Cambium Networks™
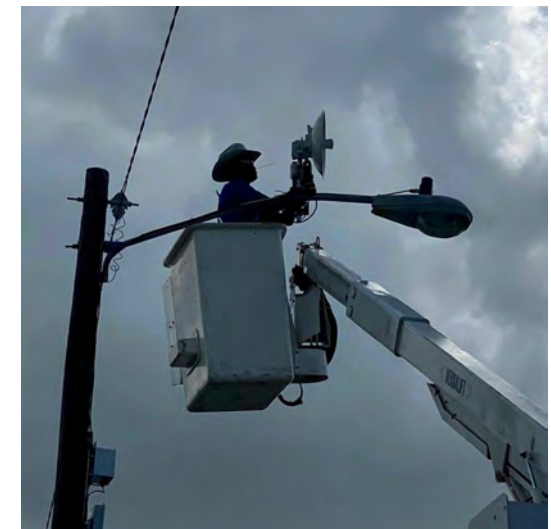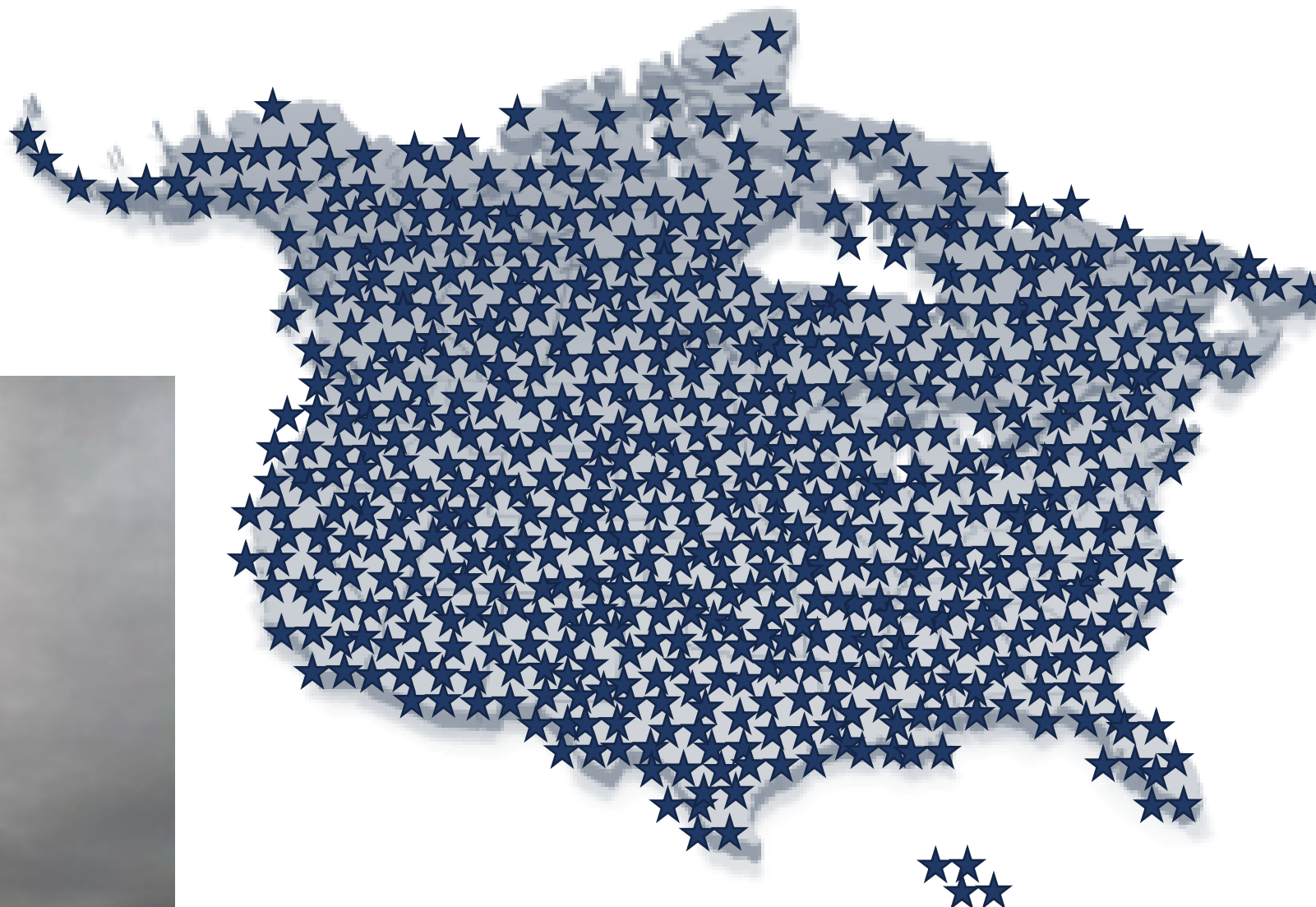
WISPs Connecting Communities
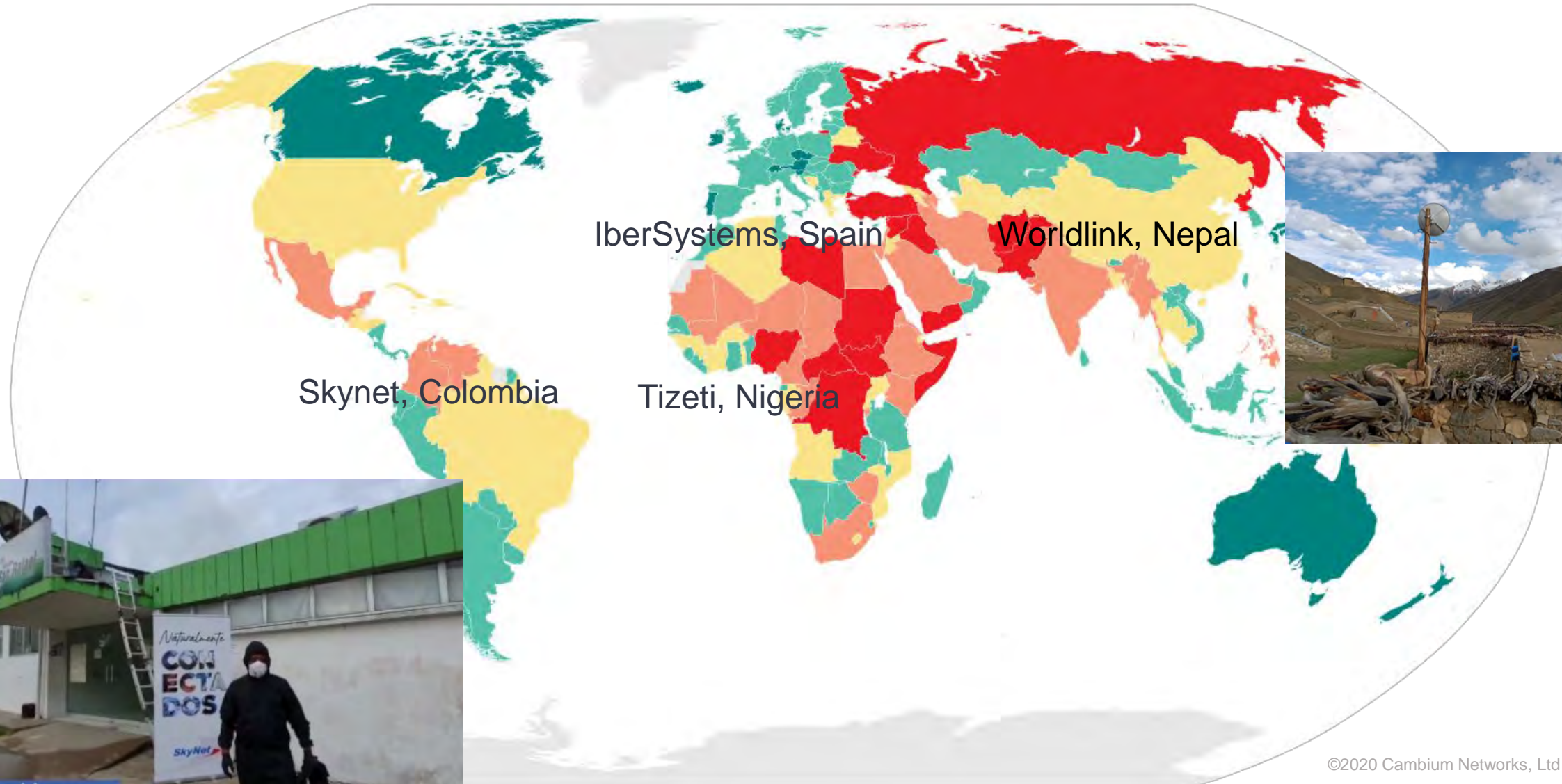
Atul Bhatnagar

President and CEO, Cambium Networks

WISPs Connecting Their Communities

IberSystems. Spain

Worldlink, Nepal

Skynet, Colombia

Tizeti, Nigeria

California Fires
Elevate Technologies created links
to connect Red Cross field stations

Hurricane Laura – Louisiana

ITDRC restored communications to local schools

©2020 Cambium Networks, Ltd

Connecting rural schools

- MVTV in Minnesota

Company-wide food drive

- Cambium employees around the world in one event coming in November

Bicycle donation

Cambium Networks™

- **60 GHz cnWave™**
- **Wi-Fi 6**
- **ePMP™**
- **PMP 450**
- **CBRS**
- **cnRanger™ LTE**
- **cnHeat**

Commitment to the WISP Industry

Support WISP initiatives

Investment protection

Regulatory advocacy

24/7 support

Technical field engineering resources

Advanced access to technology

End user demand is skyrocketing

mmWave onset

- Wireless is augmenting fiber
- Now wireless broadband can be Multi-Gigabit

WAN and LAN become multi-gigabit fabric

- Millimeter wave for broadband
- Single pane of glass
- Cloud-based management and frequency control

One Wireless Fabric: Rising to the Challenge

- **Coverage and capacity**

- **End-to-end multi-gigabit wireless**

- **Rapidly deployable**

- **Reliable, secure and scalable**

- **Gigabits delivered cost-effectively**

Multi-Gigabit Wireless Is Here

Cambium Networks™

Product Updates
Scott Imhoff
SVP Product Management
+1 847 476 7852
Scott.Imhoff@CambiumNetworks.com

Must be Present to Win!

Cambium Networks™

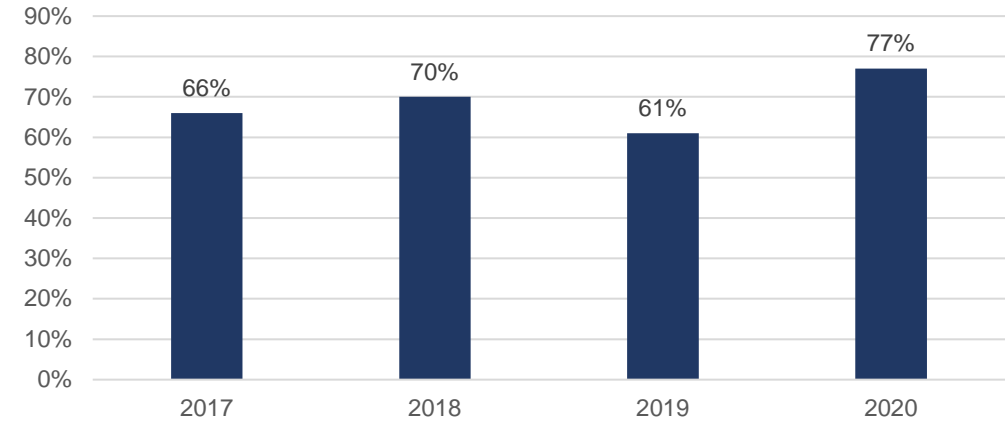PMP 450 MicroPoP Omni

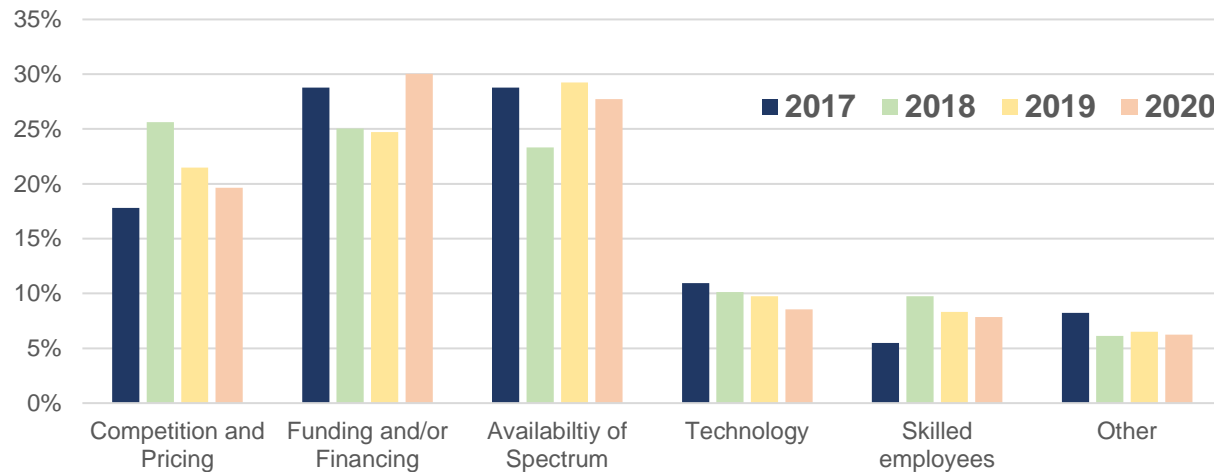PMP 450b Retro

2020 WISP Survey

Cambium Networks™

- Fourth Consecutive Year
- Participants: 433 WISPs in 58 countries
- Conducted July and August 2020
- Optimism at record high
- Financing and spectrum availability are key constraints
- 25% are offering Managed Wi-Fi services
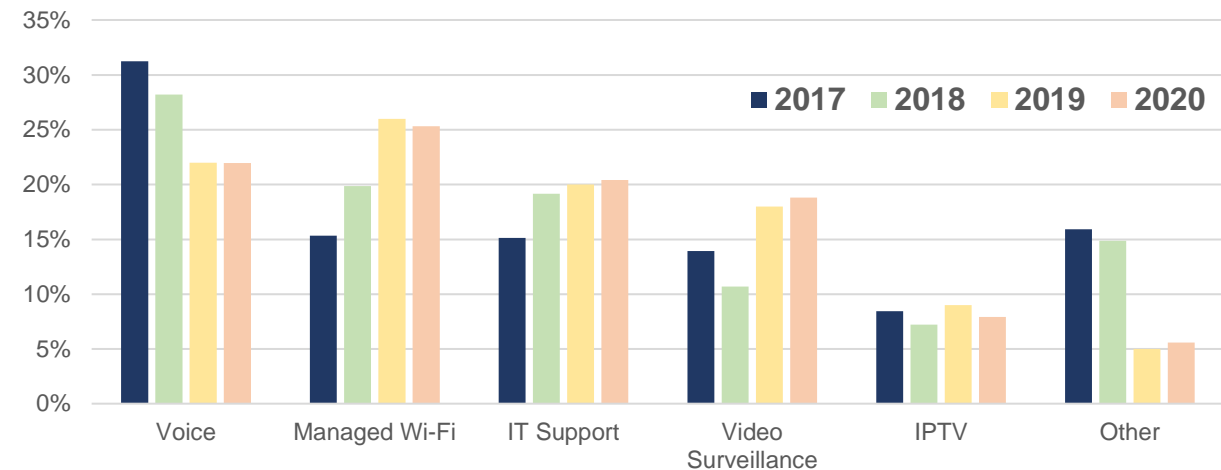- 56% of new customers are from references

WISP Overall Optimism

Constraints to Growth

Services Offered in Addition to Broadband

CBRS

The Time has Arrived

Cambium Networks™

A Proven Winner – Cambium's CBRS Solution

Cambium Networks™

- **October 17th – Critical Transition Date**
- PMP 450 platform is ready, is Software Upgradeable, and works with YOUR CHOICE of SAS Providers

federated wireless   Google   COMMSCOPE®

- Commercial operation since April
- **> 50,000** devices in operation now and rapidly expanding

All 3 GHz 450 platform equipment approved for Part 96! (as of July 10, 2019)

Cambium Networks™

- **One Simple Device to Install**

- **More than 3x Capacity vs. 450/450i**
  - cnMedusa™ 8x8 MU-MIMO technology allows simultaneous communication to four SMs

- **Supreme Spectral Efficiency**
  - DL and UL MU-MIMO supported
  - Achieve up to 750 Mbps in a 40 MHz channel

- **CBRS Users are reporting increased power levels resulting in:**
  - Enhanced coverage
  - Higher rate plans
  - Connecting additional subscribers

3 GHz 450b Subscriber
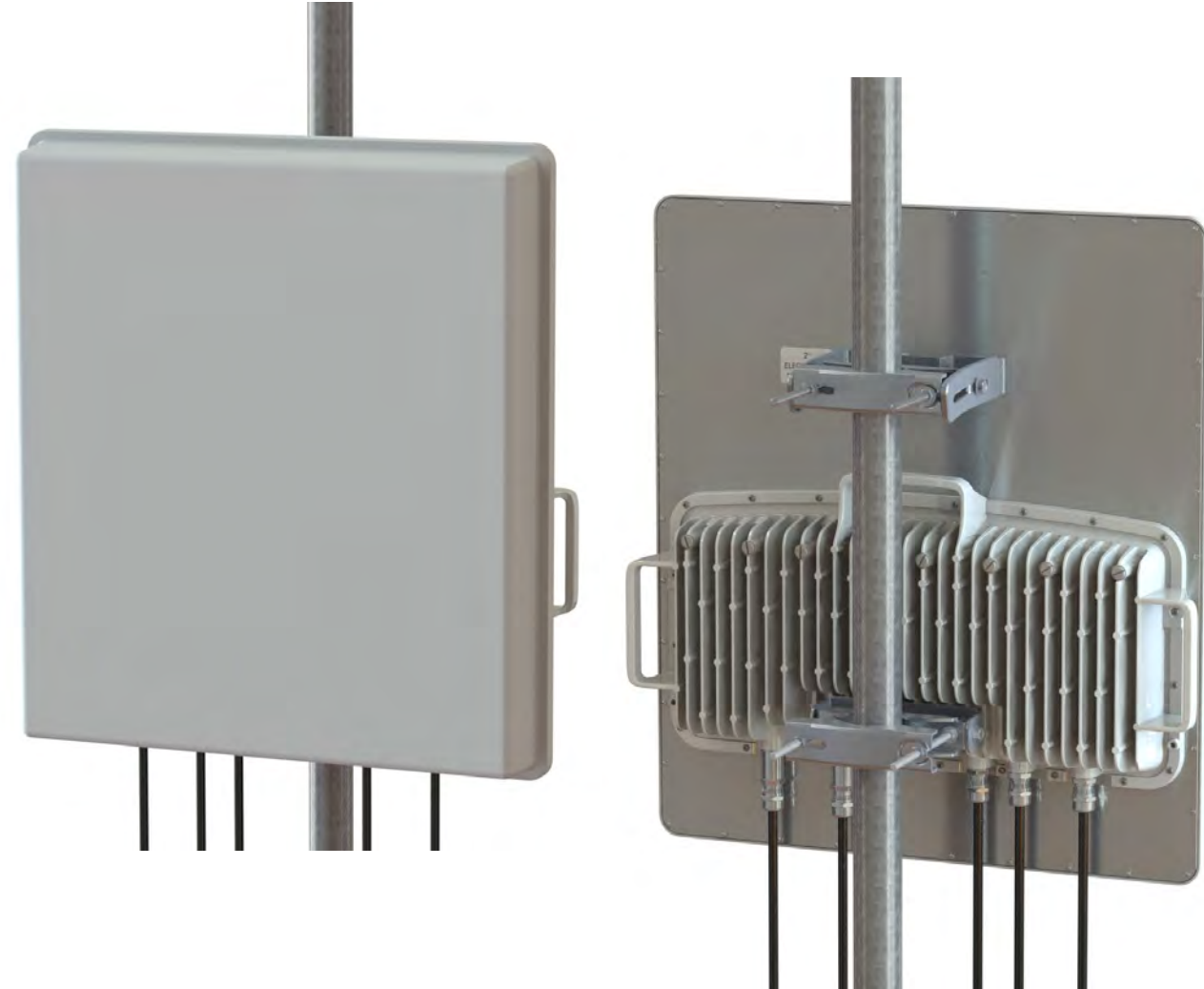
- **Form Factor**
  - High Gain integrated antenna (20 dBi), similar to 5 GHz 450b High gain
  - Up to 29 dBm Tx Power, or 49 dBm EIRP (HUGE Advantage vs. LTE equipment)
- **New FPGA / SoC architecture**
  - Next-gen processor, Enhanced Packet Processing
  - Better support for wider channels → more throughput
  - Wideband support (3.3 – 3.9 GHz) – CBRS Approved!!
- **I/O changes**
  - Single Gigabit Ethernet port
  - Audio jack for alignment tone
- **Re-use of 30 VDC Power scheme**
  - Same power supply as current 450 SM
  - Polarity Agnostic – Both "Canopy" or "UBNT" 30 VDC
- **Considerations**
  - Packaging of devices will follow the 5 GHz version
  - LEDs moved to make more visible and installation-friendly

Cambium Networks™

LOS Coverage at 13' is non-existent
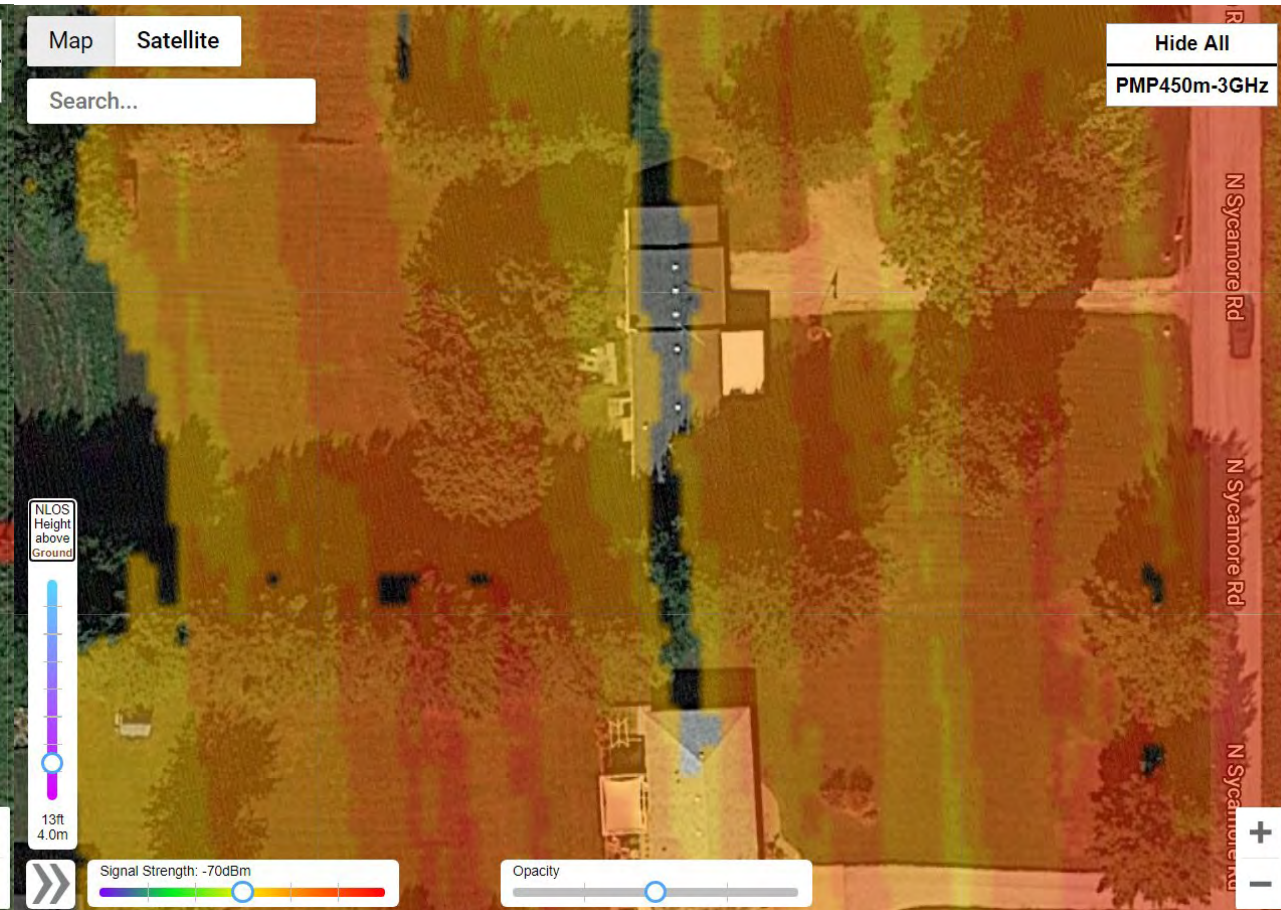
nLOS/NLOS Coverage at 13' is Plentiful

450 Platform

Enhancing and Expanding

Cambium Networks™

Cambium Networks™

- **Power / Network**
  - Gigabit Ethernet PoE
  - Standard 802.3af/at PoE IN (± 48 VDC)
- **RF Options**
  - Integrated: Omni & 90/120˚ Sector
    - Omni – 9 dBi Gain
    - 90/120˚ Sector –13 dBi Gain
- **Integrated GPS on all models**
  - External GPS antenna port
  - Supports sync over power method with cnPulse accessory

Omni

Sector

Now Shipping!

Cambium Networks™

"Like everything about the solution… Easy install, integrated GPS"

"Performance exceeds the price point, a Cambium AP under $1,000 that you can put on a pole and start receiving revenue. If you outgrow it, you can add or change to 450i/m without changing *anything* at the subscriber."

"Hope to use the lower cost point of these devices as hole fillers for gaps within our network."

Cambium Networks™

- **9 dBi Integrated**
  - 24 dBI with Reflector Dish
- **New FPGA / SoC architecture**
  - Next-gen processor, Enhanced Packet Processing
  - Wideband support (4.9 – 5.925 GHz)
- **I/O changes**
  - Single Gigabit Ethernet port
  - Audio jack for alignment tone
  - Same antenna focal point – can re-use Reflector Dish
- **Re-use of 30 VDC Power scheme**
  - Same power supply as current PMP 450 SM
  - Polarity Agnostic – both "Canopy" or "UBNT" 30 VDC

Now Shipping!

Flexibility with the PMP 450b Connectorized

- **New FPGA / SoC architecture**
  - Next-gen processor, **Enhanced Packet Processing**
  - Better support for wider channels → more throughput
  - **Wideband support (4.9 – 5.925 GHz)**
- **I/O changes**
  - Single **Gigabit** Ethernet port
  - Audio jack for alignment tone
  - IP 67 ruggedized protection
  - 2x RP-SMA connections for external antenna
  - Will fit ePMP1000 twistport adaptor from RF Elements
- **Re-use of 30 VDC Power scheme**
  - Same power supply as current 450 SM
  - Polarity Agnostic – both "Canopy" or "UBNT" 30 VDC
- **Connectorized MicroPoP has same form factor**
  - 48 VDC (PoE 802.3at) input vs. 30 VDC ("Canopy-style")
  - Onboard GPS
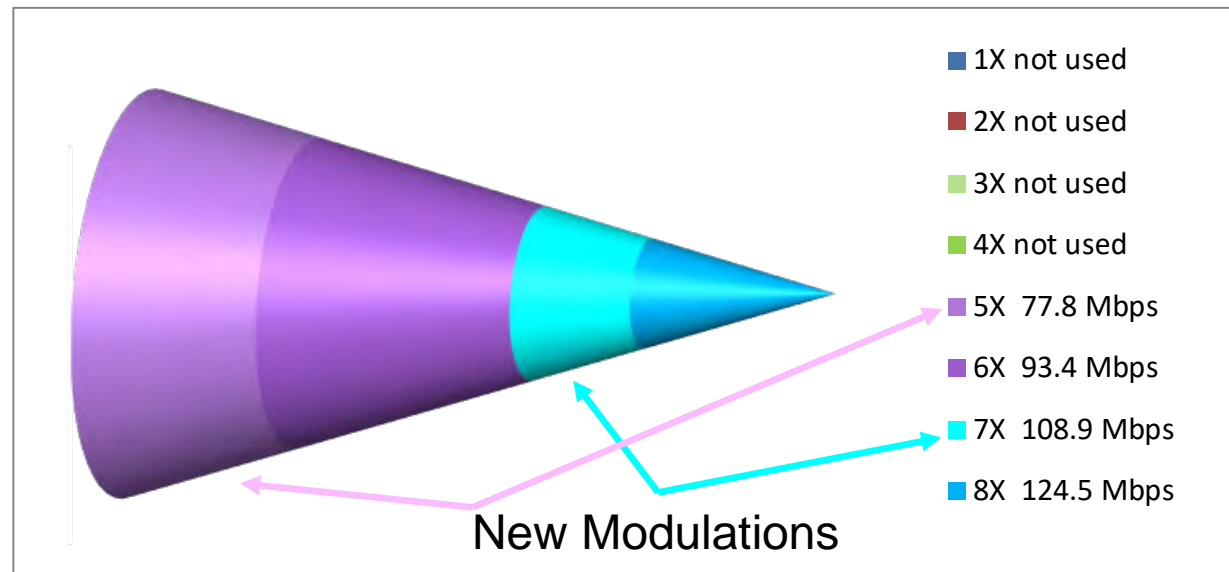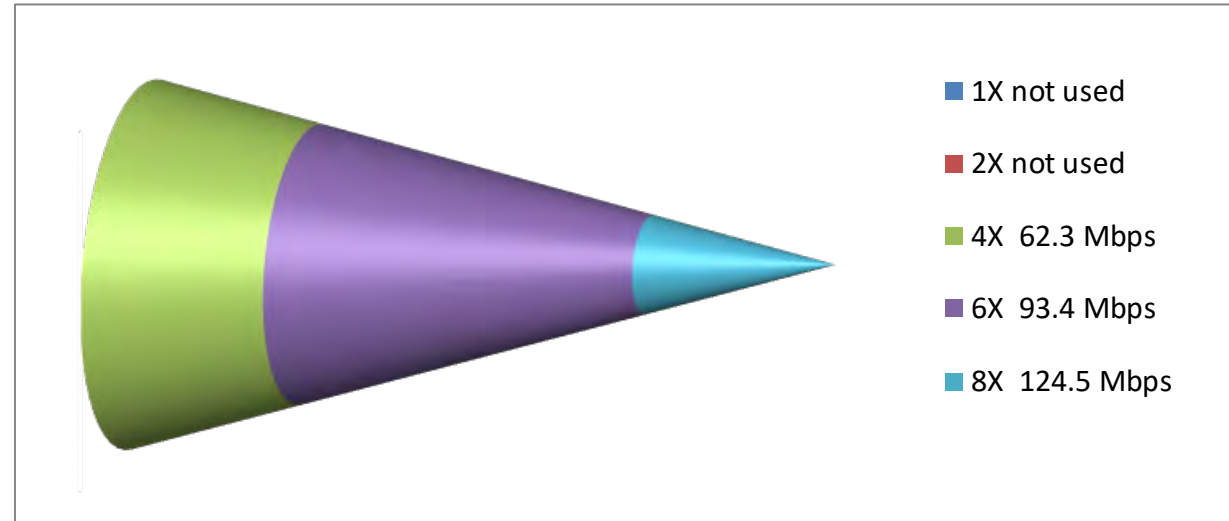
Q1 2021 Availability

Protecting and Enhancing Your Investment
It is Not All About the Hardware

- **R16.2.3 – Current Release**

- **R20 – Q4 2020**
  - Beta available now
  - Updated secure protocols, including SSH, SCP, TLS 1.3, AES w/SNMPv3
  - Full support of IPv6 (DHCP, DNS, Management)
  - Increased PPS for 450i and 450b beyond 100,000
  - Intermediate Modulation Modes

- **R20.x – Q2 2021**
  - Nomadic Mode / Rapid Re-ranging
  - 40 MHz 5ms frame support (PMP 450m)
  - Multiple Groupings per frame (PMP 450m)
  - CBRS – Coexistence Optimization
  - MAC Filtering
  - BPDUGuard/Filter

@ 6 mile range	Existing Aggregate	78.2
	With IMM	88.8
	Difference	10.6
	% Difference	13.50%

@ 8 mile range	Existing Aggregate	70.3
	With IMM	76.4
	Difference	6
	% Difference	8.60%

@ 10 mile range	Existing Aggregate	67.2
	With IMM	70.6
	Difference	3.4
	% Difference	5.10%

@ 12 mile range	Existing Aggregate	50.7
	With IMM	61.6
	Difference	10.9
	% Difference	21.50%

@ 14 mile range	Existing Aggregate	43.5
	With IMM	56.8
	Difference	13.3
	% Difference	30.70%

■ 1X not used

■ 2X not used

■ 4X 62.3 Mbps

■ 6X 93.4 Mbps

■ 8X 124.5 Mbps

■ 1X not used

■ 2X not used

■ 3X not used

■ 4X not used

■ 5X 77.8 Mbps

■ 6X 93.4 Mbps

■ 7X 108.9 Mbps

■ 8X 124.5 Mbps

New Modulations

Cambium Networks™

@ 6 mile range	Existing Aggregate	78.2
	With IMM	88.8
	Difference	10.6
	% Difference	13.50%

@ 8 mile range	Existing Aggregate	70.3
	With IMM	76.4
	Difference	6
	% Difference	8.60%

@ 10 mile range	Existing Aggregate	67.2
	With IMM	70.6
	Difference	3.4
	% Difference	5.10%

@ 12 mile range	Existing Aggregate	50.7
	With IMM	61.6
	Difference	10.9
	% Difference	21.50%

@ 14 mile range	Existing Aggregate	43.5
	With IMM	56.8
	Difference	13.3
	% Difference	30.70%

■ 1X not used
■ 2X 31.2 Mbps
■ 4X 62.3 Mbps
■ 6X 93.4 Mbps
■ 8X 124.5 Mbps

■ 1X not used
■ 2X not used
■ 3X 46.7 Mbps
■ 4X 62.3 Mbps
■ 5X 77.8 Mbps
■ 6X 93.4 Mbps
■ 7X 108.9 Mbps
■ 8X 124.5 Mbps

New Modulations

1. **MU-MIMO is a field proven technology and the industry standard in maximizing performance in a given channel**
   - ePMP 3000 supports 4x4 MU-MIMO
   - Wider Channels
   - Higher Modulation
   - Real AP providing **240Mbps** to **50SMs** in a 40MHz channel
   - Start with ePMP 3000L but grow with ePMP 3000
   - Support of STA frequencies

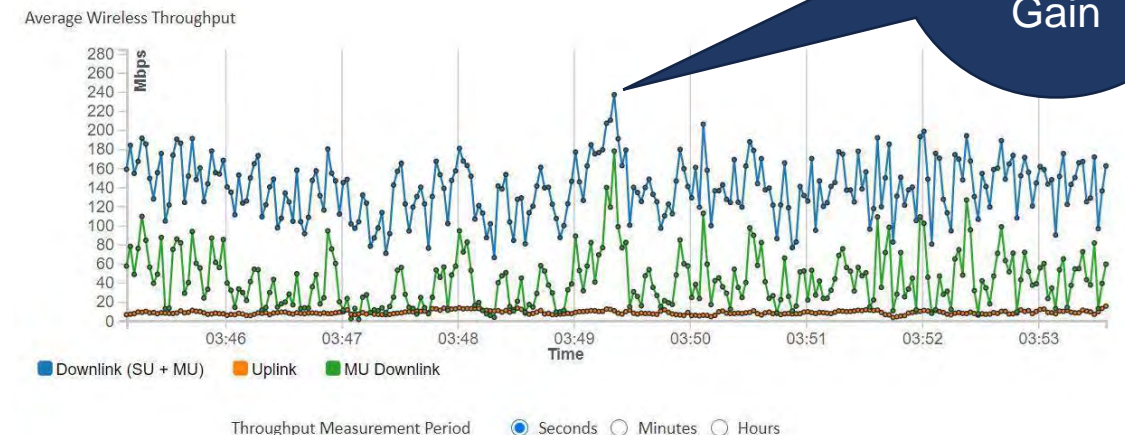2. **Leader in scalability and interference tolerance**
   - Uplink and Downlink beam-steering
   - Dynamic Filtering
   - Synchronization

3. **Protects your investment**
   - Compatibility with 11n devices and future 11ax AP

240 Mbps and MU-MIMO Gain

Average Wireless Throughput

Mbps
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0

03:46 03:47 03:48 03:49 03:50 03:51 03:52 03:53
Time

■ Downlink (SU + MU)   ■ Uplink   ■ MU Downlink

Throughput Measurement Period   ● Seconds ○ Minutes ○ Hours

Dual-Horn Case Study – Mountain West

Cambium Networks™

"The dual-horn antenna allows us to take advantage of a narrower beamwidth while leveraging the benefits of superior noise rejection of a horn. This helps us get a better signal to a tighter grouping of users in high-noise areas."

- TIM MEADS, NETWORK/INFRASTRUCTURE MANAGER, MOUNTAIN WEST TECHNOLOGIES

Fight interference with horn but get the benefits of MU-MIMO

ePMP MicroPoP

ePMP 3000L

ePMP 3000

Sector

Omni

Twist-Port Adaptor
RF Elements

MU-MIMO
Sector

MU-MIMO Omni
KP Performance

MU-MIMO
Omni
ITELite

MU-MIMO
Dual Horn

1 Gbps ePMP PTP on the Horizon!

- **Target Markets / Applications**
  - **Enterprise Access** – 500Mbps+ Service Packages
  - Low-cost **WISP Backhaul** – small cells / MicroPoP's
  - **Fiber Extension** – GPON last mile
  - **Wi-Fi/Video Surveillance Backhaul**

- **Key Specifications**
  - Gbps usable throughput
  - Sub 5 ms latency
  - 4.9 to 6.135 GHz
  - IP67 Ruggedization
  - 25 dBi integrated dish (optional 28 dBi range extender)
  - GigE and SFP port (optional GPON module)

Q1 2021
Availability

Learn more at #WirelessWednesday
Webinar on November 11th

cnPilot

At the Edge

Cambium Networks™

Meeting your Home Gateway Performance Needs

|	Model	Wi-Fi Technology	Ethernet	Voice Ports	30VDC Power Out	Key Value for Home Network
	r195W	11ac dual band (a.b.g.n.ac)	5 x GE			Best coverage and capacity 30% > than r201 >900Mbps throughput (GE←→GE)
	r195P	11ac dual band (a.b.g.n.ac)	5 x GE	✓	✓	Voice ports, power out Improved power surge protection >900Mbps throughput (GE←→GE)

30%
greater coverage than r201

>20%
faster than r201

r195P same price as r201P

r195W sweet spot for price/performance

WDS MESH for large homes

2021 Plan for Managed Residential Wi-Fi
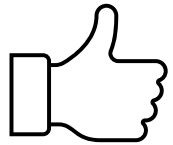
Cambium Networks™

Wi-Fi 6 Residential Routers
- Modern 'bookshelf' design plus hard mount attachment
- Future-proof and pandemic-proof Wi-Fi, backward compatible
- Low latency, high speed network optimal for AR/VR, streaming video, concurrent voice/video
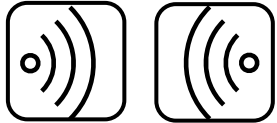
Whole House Wi-Fi
- Automatic MESH connectivity, purposely designed for Internet Service Providers

Quality of Experience
- Integrated network health monitoring, speed tests, whole house quality of experience

cnMaestro Cloud integrated
- Home user accounts managed on cnMaestro, designed for Internet Service Providers

Designed for service providers to deliver managed whole home Wi-Fi

App-based and cloud-enabled network health tools empower the consumer, and give the service provider more tools to reduce truck rolls and improve quality of experience

Learn more at #WirelessWednesday
Webinar on December 16th

Indoor Wi-Fi 6 Access Points

Cloud / On-Prem Management | Wi-Fi 6 | 802.3bz Multi-gig Uplink | Application Control

	XV3-8	XV2-2
Unique Value	Tri-Radio 11ax with Software Defined Radios and Dedicated Sensor	High performance 2x2, cost effective 11ax, standards-compliant
802.11 Radios	2 or 3 (Software Defined Radio)	2
Streams	4x4 in 2.4G; 8x8 in 5GHz; or dual 4x4 5GHz	2x2 in 2.4G; 2x2 in 5GHz
Antennas	Internal	Internal
Bluetooth	Yes, BLE 4.0	No
Sensor	Dedicated dual-band sensor radio. 2x2:2 for WIPs / Location services / RF scan / Network scan	Shared sensor with data radios. WIPs / Location services / RF scan / Network scan
Security	WPA3	WPA3
Wired	1 x GigE + 1 x 5GigE	1 x 2.5GigE
Power	802.3at (without USB, 35W with USB)	802.3at
Management	XMS-Cloud or cnMaestro	XMS-Cloud or cnMaestro
Use Cases	Education, Public Venues, Enterprise	SME, Education, Hospitality, Retail

Optimized for High Density

MSRP: $1095

Cost-effective performance for a broad set of use cases

MSRP: $395

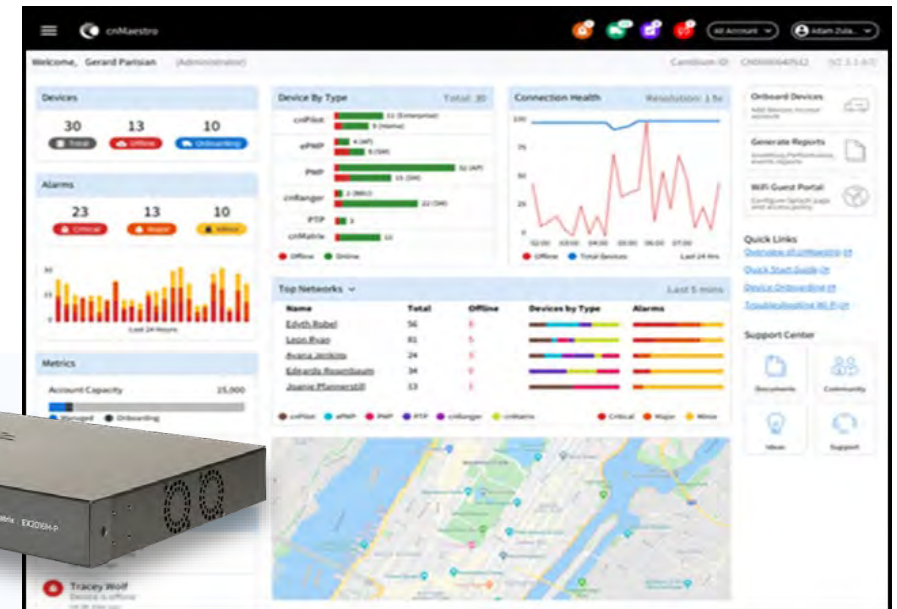# Enterprise Multi-gigabit Network – Unbeatable Combination

Cambium Networks™

Simplify operations *with Policy Based Automation & Zero Touch Provisioning*

Improve security *with Auto Segmentation, Device Profiling & Policy Enforcement*

Improve **network resiliency,** *reduce manual configuration errors*

cnMaestro Cloud Dashboard

Multi-gigabit Ethernet
EX-2016M – 2.5GbE, 60w per port

Wi-Fi 6 Edge Access Point
XV3-8 – Multi radio with SDR, dedicated sensor, 8x8
XV2-2 – Dual radio 2x2

Learn more at #WirelessWednesday
Webinar on November 18th

cnMatrix

Wireless Aware Switching for the WISP

Cambium Networks™

Wireless Aware Switching Purpose Build for the WISP Industry
Introducing the cnMatrix TX2020R-P Tower Switch

Cambium Networks™

cnMatrix TX switch, purpose built for WISP Tower deployments, is a fully integrated solution that includes intelligent PoE, Cambium Sync and a comprehensive set of Layer 2/3 switching functionality

- **Dual redundant AC/DC removable power supplies** that deliver intelligent, flexible PoE options: 802.3af/at/bt, low voltage Passive PoE, & High Power 4PPoE

- **Cambium Sync**: Dual redundant GPS synchronization sources

- **Fully Featured Switch**: Enterprise grade, non-blocking, Layer 2 & Layer 3 features with Cambium Policy Based Automation that improves security and simplifies operations

- Cloud/On-premises management with **cnMaestro** for the end-to-end Cambium **Wireless Fabric** experience

Available Q1 2021

Learn more at #WirelessWednesday
Webinar on December 9th

cnMatrix TX2020R-P

Removable Power Supplies

cnMaestro Dashboard

COVID Induced Service Plan Impact Poll

cnWave

Gb to the Edge

Cambium Networks™

Gigabit to the Edge – 60 GHz cnWave

- **Standards:** 802.11ay standard, Mesh support, Terragraph certified
- **Performance:** Up to 15.0 Gbps with channel bonding
- **Installation:** Bi-directional auto beam forming
- **Operation:** Auto expansion, auto healing with Mesh support
- **Configuration:** Point-to-Point, Point-to-MultiPoint, Mesh
- **Management:** cnMaestro™

Cost and Space Efficient Coverage
cnWave V5000 – 280º Coverage with a Single Node

Frequency: 57 to 66 GHz

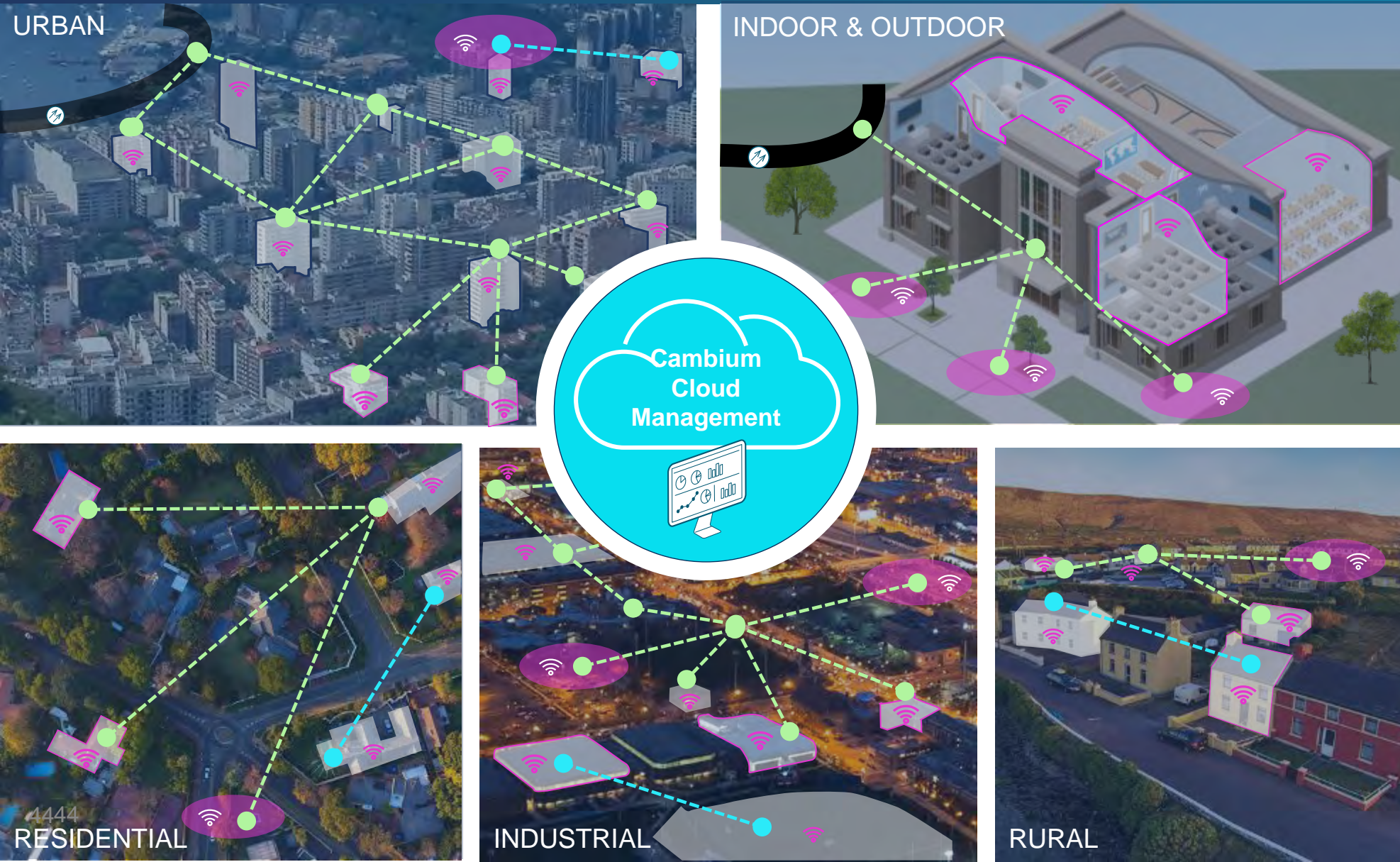**Modulation:** BPSK to 16 QAM (MCS 0 to MCS 12) with ACM

Throughput:

- 1.9 Gbps Uplink + 1.9 Gbps Downlink per sector

- 3.8 Gbps Uplink + 3.8 Gbps Downlink with channel bonding* per sector

Coverage: Dual Sector 280 Degree Coverage with Beam Forming

Configurations: Up to 30 CNs or 4 DNs + 26 CNs

Latency: < 1 ms

Sector 1   Sector 2

- **LINKPlanner**
  - Support PTP/PMP configuration with BOM creation
  - Engineering report for

- **Advanced Network Planer**
  - Mesh network designing
  - Site identification and preparation
  - LOS identification & optimization
  - Build-in TCO/CAPEX calculator

#Wireless Wednesday WISP Webinar Series

Cambium Networks™
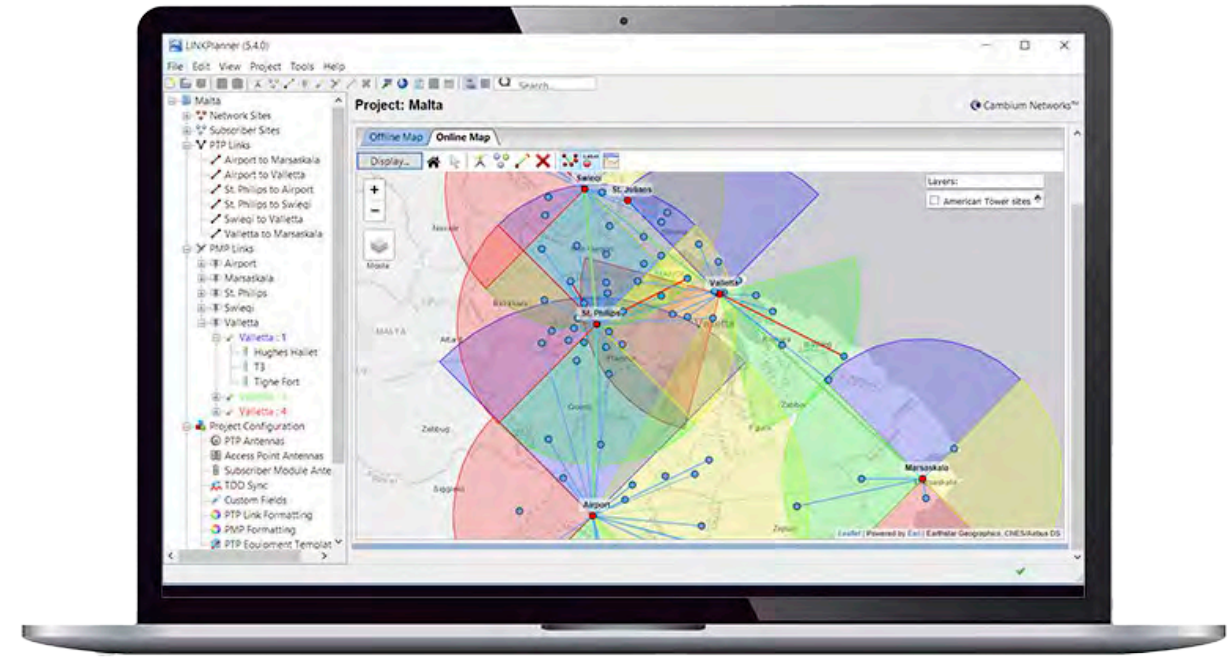
Topic: **60 GHz cnWave Field Results**

Date: Wed 28 Oct, 9:00 AM CT

Topic: **The Future of Shared Access Spectrum: Lessons from the FCC's CBRS Plan**

Date: Wed 4 Nov, 9:00 AM CT

Topic: **ePMP Updates & Product Sneak Preview**

Date: Wed 11 Nov, 9:00 AM CT

Topic: **Enterprise Wi-Fi 6 for WISPs**

Date: Wed 18 Nov, 9:00 AM CT

Topic: **Build New Revenue Streams with Express Wi-Fi**

Date: Wed 2 Dec, 9:00 AM CT

Topic: **Introducing the WISP Switch**

Date: Wed 9 Dec, 9:00 AM CT

Topic: **Managed Services for Residential Wi-Fi with Wi-Fi 6**

Date: Wed 16 Dec, 9:00 AM CT

For more detail and registration links, visit the WISP Solutions page on the Cambium Community:
https://community.cambiumnetworks.com/t/webinar-series-virtual-open-house-and-wirelesswednesday-webinars/73024

Raffle (for WISPs)

Must be Present to Win!

Cambium Networks™

PMP 450 MicroPoP Omni

cnMatrix TX2020R-P Tower Switch

PMP 450b Retro

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Questions?

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THANK YOU