



Cambium Networks™

Fixed 5G From mmWave to NR-U

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- **Expanding Demand and New Use Cases**
 - Work/Learn/Entertain from Home
 - Over-The-Top Media Access
 - Industrial Automation
- **Spectrum Availability**
 - 6 GHz: FCC 5.925 – 7.125 GHz
 - CBRS: 3.550 – 3.700 GHz
 - 60 GHz: 57 – 66 GHz
 - 5G: 24.25 – 29.50 GHz
- **Supporting Standards**
 - IEEE 802.11ax
 - IEEE 802.11ay
 - 3GPP 5G NR (Release 15 & beyond)
- **Enabling Technology**
 - Massive Multi-User MIMO
 - Smart Antenna
 - System on Chip
- **3GPP Acknowledgment in 5G NR**



- **Release 15 Foundation / Validation**
- **Higher Data Rates**
- **Lower Latency**
- **Denser Networks**
- **Improved Symmetry**
- **Defined facilities for specific vertical applications**

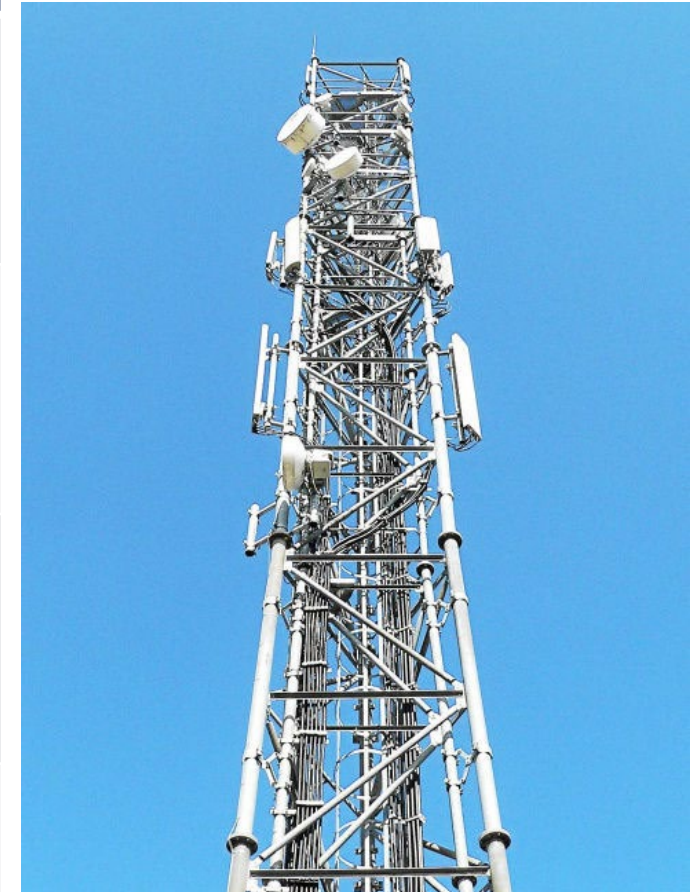
Three Defined Applications:

- **eMBB: Enhanced Mobile Broadband** progresses mobile broadband access and performance beyond 4G
- **URLLC: Ultra-Reliable Low-Latency Communications** for mission critical applications
- **mMTC: Massive Machine-Type Communications** to support IoT connections

Release 15 for Fixed Wireless Access

April 2019

Attribute	Benefit
Native mmWave support	<ul style="list-style-type: none">• Explicit support for beamforming during acquisition & operation• Wide subcarrier spacing to mitigate phase noise degradation
Wide Channel Size (up to 800 MHz)	<ul style="list-style-type: none">• Very high throughput
Flexible Frame Structure	<ul style="list-style-type: none">• Support wide range of up/down asymmetric traffic• Always On• Well suited to FWA
Uplink OFDMA	<ul style="list-style-type: none">• Efficient, cost effective CPE



Release 16 for Fixed Wireless Access

July 2020

Attribute	Benefit
Unlicensed Spectrum Support	<ul style="list-style-type: none">• Provides ubiquitous access to 5G NR technology by lowering the high cost of acquiring licensed spectrum
Coexistence with non-3GPP systems	<ul style="list-style-type: none">• Opportunity to access/share spectrum
Enhancements to Ultra-Reliable Low Latency Communication	<ul style="list-style-type: none">• Support for mission critical applications
Industrial IoT	<ul style="list-style-type: none">• Opening up IIoT Use Cases



Release 17 for Fixed Wireless Access December 2021

Attribute	Benefit
52.6~71 GHz support	<ul style="list-style-type: none">• Standard air interface for 26/28/39 and 60 GHz
Dynamic Spectrum Sharing	<ul style="list-style-type: none">• More efficient use of available spectrum
Low complexity NR devices	<ul style="list-style-type: none">• Cost optimized CPEs
Integrated Access & Backhaul enhancements	<ul style="list-style-type: none">• Lower cost, faster deployment, “all wireless” networks
Coverage Enhancements	<ul style="list-style-type: none">• More cost-effective networks



NR: New Radio

- **5th Generation Radio Access Technology**
- **Defines the 3GPP 5G Air Interface**
- **Significant performance enhancements**
 - Dynamic Spectrum Sharing
 - Coordinated Multipoint and Synchronized Sharing
- **Three Applications**
 - eMBB
 - URLLC
 - mMTC

NR-U: New Radio – Unlicensed

- **Applying NR to Unlicensed Spectrum**
 - Release 16 – July 2020
 - For example 5 / 6 / 60 GHz
- **Anchored or Standalone Core Network**
 - LTE – Dual Connectivity
 - 5G – Carrier Aggregation
 - 5G Standalone
- **Bandwidth**
 - ≤ 100 MHz UL
 - ≤ 400 MHz DL
- **Private Networks**

- **5G-NR Frequency Band**

- n257 (26.50 – 29.50 GHz), 28 GHz, TDD
- n258 (24.25 – 27.50 GHz), 26 GHz, TDD
- n261 (27.50 – 28.35 GHz), 28 GHz US, TDD

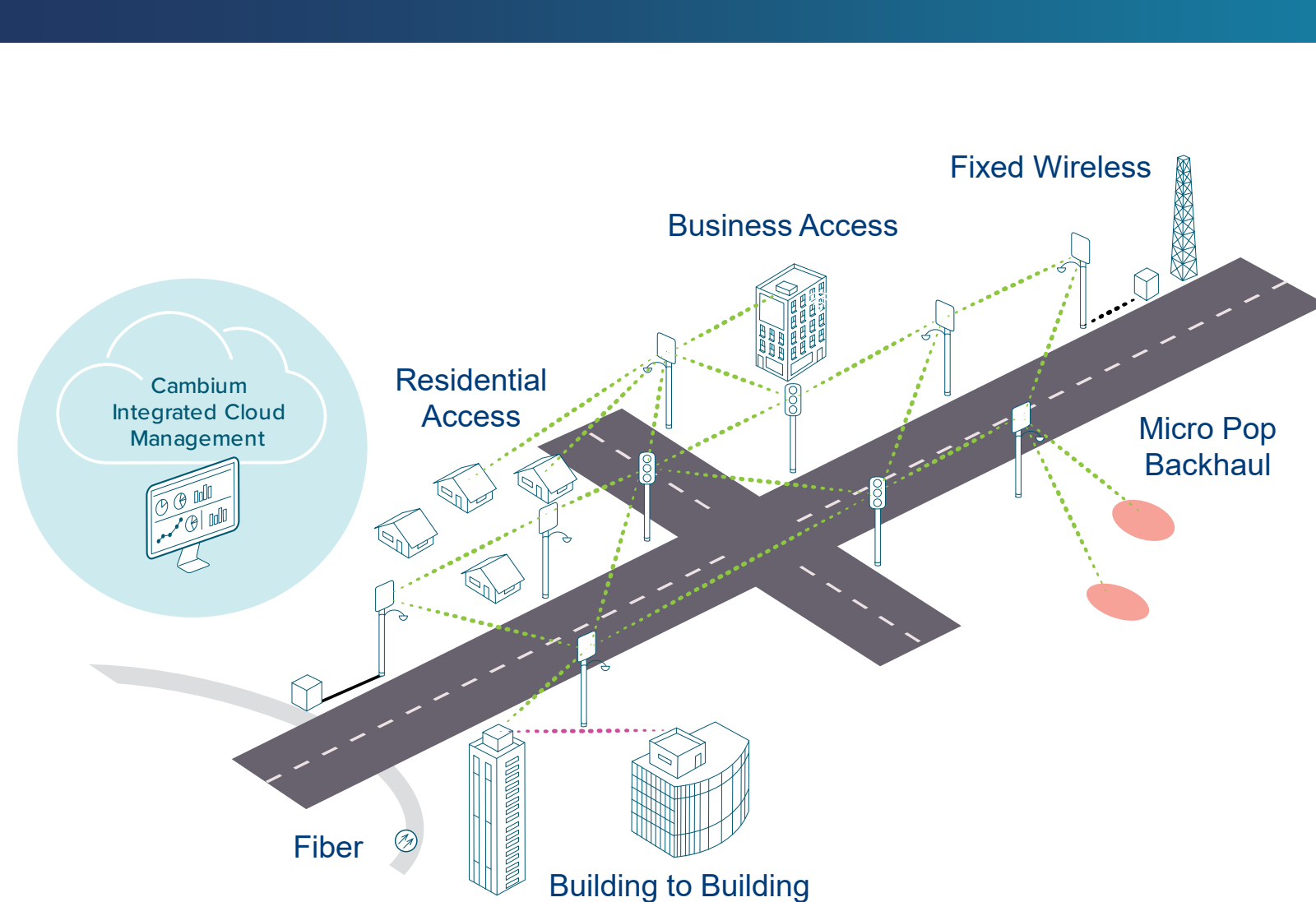
- **Highlights**

- 8x8 MU-MIMO
- 50/100 MHz (5G-like) and 56/112 MHz (legacy) channel sizes
- Up to 3.2 Gbps in 112 MHz
- Up to 240 CPEs per sector
- High antenna gain CPE for 5+ km cell radius



- **Optimised End-to-End for FWA**
 - Benefits for cnMedusa world-class MU-MIMO expertise
 - Lower cost & complexity solution (no mobility!)
 - Optimized for high throughput
- **Simple to deploy and operate**
 - Stand-alone BTS with integrated Core Network
 - Layer 2 wireless bridge with four QoS level per CPE
 - SIM-free CPE optional operation
- **Optimised for professional installation**
 - CPE has high gain dish antenna
 - Beam steer capability to ease installation (Patent submission pending)
- **BTS beam steers in azimuth only**
 - Elevation beam steer adds complexity but does not improve performance
 - CPE optimized for high throughput in clear sky conditions

	Product 802.11ad based	Product 802.11ay based
Protocol	802.11ad (2016)	802.11ay
CPE per Sector	8	15
Sector Maximum Throughput (L1)	5 Gbps	10 Gbps
Maximum Channel Width	2160 MHz	4320 MHz with Channel bonding
Channel Access	CSMA	TDMA
Network Synchronization	No	TDD
Configuration	PTP, PMP	PTP, PMP, Mesh

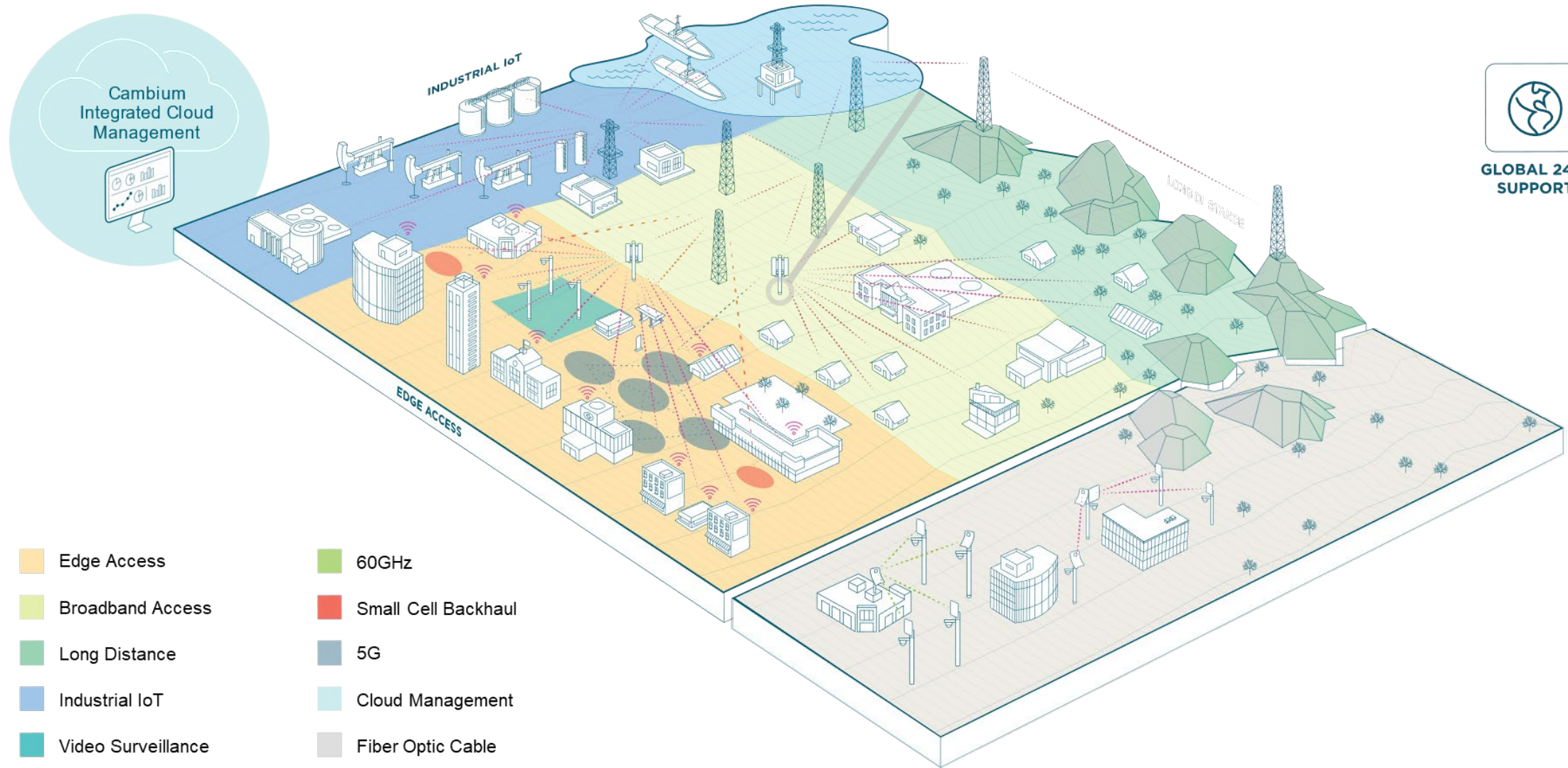


- **WTTH – Wireless To The Home**
 - Providing Wireless Broadband access directly to the home.
- **WTTB – Wireless To The Building**
 - Wireless Broadband access provided to rooftops or side of buildings, which then get distributed to individual offices and homes via wire.
- **RTRTR – Roof-Top To Roof-Top**
 - Long range Point to Point with high gain dish
 - Multi Dwelling Distribution
- **Fiber Extension**
- **Backhaul** for 5G Small Cell, outdoor Wi-Fi, MicroPoP and CCTV

- **Provide high capacity wireless solution to resident, enterprise and backhaul for Wi-Fi or small cell**
- **PMP, PTP and Mesh configurations**
- **Terragraph Certified**
- **Highlights**
 - 802.11at based
 - Auto-alignment
 - TDD / TDMA channel access and scheduling
 - Support network synchronization through 1 PPS
 - Up to 15 Gb Aggregate Capacity
 - Support 30 CPE
 - Comprehensive network design tools
 - cnMaestro Integrated Management



Cambium Networks' Gb Wireless Fabric



- **Fixed Wireless Access Renaissance**
- **3GPP 5G Legitimizes Fixed Access**
 - Release 15 Foundation
 - Release 16 Extends to Unlicensed Bands
 - Release 17 brings V-Band
- **Cambium Networks is adding threads to our Wireless Fabric**
 - Adopting Standards
 - Addressing 28 GHz
 - Addressing 60 GHz
- **Leveraging Decades as a Fixed Wireless Broadband Leader**



Mark Your Calendar

Date	Title
26 August	<i>Fixed 5G: From mmWave to NR-U</i>
22 September	6 GHz Is Opening up Globally – What Does That Mean for You?
14 December	Why MU-MIMO Delivers Spectral Efficiency and Performance in High-Noise Environments
4 November	The Future of Shared Access Spectrum: Lessons from the FCC's CBRS
2 December	Leveraging MicroPoP Architecture to Economically Reach New Customers



<https://www.cambiumnetworks.com/webinars/>



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Questions?



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