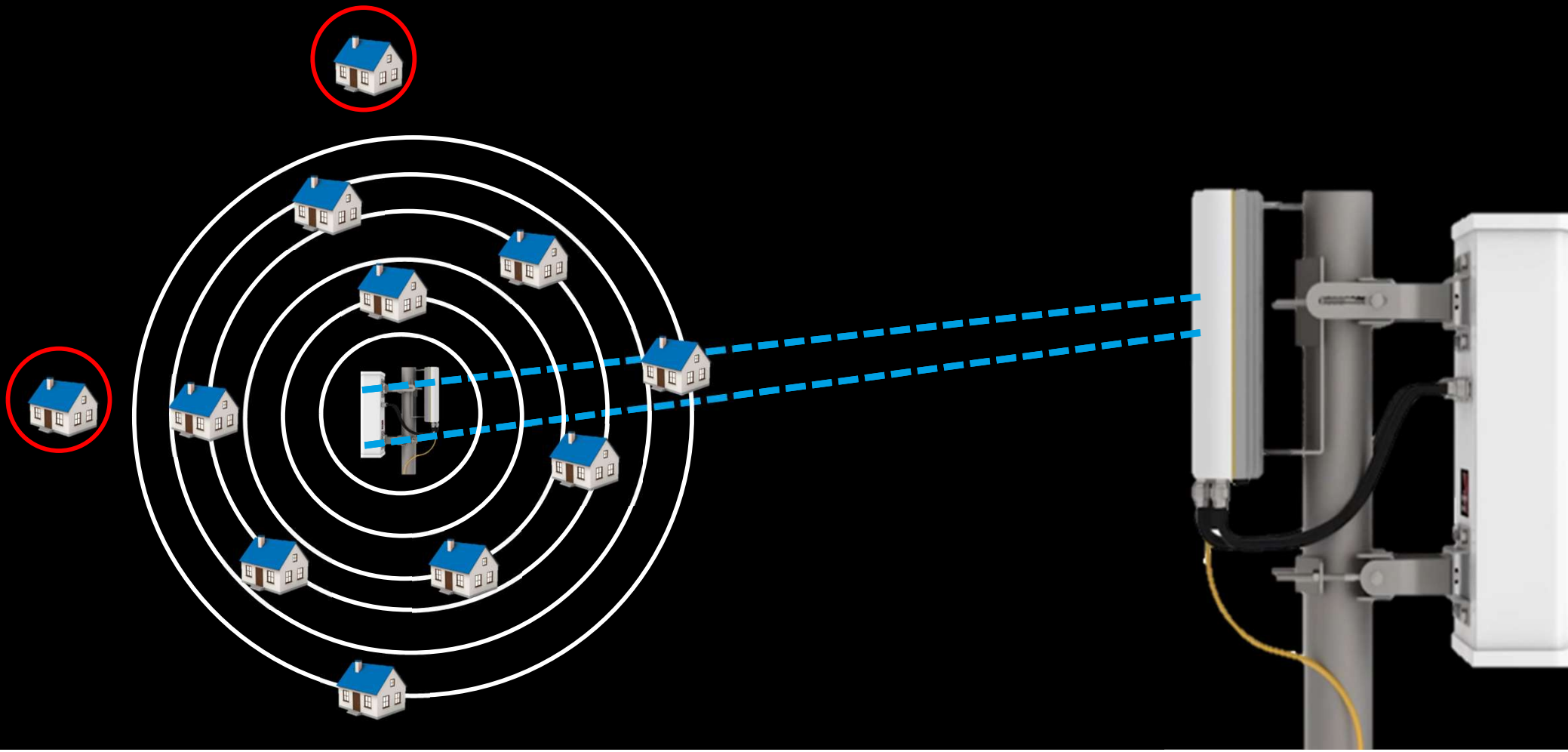
In FWA why does distance to the tower matter?

Free Space Path Loss

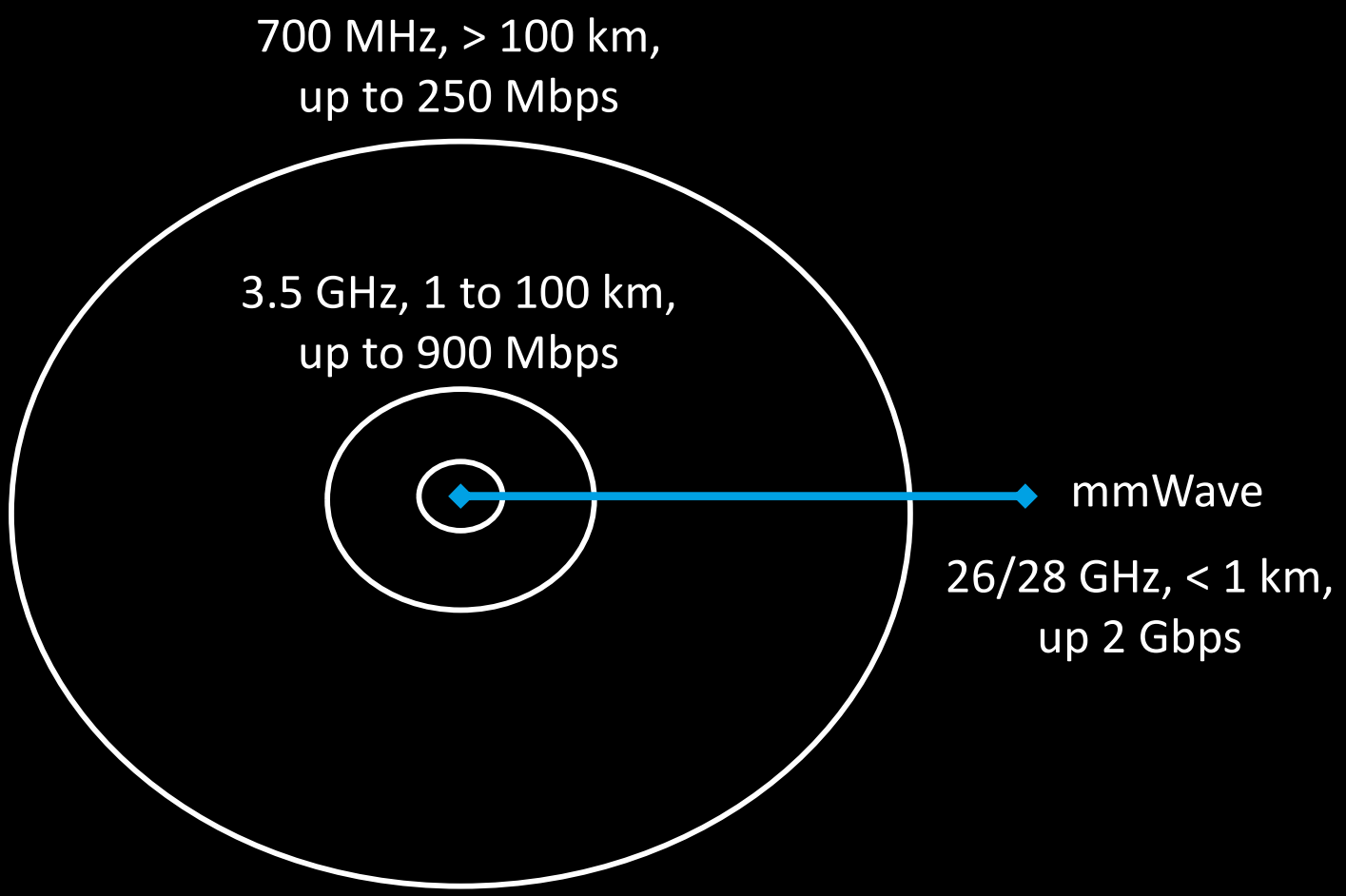
DISTANCE?



Fix Wireless Experience Factors: Distance

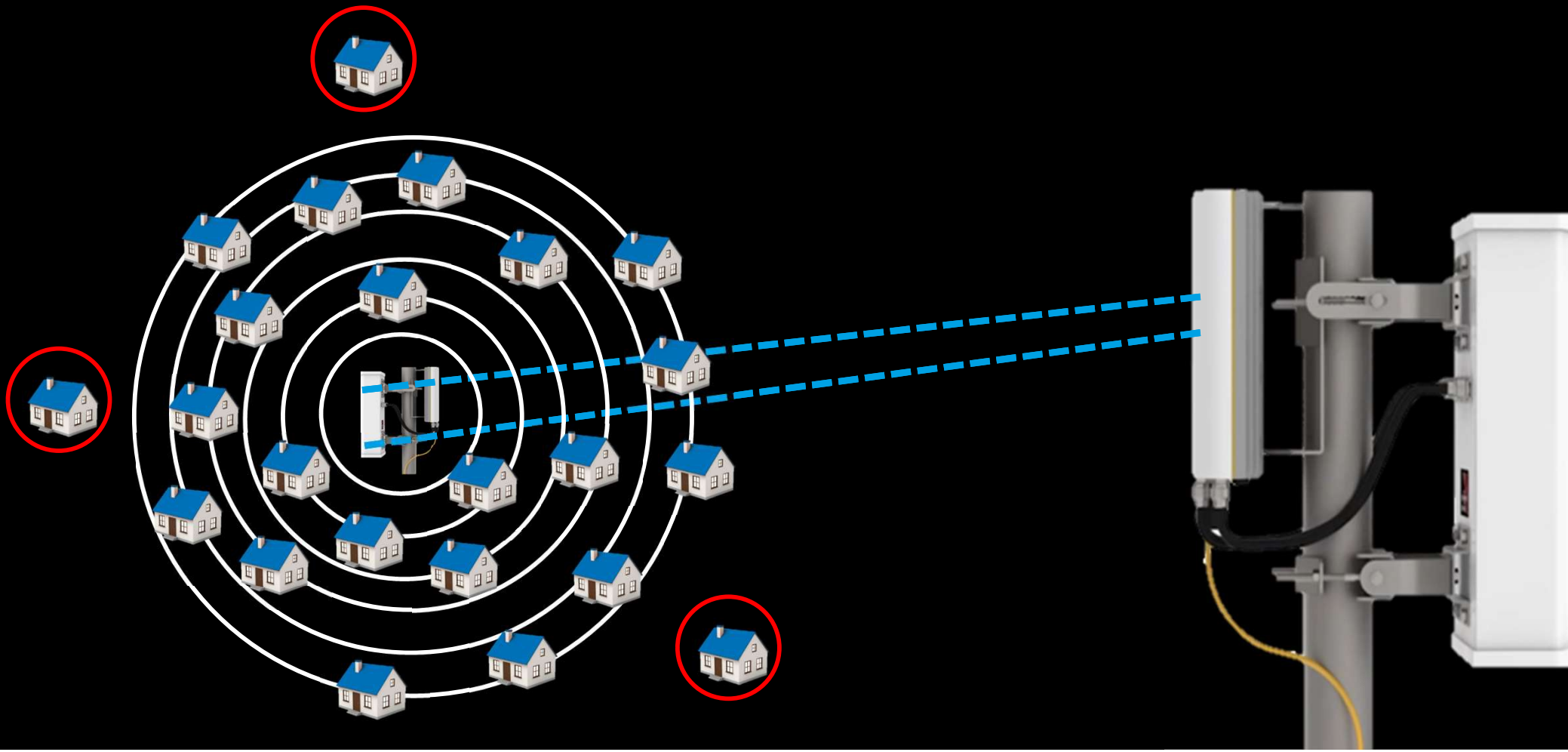


FWA Propagation

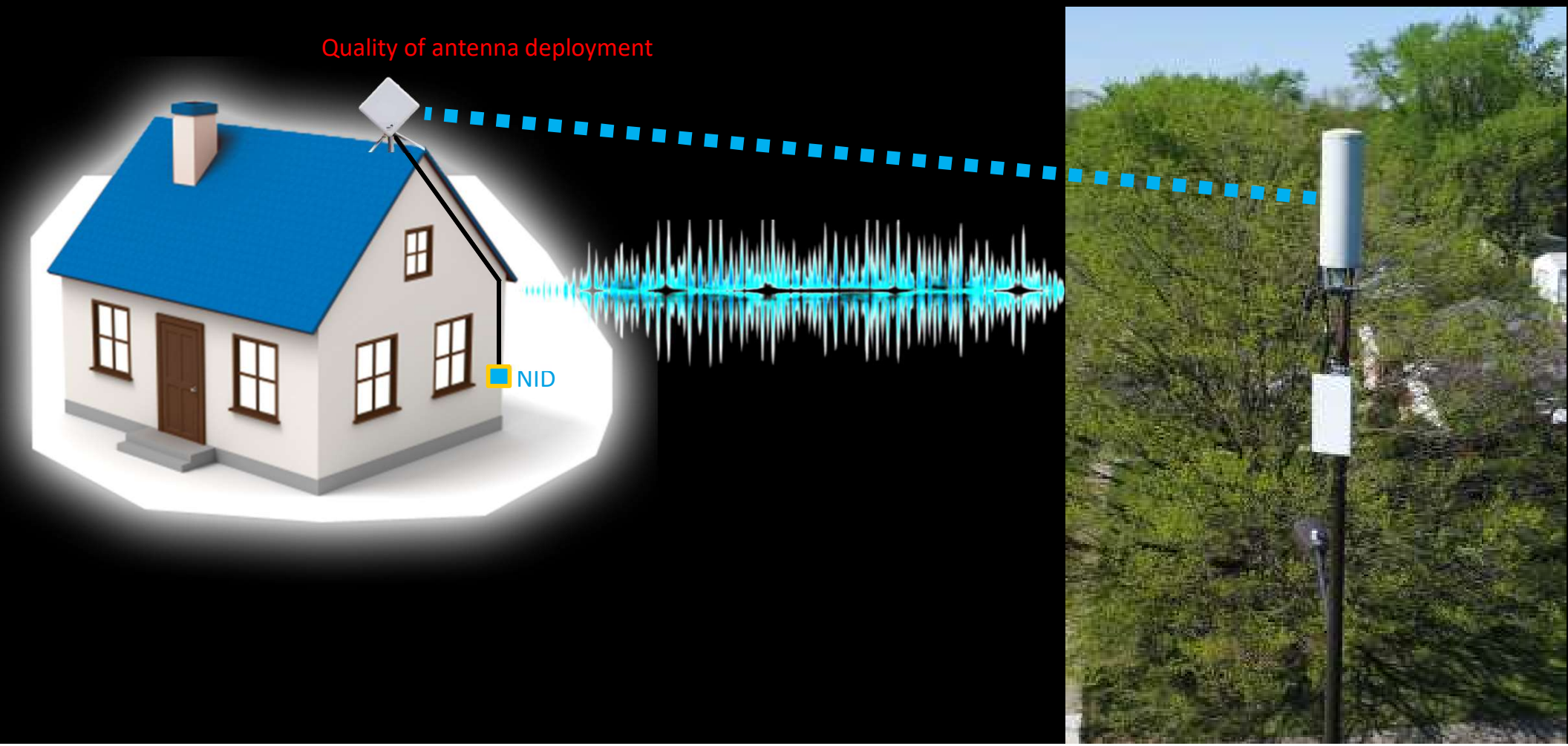


https://www.lightreading.com/5g/c-band-auction-maps-and-charts-who-won-what-where-and-how-much/d/d-id/767682

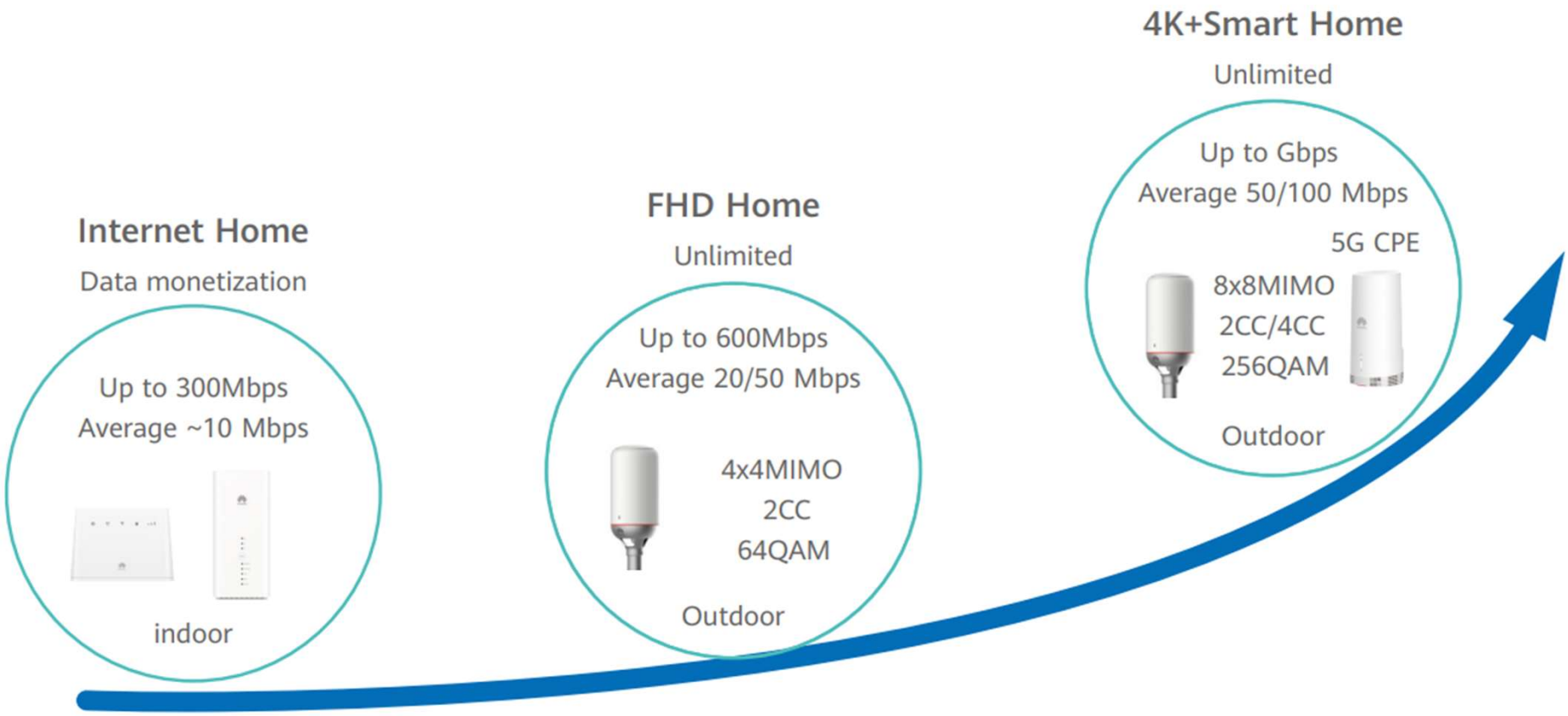
Fix Wireless Experience Factors: Distance, Load and Usage



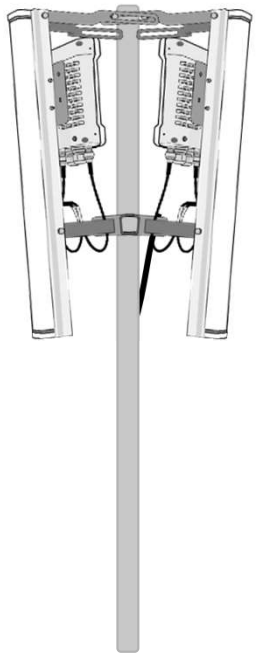
Fix Wireless Experience Factors: Antenna, Interference



Installation Types



Recognize the frequency spectrum used by FWA



Frequency Bands

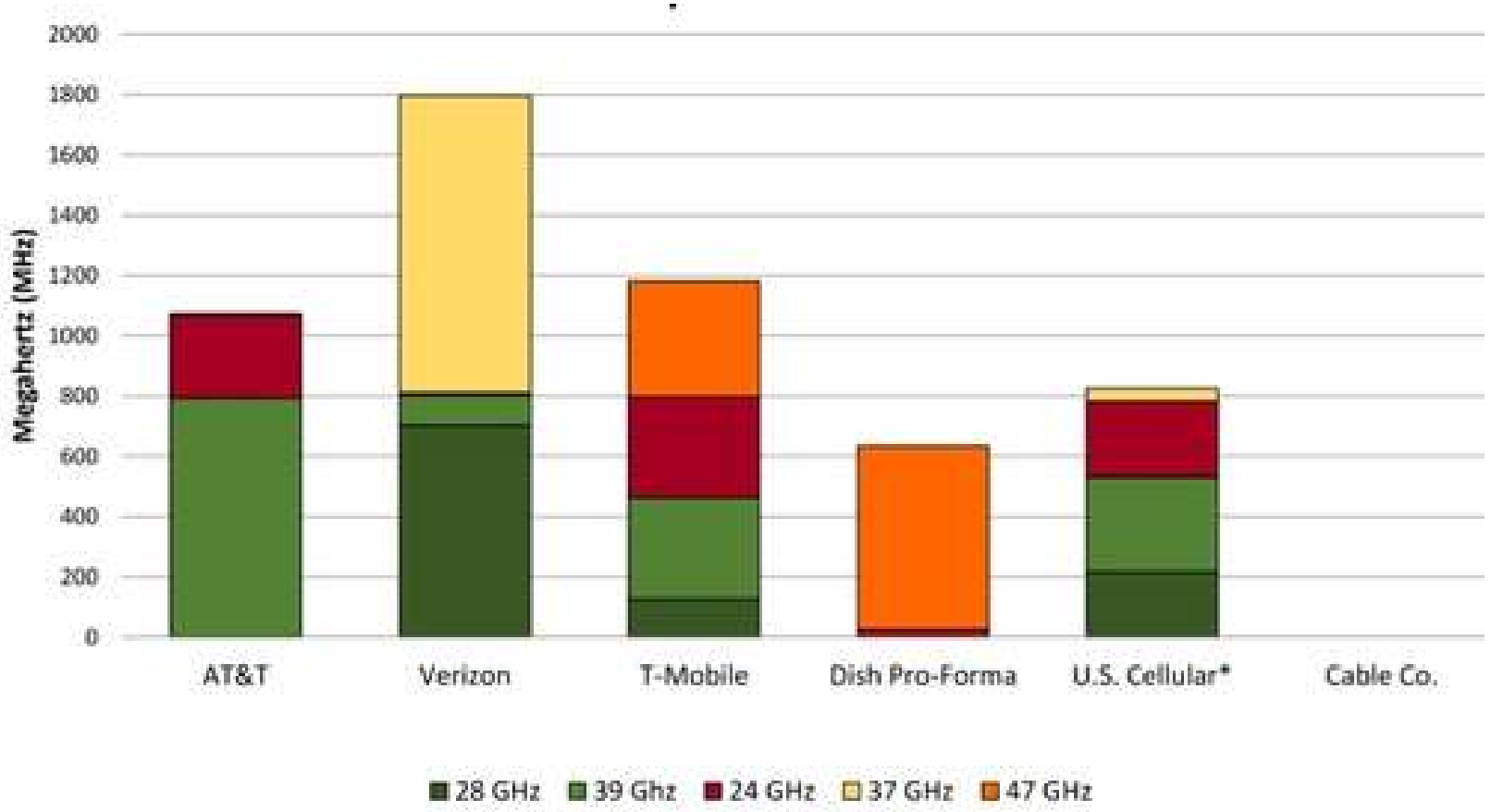
- Millimeter wave (mmWave) – carriers up to 400 MHz wide, higher data rates, higher path loss
  - High Band (> 6 GHz): 24 GHz to 39 GHz (5G), 47 GHz (5G)
  - Antennas highly directional
- Sub 6 GHz - carriers up to 100 MHz wide, lower data rates
  - Low Band (< 1 GHz): 700 MHz 800 MHz (rural)
  - Mid Band (< 6 GHz): 1.8 GHz, 2.1 GHz (rural)
  - Mid Band: 2.3 GHz, 2.6 GHz, 3.6 GHz (urban), C-Band: 3.7 – 4.2 GHz
  - Mid Band: 5.8 GHz (urban)

Deeper look at Allocation

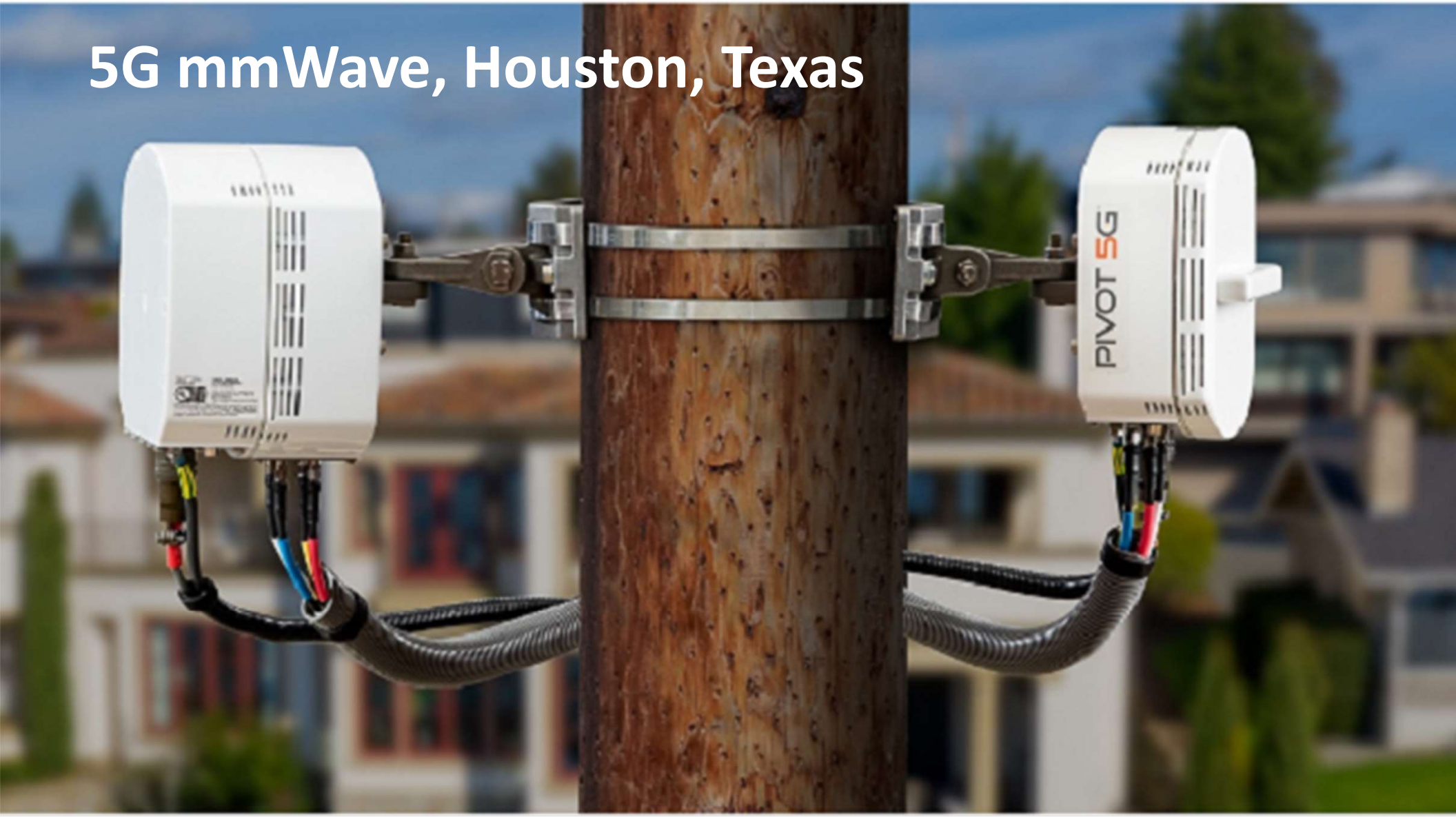
Band Name	Frequency	Total Spectrum	Allocation	How Licensed
Low Band Spectrum				
600 MHz	600 MHz	70 MHz	2x5MHz Blocks	Licensed
700 MHz	700 MHz	104 MHz	2x[1, 5, 6, or 11] MHz Blocks	Licensed
Mid Band Spectrum				
WCS	2.3 GHz	30 MHz	2x5MHz Blocks	Licensed
ISM	2.4 GHz	85 MHz	10, 20, or 40MHz Blocks	Unlicensed
BRS/EBS	2.5 GHz	190 MHz	6, 16.5, 49.5, 50.5MHz Blocks	Licensed
CBRS (secondary use)	3.5 GHz	150 MHz	10MHz Blocks (PAL)	Lightly Licensed
C-Band (secondary use)	3.7 GHz	280 MHz	20MHz Blocks	Licensed
U-NII	5 & 6 GHz	1,525 MHz	10, 20, 40, or 80MHz Blocks	Unlicensed
mmW Spectrum				
UMFUS – Auction 101	28 GHz	850 MHz	425MHz Blocks	Licensed
UMFUS – Auction 102 (secondary use)	24 GHz	700 MHz	2x40MHz Blocks	Licensed
UMFUS – Auction 103	37/38/47 GHz	3,400 MHz	100MHz Blocks	Licensed
V-Band	60 GHz	5,000 MHz	2160MHz Blocks	Unlicensed

Table 1 – Portion of Radio Spectrum Available for Broadband

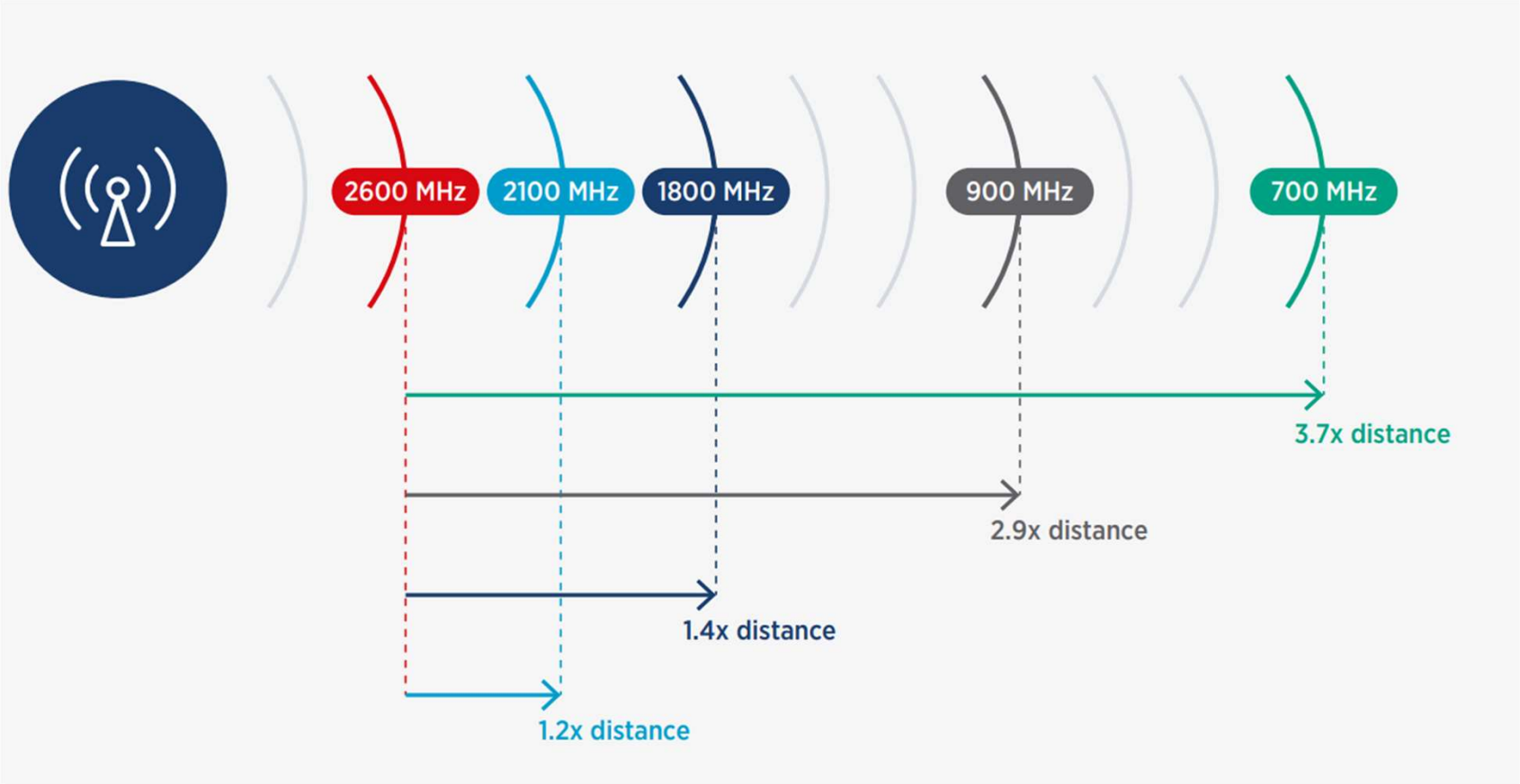
mmWave Holdings US Market



5G mmWave, Houston, Texas

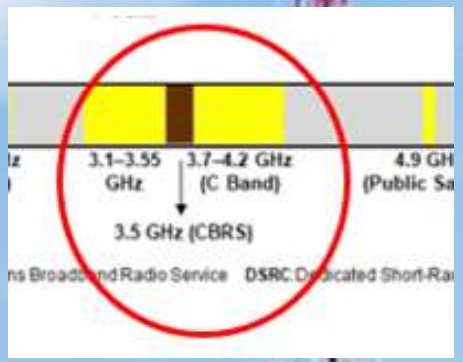


Propagation



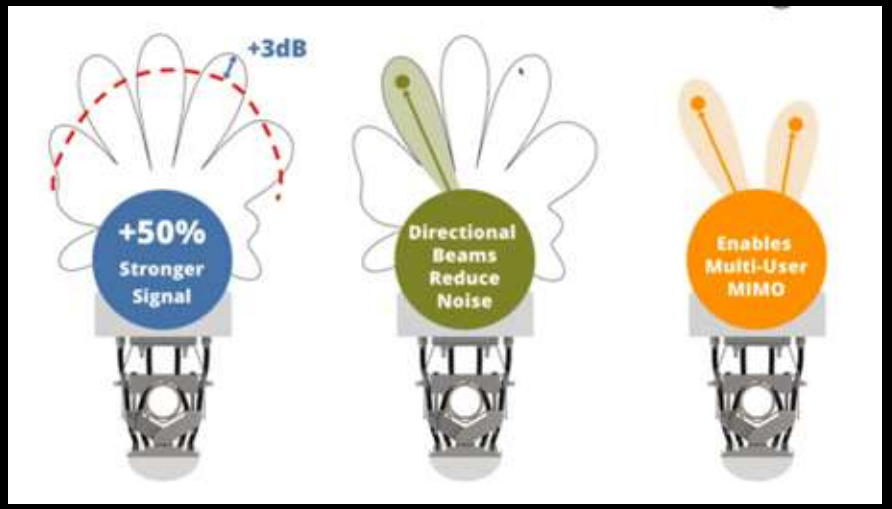
Fixed line operators can leverage CBRS 3.5 GHz in US.

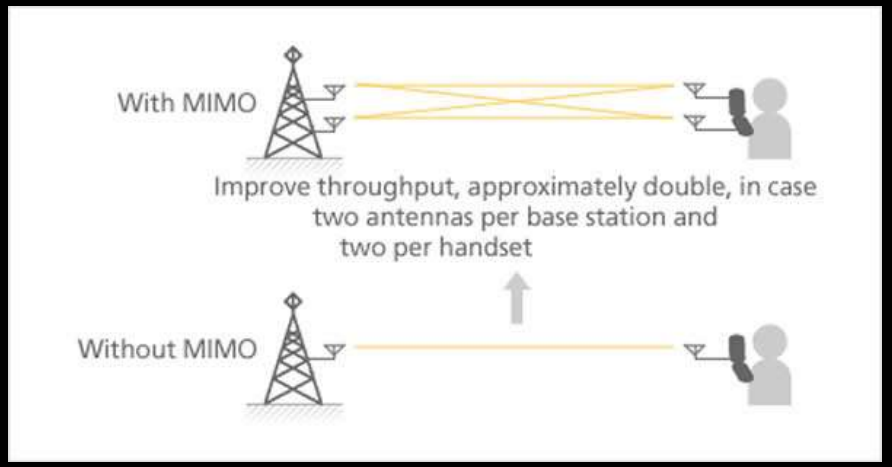
150 MHz = 3.500 – 3.700 GHz



Antenna Arrays

- Active antenna systems (AAS), beamforming
- Massive multiple input/multiple output (MIMO)

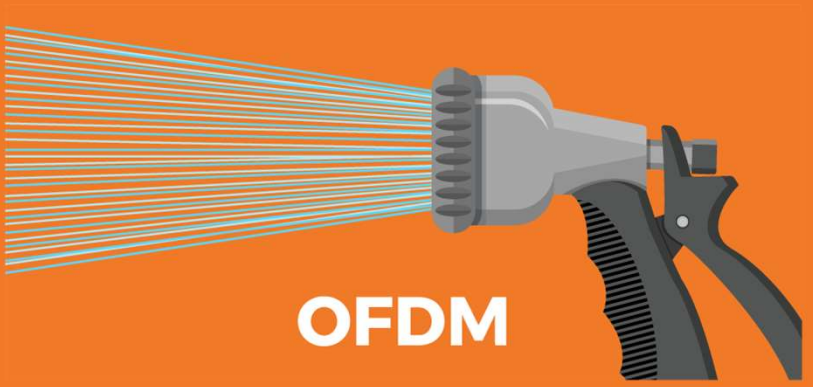




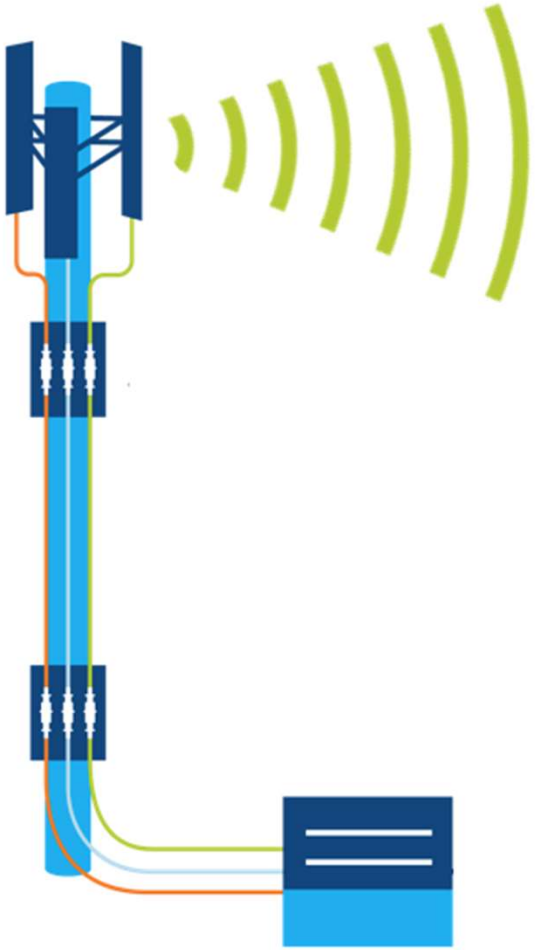
MIMO Sector Antenna 4x4 Example

SC-QAM and OFDM

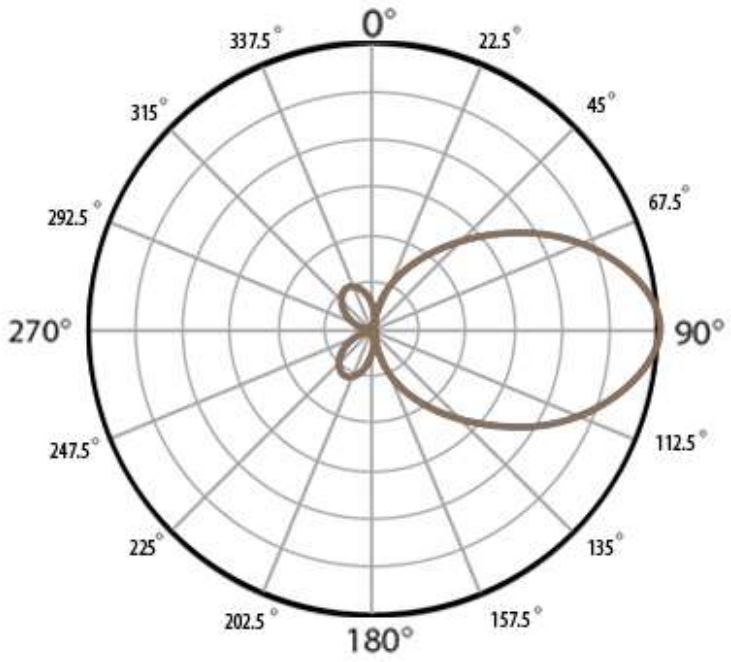
- Multi-Carrier Technology
- Thousands of Subcarriers
- FFT-based Implementation
- Enables ultra-wide channels



Base Station
AP Cluster
(Up to 12)



	Maximum EIRP (dBm/10 MHz)
Category A	30
Category B	47



Effective Isotropic Radiated Power

Summary

- Explores FWA and its capability to provide a broadband service
- Will FWA be a substitute to fiber services?
- Understood the spectrum considerations, propagation/range, capacity, pros/cons, and customer premises equipment (CPE)
- Recognize the frequency spectrum used by FWA

THANK YOU!

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