



Cambium Networks

CAMBIUM NETWORKS: PRIVATE NETWORK CONSIDERATIONS & APPLICATIONS

SCOTT IMHOFF

SENIOR VP, PRODUCT MANAGEMENT

CAMBIUM NETWORKS

future
TECHNOLOGIES

**TECHNOLOGY
SUMMIT
2024**

Cambium Networks at a Glance



Spun out of Motorola Solutions in October 2011



Pioneer in Point-to-Multipoint & Point-to-Point IP Wireless Broadband Solutions



Focused on Gb wireless connectivity; 2 meters to 246km – people, places, & things



HQ outside of Chicago, IL; Development Centers in the UK (Ashburton,) USA (Hoffman Estates,) and India



More than 12 million radio nodes shipped



Emerging leader in IIoT and Fixed 5G solutions

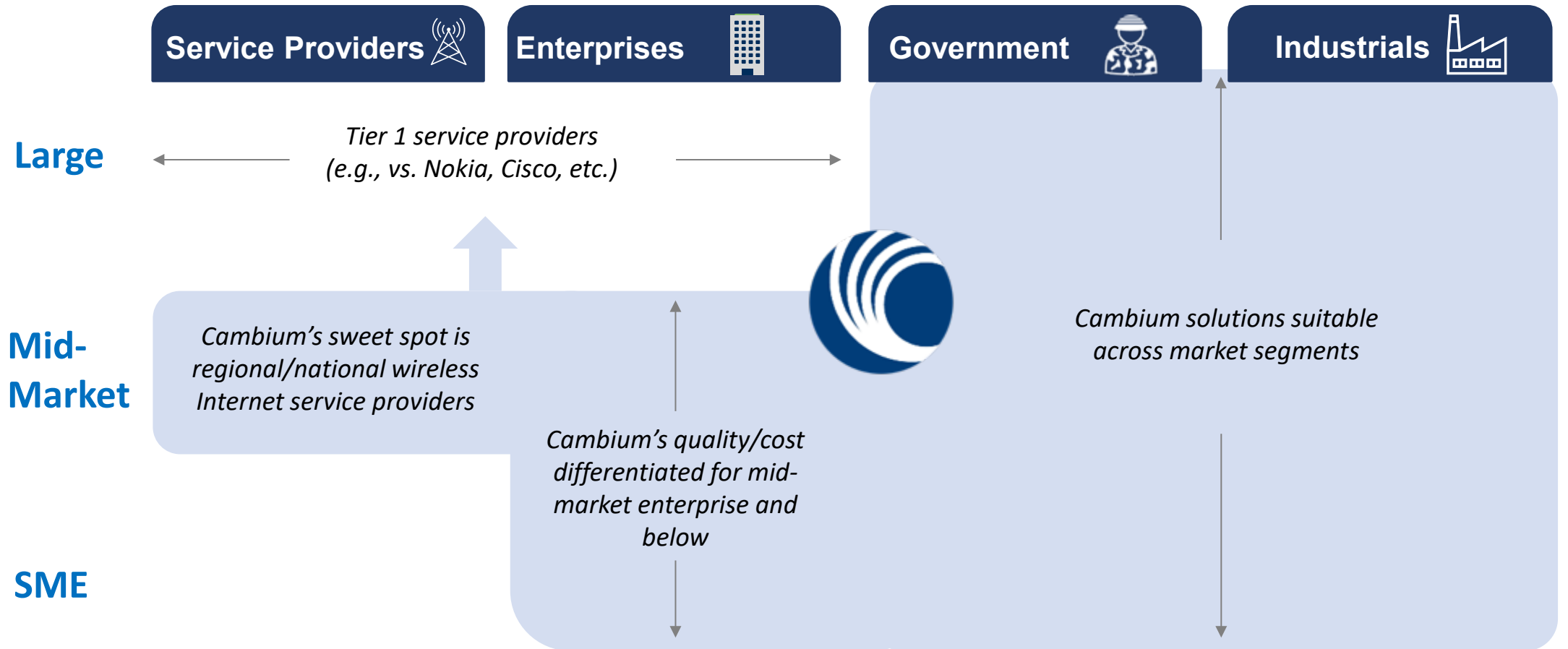


164 Countries and more than > 23,000 unique end-customer networks

CMBM Initial Public Offering 26 June 2019



Focused on Growing Markets of Mid-Sized Service Providers and Enterprises That Are Traditionally Underserved



Serving a Broad and Diverse Customer Base

Networking Service Providers



Small/Medium Enterprise



National & Local Governments



Private Industrial Networks



Point-to-Multipoint



PMP 450m

60 GHz cnWave

28 GHz cnWave

Point-to-Point



PTP 670/700

ePMP Force 425

Wi-Fi & Switching



Wi-Fi 6/6E

cnMatrix

RV22 Home Mesh Router

NSE/QoS

IloT



cnReach

Cloud Software and Wireless Fabric Management: Design, Commission, Manage

cnMaestro

Cloud management
Enables secure, end-to-end network control



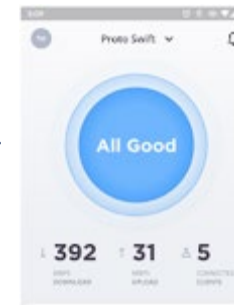
LINKPlanner

Network design tool
Optimizes RF performance



Subscriber app

Lightweight AP tool
Manage small Wi-Fi deployments

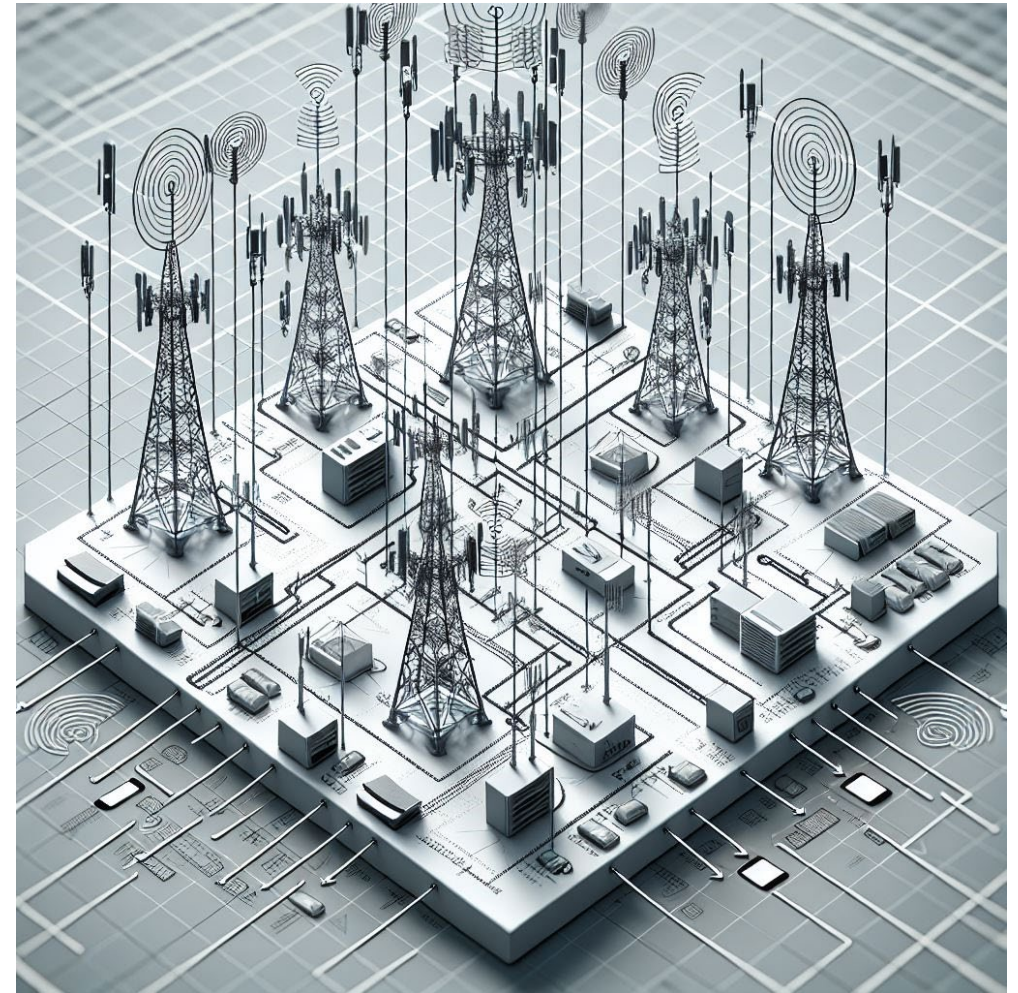


cnHeat

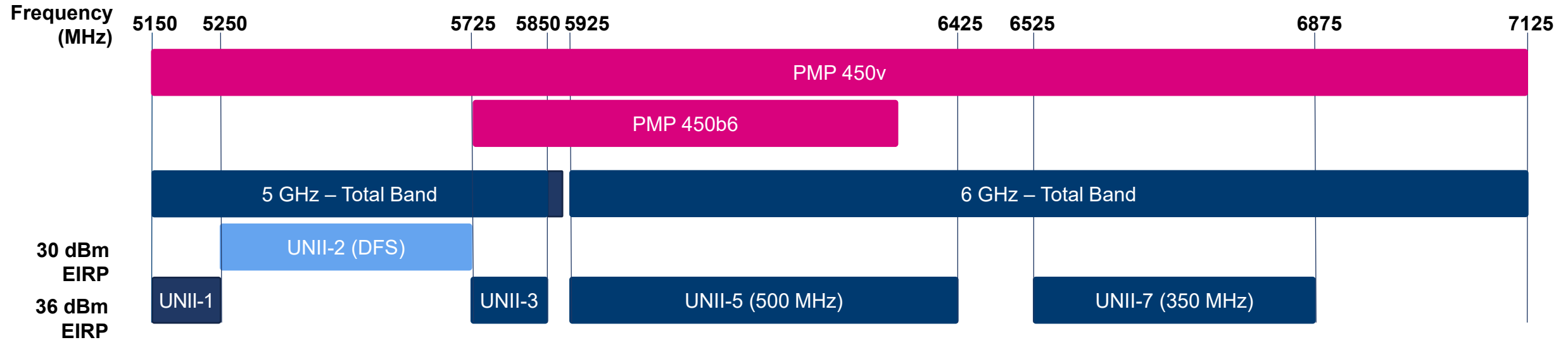
Network planning
Site Identification & placement



- **Just like “public” networks except...**
 - Hybrid Networks – no single solution
 - WAN/LAN
 - Spectrum diversity
 - PTP, PMP, Distributed wireless architectures
 - Wireless and Fiber
 - Application-specific performance modeling and testing – anchor application dictates selection
 - Latency
 - Jitter
 - Prioritization
 - Mission-critical network design and maintenance attributes emphasized
 - Hardened hardware
 - Redundancy and Diversity
 - Technical support
 - Sparing strategies

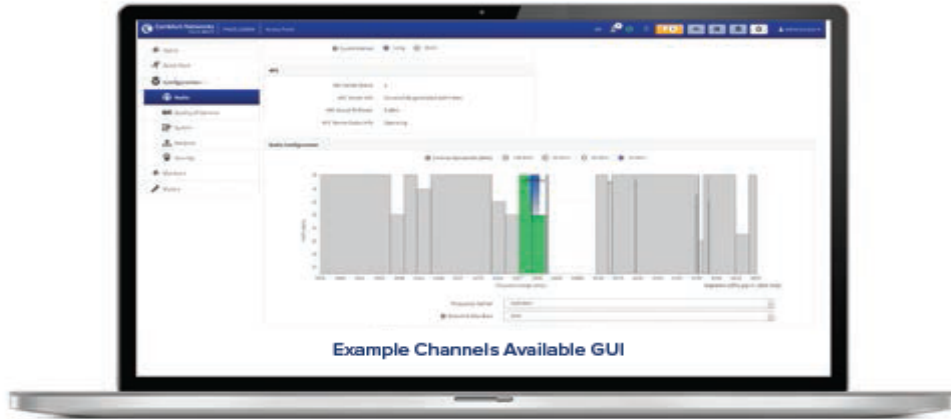
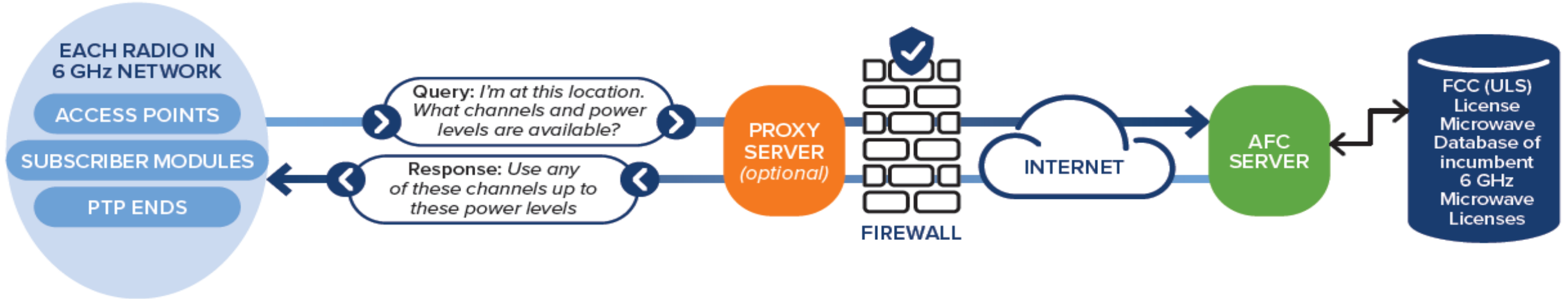


Spectrum Landscape



- In the US, FCC has allowed usage of 5850–5895 MHz.
- Requires the use of Automated Frequency Coordination (AFC).
- UNII-5 and UNII-7 will be allowed for outdoor use at standard power (36 dBm EIRP).
- UNII-6 and UNII-8 will be restricted to LPI (low-power indoor) use.
- 450v can operate anywhere from 5.15 GHz to 7.125 GHz

How does the AFC work?

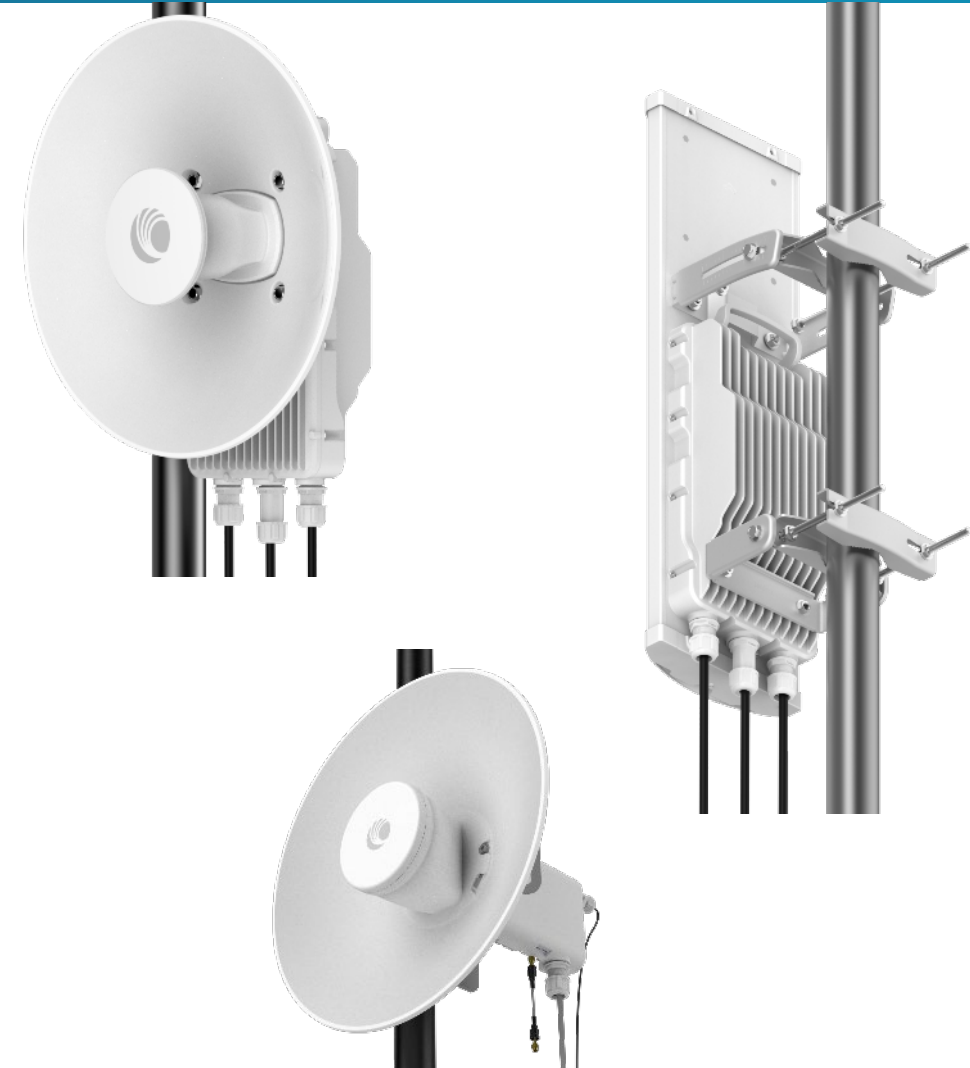


- Available channels and power levels
- Configured channel on the 4600 AP
- Channels occupied by the 4600 AP

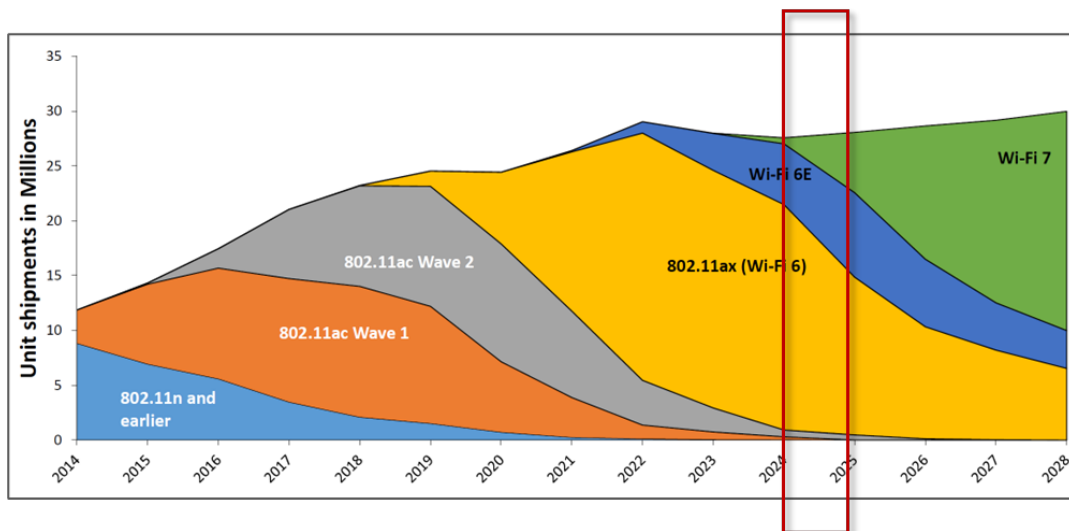
- A GPS
- Each ra
- An opt
- Querie
- Querie
- Radios
- Cost of
- AFC protects the incumbent, it does not provide guaranteed access
- CBRS SAS General Authorized Access (GAA) ensures access but does not assure carrier capacity

PMP 450v – The Next Generation

- **Deliver extreme performance to business and residential locations**
 - Extend the life of deployed PMP 450 gear
 - Reduce churn, remain competitive
 - Enhance service plans, provide more bandwidth than ever
- **Operates from 5.15 GHz to 7.125 GHz in a single SKU**
- **Backward and forward compatible and future proof**
 - Purpose-built software-defined radio platform
 - Utilize existing investment in 450 platform
 - Extend and enhance performance using wide channels in 6 GHz
- **4x4 MIMO access point**
 - Use more bandwidth, up to 200 MHz
 - Dual sector mode or carrier aggregation
 - 1.5 Gbps total capacity
- **4x4 (high performance) 2x2 subscriber modules**
 - 4x4 SM capable of carrier aggregation and gigabit speeds
 - 2x2 SM capable of 100 MHz channel support and 700+ Mbps
 - 450b6 capable of 40 MHz and 250+ Mbps



- iPhone 16 supports Wi-Fi 7 – inclusive of 2.4, 5 and 6 GHz
- Not the first phone to support 6 GHz – that claim belongs to Samsung – but now common across phone manufacturers
- 6 GHz client tipping point likely 3 years plus out given subscriber renewal rates



The iPhone 16 is available right now — here's who should (and shouldn't) upgrade

By [Henry T. Casey](#), CNN Underscored
Published 6:00 AM EDT, Fri September 20, 2024



Wi-Fi 7, Tri-Band, Tri-Radio 2x2

cnMaestro managed

Multi-mount brackets

X7-35X

X7-35X Indoor Tri-band Wi-Fi 7 AP 2X2. 6 GHz radio enabled 2.5 GbE



Typical Markets and Applications

Apartment MDU	Define the next generation of Wi-Fi for tenants. Supports growth in stream media, gaming, and spatial computing (AR/VR)
Enterprise / Retail	Skip Wi-Fi 6E and upgrade to Wi-Fi 7 for the next decade of Wi-Fi staff and customer devices
Hospitality	Front of house, meeting rooms, lobby. Deliver greater speeds, modern technology and upgrade the property to “Wi-Fi 7”
Education	Support the newest devices as they come into higher education dormitory housing, lecture and Campus Wi-Fi

Product Quick Specs

- Tri-band, 2.4 GHz, 5 GHz, 6 GHz
- Streams: 2x2 in three bands
- 6 GHz LPI power class: sub-bands UNII-5, 6, 7, 8
 - Subject to individual country regulations on 6 GHz operation
- Antenna: omni with 30° down-tilt gain
- Multi-rate Ethernet port up to 2.5Gbps
- Dual function Zigbee/BLE 4.0 transceiver supporting Matter, Thread
- USB 2.0 interface with 0.5 watts power. Designed for a future GPS transceiver
- 0C to +50C ambient operating temperature
- Up to 25 watts of power, 802.3at, required at full load
- Limited Lifetime Warranty

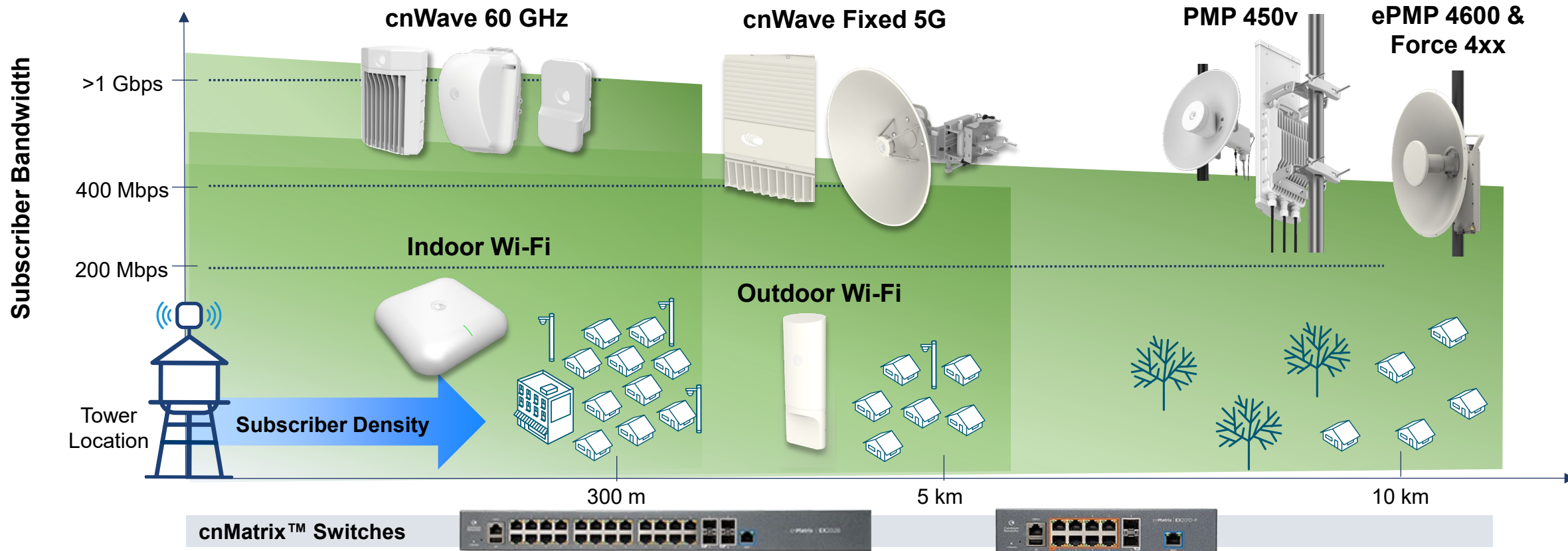
Spectrum Map – Exercising Our Natural Resources



Platform	Architecture				Standard	Spectrum Bands																				
	PTP	PMP	Distributed	Wi-Fi		Purpose-Built	802.11	3GPP	220 MHz	450 MHz	700 MHz	896 MHz (A-Block)	900 MHz	2.4 GHz	2.5 GHz	3 GHz	3700 – 4200	4.4 – 4.9 GHz	4.9 GHz	5.4 GHz	5.8 GHz	5.925 – 7.125 GHz (6E)	6 – 42 GHz	24.25–29.50 GHz	60 GHz	80 GHz
Wi-Fi				✓		✓							✓						✓	✓	✓					
cnReach	✓	✓			✓			✓	✓	✓	✓	✓														
PTP 450i	✓				✓										✓			✓	✓	✓						
PTP 550					✓														✓	✓						
PTP 670	✓				✓													✓	✓	✓						
PTP 700	✓				✓												✓	✓	✓	✓						
PTP 8xx	✓				✓																	✓	✓		✓	
PMP 450		✓			✓							✓	✓		✓	✓		✓	✓	✓	✓					
ePMP	✓	✓			✓								✓					✓	✓	✓	✓					
60 GHz cnWave	✓	✓	✓			✓																		✓		
28 GHz cnWave		✓					✓																✓			

Wireless Fabric Agility

ONE Network – 100 mb to 1 GB to the Edge



KPI		
Technology	802.11ay	5G
Sector Capacity	> 15 Gbps	> 3 Gbps
Subscribers per Sector	30	240
		cnMedusa Gen 2 & 802.11be
		> 5 Gbps
		238

Management



cnMatrix – TX 2K and TX 1K Tower Switches

- **Purpose built for tower deployments**
- **Enterprise Grade, Non-Blocking, Fully Managed, L2/L3 switching**
 - Cloud-based Network Management – cnMaestro
 - Zero Touch Simplicity with automated configuration (PBA)
 - Automated security with device profiling and policy enforcement (PBA)
- **Intelligent & flexible PoE**
 - Standards based 802.3af/at/bt and Passive PoE (24V & High Power (90W))
- **Dual redundant GPS synchronization sources (TX 2K)**
- **Dual redundant AC and DC removable power supplies (TX 2K)**
- **Hardened with extended temperature range & extra surge suppression**



Distribution Node



V5000
Dual Sector

Client Nodes (PMP or PTP)



V3000
High Gain
44.5 dBi Dish



V2000
Flexible
Mid-Range
40.5 dBi Dish



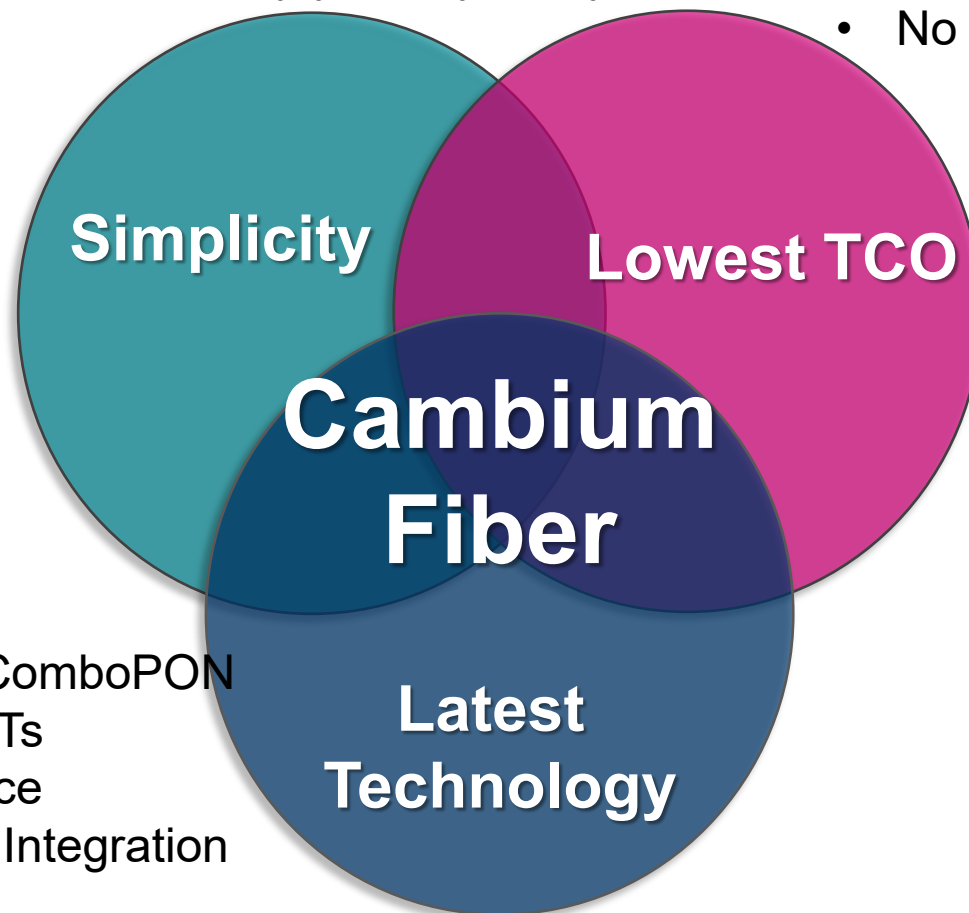
V1000
Small
Form Factor

All cnWave 60 GHz products include:

- Cloud or on-premises network management with cnMaestro
- Optional advanced management features with cnMaestro X
- Network planning capabilities with cnHeat, LINKPlanner, and ANP
- On-board or remote e2e controller software
- Layer 2 or layer 3 network connectivity
- IPv4 or IPv6 networking protocols
- Security with HTTPS interfaces and 128-bit AES encryption
- 3-year warranty
- Options for extended warranty, Cambium Care Pro, and advanced replacement

- cnMaestro Management: Single pane of glass
- Operations: Up and running in minutes
- Supplier engagement: Same way you buy today

- Low on-going support costs
- Reliable, attractively priced hardware
- No professional services contracts required
- No paid training required



- Carrier grade OLTs
- GPON/XGS-PON/ComboPON
- Indoor/Outdoor ONTs
- Quality of Experience
- ONT/OLT/Wireless Integration



8 Port



16 Port



Scaled 1RU Fiber OLT

Uplink	100 GbE, 40 GbE, 25 GbE, 10 GbE (2x SPF28, 2x QSFP28)
PON	Combo PON, GPON, or XGS-PON 1:128 splits, software upgradeable to 256
Performance	Non-blocking 300 Gbps switching capacity
Environmental	Hardened -40°F to 149°F (-40°C to 65°C)
Accessories	Hot swappable redundant AC or DC PSU Replicable fan assembly Combo PON, XGS-PON, GPON transceivers

8 Port



16 Port



DC PSU



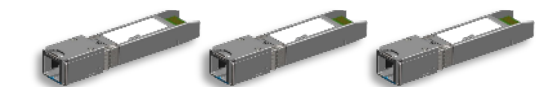
Fan



AC PSU



PON Transceivers



Combo XGS-PON GPON

Scan for
more info:





SGT00 Gigabit Outdoor GPON

LAN	10/100/1000 GbE auto MDI-X
PON	GPON
Environmental	Outdoor -22°F to 140°F (-30°C to 60°C)
Power	30v PoE adapter (Cambium or standard polarity)

SXT00 Multi-Gigabit Outdoor XGS-PON

LAN	10/100/1000/2500 GbE auto MDI-X
PON	XGS-PON
Environmental	Outdoor -22°F to 140°F (-30°C to 60°C)
Power	30v PoE adapter (Cambium or standard polarity)

Scan for
more info:



Planning & Design Software Solutions



cnHeat

Improve precision of site surveys.
Save time and money.
Provide exact antenna location for best connectivity.



LINKPlanner

Design networks for optimal deployment and cost effectiveness, quickly and easily.



cnInstaller

Free Android app improves installation accuracy.
Properly configure and align PMP subscriber modules.



Wi-Fi Designer

Fast and easy design tool for Cambium Wi-Fi networks.
Available online and free to use for anyone.

Typical Application

Quickly pre-qualify new customers saving time and money.
Identify and market to addresses of unserved customers.
Determine optimal greenfield site placement.

LOCATE subscriber installations.
IDENTIFY unserved customers.
OPTIMIZE greenfield site placements.

Model scenarios based on geography, distance, antenna height, transmit power, etc., to optimize system performance before purchase.
Quickly and easily design networks for optimal deployment and cost effectiveness.
Free, user-friendly link-design tool.

Designed with input from field technicians and years of experience on millions of modules.
Validates configuration and alignment in seconds.
Boost the number of installs done right the first time and increase customer satisfaction.
Eliminate problems and focus manpower on connecting new subscribers as your network grows.

Enables design of Wi-Fi networks. Import floor plans, draw walls, place Aps, and model AP coverage to generate the bill of materials.
Supports all indoor and outdoor APs across the Cambium Wi-Fi 6, cnPilot, and Xirrus product lines.
Creates PDF output report that includes heat maps and BOM.

Products Supported

ePMP
PMP

cnReach
ePMP
PMP
PTP

ePMP
PMP 450

Wi-Fi 6
cnPilot

cnMaestro provides an integrated, intelligent, easy way to manage your network in the cloud or On Premise



Easy onboarding – Claim devices in the cloud or on-site



Configure devices – Automatically provision devices upon registration, or group devices and apply configuration parameters across your network



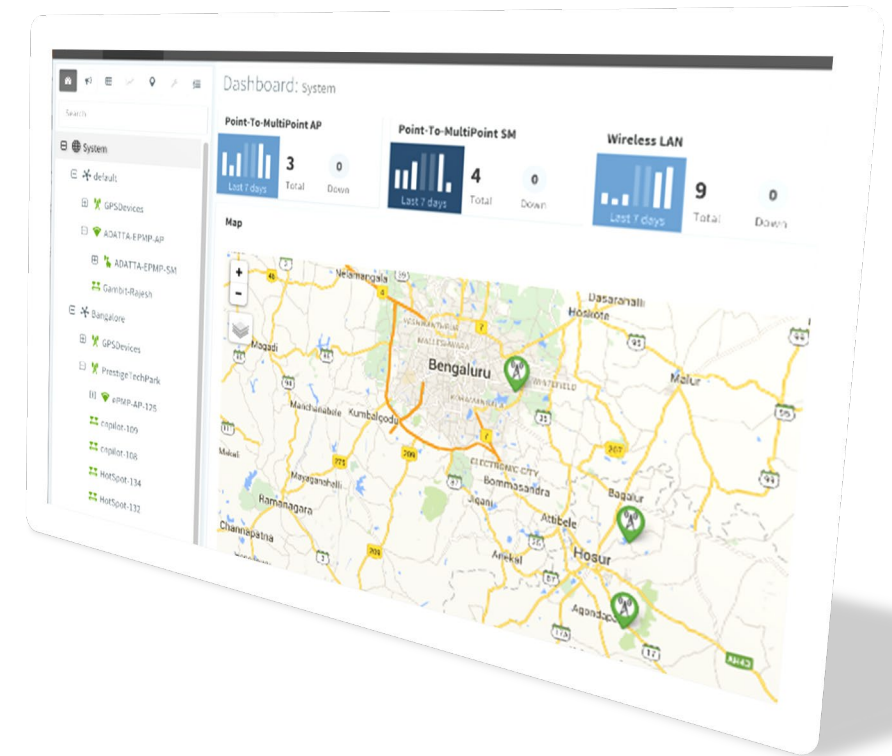
Monitor your entire Cambium network – Leverage hierarchical dashboards, statistics, and maps to view status and drill into problem areas



Intuitive end-to-end troubleshooting – Visualize tower-to-edge device health and evaluate real-time client network connectivity



Comprehensive and extensible API – Easily integrate with manager-of-manager and third-party applications to extend the value of cnMaestro and its data warehouse



Distribution Center Marshaling Yard Coverage

USE CASE

- Latency-sensitive LiDAR application
- Brownfield application
- Outdoor Wi-Fi coverage
- CCTV Transport



CHALLENGE

- Latency sensitive applications
- Requires 99.999% availability
- Time to service is critical
- Trenching not viable

CAMBIUM NETWORKS SOLUTION

- Fixed wireless broadband infrastructure
- Outdoor Wi-Fi access

RESULTS

- Installation and deployment did not disrupt operations
- LiDAR sensor network enables autonomous vehicles
- Wi-Fi access, CCTV surveillance, physical security, data acquisition applications enabled

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USE CASE

- Building to building connectivity on enterprise campus
- Wi-Fi connectivity in enterprise parking lots
- CCTV transport



CHALLENGE

- Needed rapid deployment
- Could not disrupt operations

CAMBIUM NETWORKS SOLUTION

- 60 GHz cnWave multi-gigabit infrastructure
- Outdoor Wi-Fi access points

RESULTS

- Proven for primary connectivity
- Proven for resilient back up for diversity
- Easily interoperates with devices and laptops

Multi-Gigabit 60 GHz for Class 1 Rail Yard Coverage – USA & Canada

USE CASE

- Backhaul for Wi-Fi coverage
- Connect outdoor train yard, indoor facilities, refueling stations, nomadic maintenance personnel

CHALLENGE

- Minimize operating cost without compromising service level
- Increasing number of connected Wi-Fi devices on site
- Maintain clean channels and reliable communication

CAMBIUM NETWORKS SOLUTION

- 75 60 GHz cnWave nodes
- Enables mmWave distributed mesh networking technology
- cnMaestro end-to-end cloud-based network controller

RESULTS

- Eliminated interference issues with Wi-Fi APs co-located throughout the rail yard



Campus Network: Mining Camp, 500 rooms

Fixed wireless campus backbone



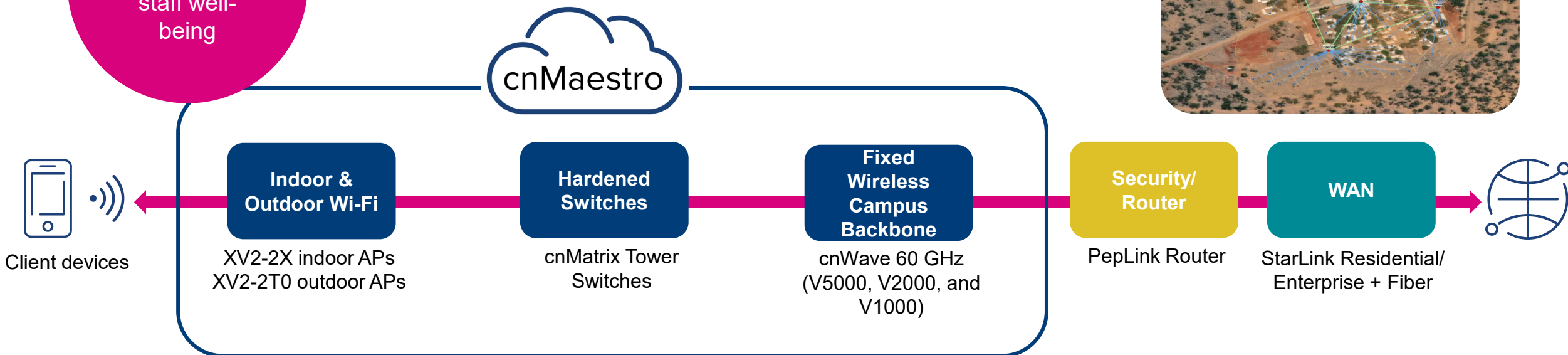
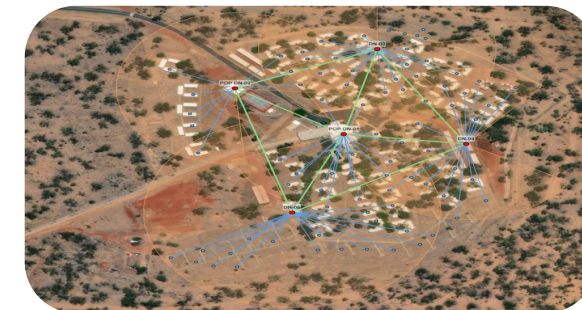
The Need:

A scalable, reliable connectivity solution to not only support operations but also improve the quality of life for the workforce. Current network had limited fiber capacity and minimal 3G coverage.

500 Mbps internet speeds facilitate:

- Wi-Fi calling
- Video conferencing
- Internet browsing
- Streaming services

Enhanced operational excellence & staff well-being





Cambium Networks™



Fixed Wireless Portfolio Leadership



Cambium Networks ONE Network Summary

Network Management	cnMaestro X – Cloud Managed Services							
	X Assurance		Easy Pass			Application Control		
Network Services	QoE and NSE 3000 Advance Services Platforms							
Wired Interface	cnMatrix – Wireless Aware Switching							
Product Platform			Fixed Wireless Broadband					
	Wi-Fi 6/6E	Fiber	PTP 820/850	PTP 550/670/700	PMP 450	ePMP	cnWave	cnReach
Design Focus	Software Defined Radios, Cloud Managed, High Performance Wi-Fi	XGS PON Converged Fiber and Wireless Networks	Licensed Microwave Backhaul	Industry Leading Sub-6 GHz and 7/8 GHz TDD Backhaul Performance	Unparalleled Scalability for Multipoint networks	Price / Performance PTP and PMP Leadership	Gb to the Edge for Urban, high-density Suburban, and Rural markets	Licensed Narrowband in rugged I/O rich package
Throughput	1+ Gbps / AP	10 Gbps Symmetric OLT	2+ Gbps	450–1400 Mbps	1.2 Gbps / Sector	1.2 Gbps / Sector	15 Gbps / DN 3 Gbps / BTS	KB to MB
Spectrum <small>(GHz except as noted)</small>	2.4, 5, 6	PON	6–38	4.400–5.925 7.125–8.500	3, 5, 6	2.4, 5, 6	24.25–29.50 57–66	220, 450, 700, 900 MHz

Outdoor Wi-Fi 6/6E: Extended range, easy installation

High Efficiency Antenna

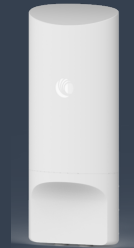
Self-optimizing for consistency & quality

PoE out, 2.5GbE, Sector ant

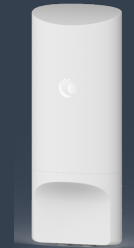
XV2-23T



XV2-2T0



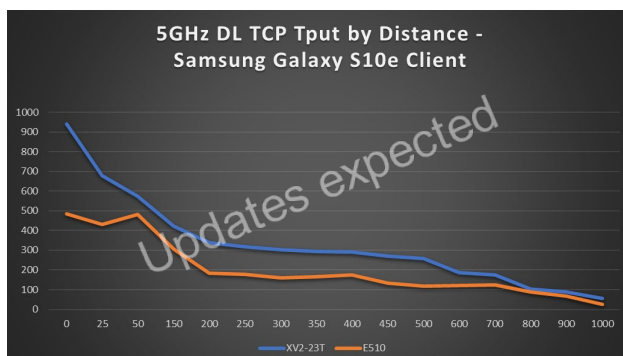
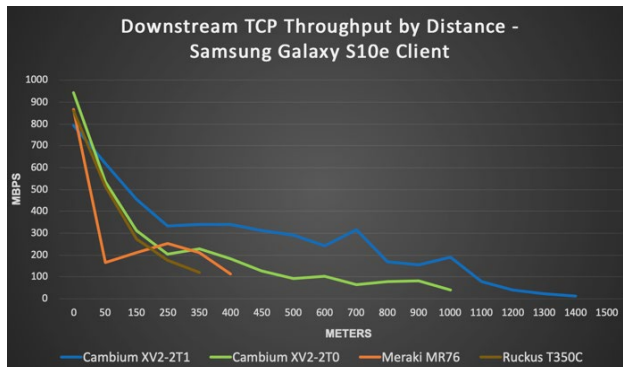
XV2-2T1



XE3-4T



WiFi 6/6E with SDR



Higher Education/K12 Outdoor	Higher Education/K12 Outdoor	Higher Education campus
Poolside, parking lots	Retail Transportation & Logistics	Stadium, Outdoor venues
Cold storage, digital warehouse	yard, wireless cameras, mobile devices, digital scales	Indoor high ceiling, high density
Public / municipal Wi-Fi	Public Wi-Fi, outdoor venues	Transportation & Logistics

	XV2-23T	XV2-2T0	XV2-2T1	XE3-4T
Wi-Fi	Wi-Fi 6, Omni antenna	Wi-Fi 6, Omni antenna	Wi-Fi 6, 120° sector antenna	Wi-Fi 6/6E
Streams [2.4/5/6GHz]	2+2	2+2	2+2	2+2+4 SDR
5GHz EIRP	36dBm	36dBm	36dBm	36dBm
Ethernet	GbE	2.5 GbE / 1 GbE	2.5 GbE / 1 GbE	2.5 GbE, 1 GbE
Other ports		PoE out	PoE out	GPS
Key Point	IP67, -40°C to 65°C Integ pole/wall mount ~11 watts required	Best-in-class rate up to 1km PoE out to connect broadband SM, IP camera, other IP67 rated, -40°C to 65°C operating temperature		IP67, -40°C to 65°C 0Connectorized antennas 5/6GHz split-band SDR

Indoor ONT

SGX00 Gigabit Indoor GPON

LAN	10/100/1000 GbE auto MDI-X
PON	GPON
Environmental	Indoor 32°F to 113°F (0°C to 45°C)
Power	12v power adapter

SXX00 Multi-gigabit Indoor XGS-PON

LAN	10/100/1000/2500 GbE auto MDI-X
PON	XGS-PON
Environmental	Indoor 32°F to 113°F (0°C to 45°C)
Power	12v power adapter



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