Cambium Networks™

Animal Farm

WISPAmerica 2020

Animal Farm!?

Cambium Networks™

Agenda

8:00 – 9:30 am
March 18, 2020

Cambium Networks™

- Welcome and Introductions – Matt

- 60 GHz – Allen
- PMP 450 – CBRS - cnRanger – Matt
- ePMP – Bruce and Sakid
- cnHeat – Dan and Joseph
- cnPilot/Xirrus – Daran
- cnMatrix – John
- cnMaestro – Azif/Jagdish
- 5G – Matt

- Q&A

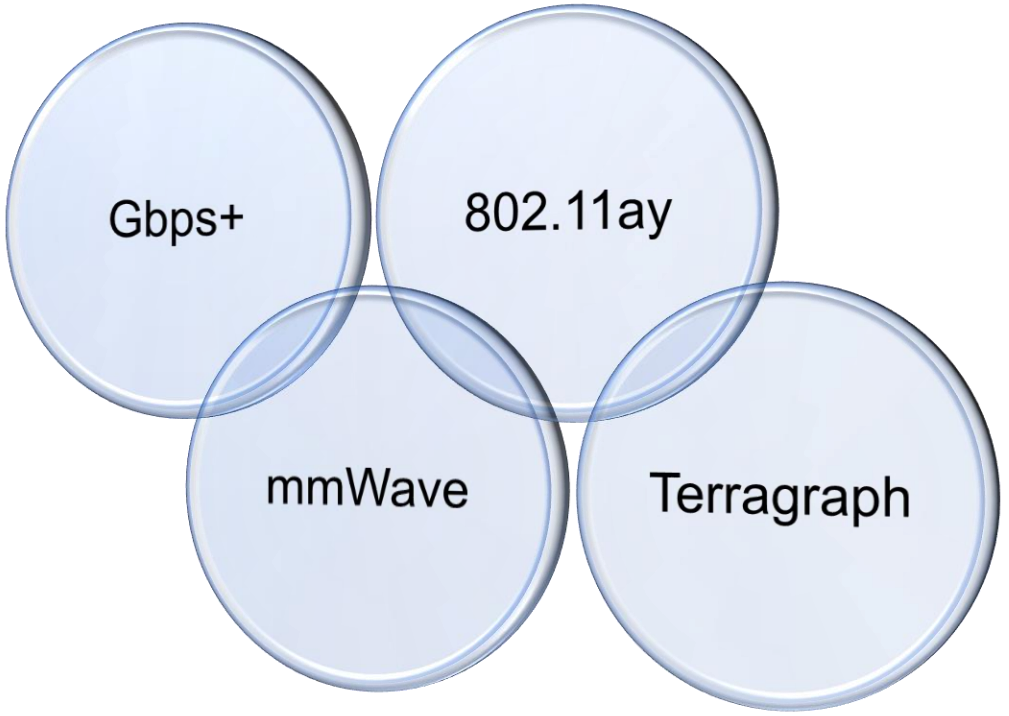
60 GHz Solution

Allen Yu

Cambium Networks™

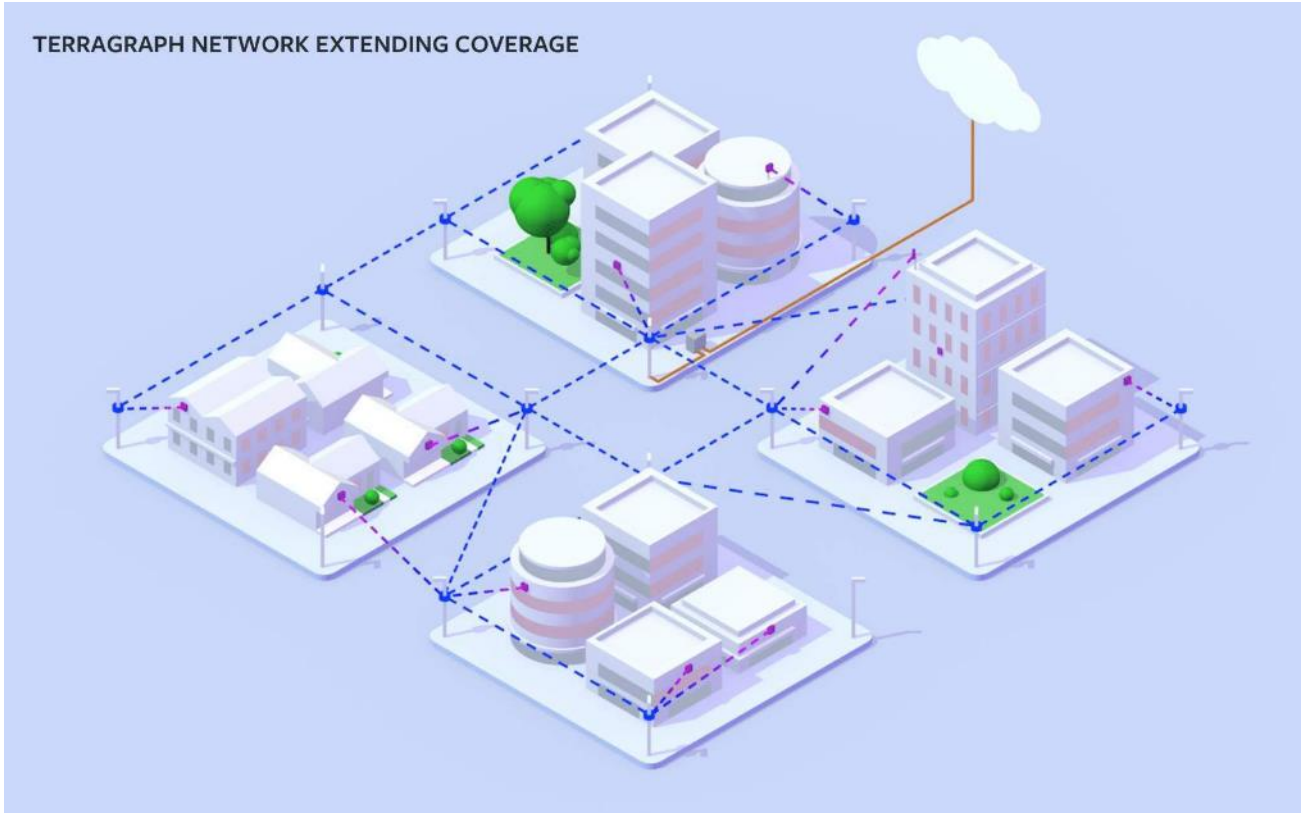
What is Cambium 60GHz Solution?

- **V-band 60 GHz, 57 – 66 GHz**
  - Unlicensed spectrum
- **PMP/PTP wireless solution with Mesh**
  - Self healing, scalable and redundant network
- **Provides Gbps+ connectivity for urban, high density suburban and rural areas**
- **802.11ay technology embedded with Terragraph technology**
- **Easier, faster and cost-effective solution**
  - Auto provisioning, beam forming, compact size



Applications

- Fixed Wireless Access
- Small Cell Backhaul
- Gbps+ Backhaul for Outdoor Wi-Fi
- Distributed Backhaul for Industrial IOT
- Backhaul for Smart City



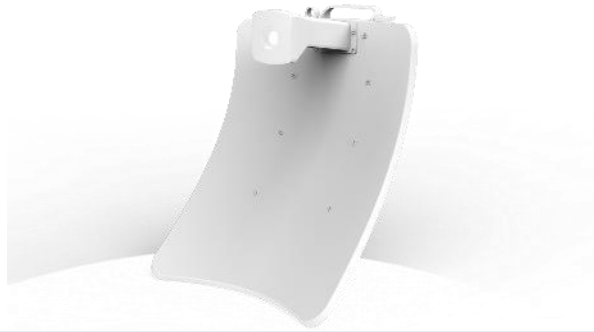
Source: Facebook

Products 802.11ad based vs. Pre 802.11ay based

	Product 802.11ad based	Product Pre-802.11ay based
Protocol	802.11ad (2016)	Pre-802.11ay
Channel support	2-3	1-4
Maximum Throughput	5 Gbps	10 Gbps
Maximum Channel Width	2160 MHz	4320 MHz (Channel bonding)
Channel Access	CSMA	TDMA
Network Synchronization	No	TDD
Mesh Support	No	Yes
CPE per Sector	8	15

Portfolio Overview

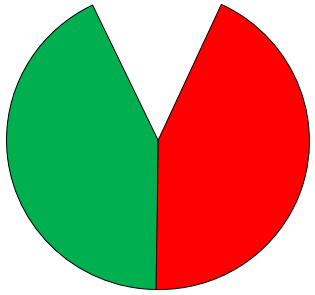
Cambium Networks™

	V5000	V1000	V3000
			
Supported Modes	PMP-DN	PMP-CN, PTP	PMP-CN, PTP
No. of Channels	1 to 4	1 to 4	1 to 4
Antenna Gain (dBi)	20	20	42
EIRP	Beamforming, 39 dBm	Beamforming, 39 dBm	Limited Beamforming, 61 dBm
IP Rating	IP 66/67	IP 66/67	IP 66/67
PHY Rate (Air interface)	20 Gbps	10 Gbps	10 Gbps
Client to AP ratio	Up to 30	n/a	n/a
Antenna Coverage (degree)	+/- 140.0 (azimuth) +/- 25.0 (elevation)	+/- 35.0 (azimuth) +/- 25.0 (elevation)	+/ 2.0 (azimuth) +/- 1.0 (elevation)
Ethernet Interfaces	1 x 10 GE + PoE in 1 x 1 GE + PoE out 1 x SFP+	1 x 1 GE + PoE in	1 x 10 GE + PoE in 1 x 1 GE + PoE out 1 x SFP+

60 GHz – PMP and Mesh Configuration

Up to 2 DNs per sector

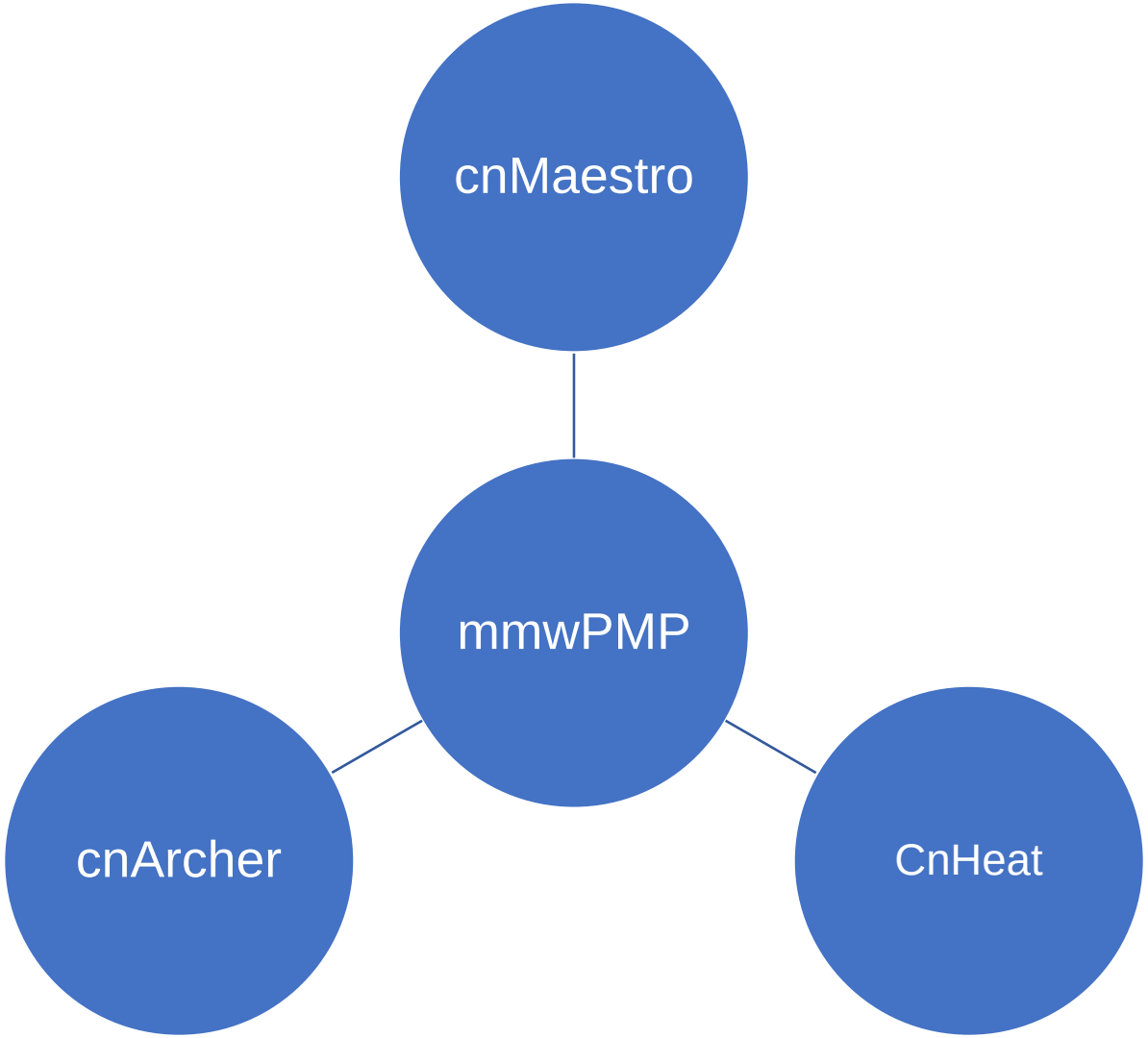
Up to 15 CNs per sector



Up to 15 CN+DN per sector (up to 2 DN per sector)


259
206
199
24
230
213
212
205
207
187
19
101
23
238
228
132
137
104
266
247
20
21
277
140
200
258
248
209
231
57
9
10
Image © 2020 Maxar Technologies
Google Earth

E2E Solution from Cambium



PMP / CBRS / cnRanger

Matt Mangriotis

Cambium Networks™

Key Example of World Class Operator

A regional operator using Fixed Wireless Solutions:

- **Netflix report (Italy 2017): ISP Speed Index** https://ispspeedindex.netflix.com/country/italy
  - Average speed of Netflix users based on Italian providers' connections in «prime time» evening.

ITALY

ISP LEADERBOARD - MAY 2017

RANK	ISP	SPEED Mbps	PREVIOUS Mbps	RANK CHANGE	TYPE
1	Vodafone Italy	3.53	3.47		
2	Fastweb	3.50	3.42		
3	Telecom Italia	3.39	3.32		
4	Wind	3.19	3.14		
5	Tiscali	3.17	3.08		
6	EOLO - NGI	2.98	2.95		
7	Vodafone TeleTu	2.86	2.67		
8	Linkem	2.61	2.50		

Today's Results

Cambium Networks™

Netflix report (January, 2020): ISP Speed Index, https://ispspeedindex.netflix.com/country/italy

#1

ITALY

ISP LEADERBOARD - JANUARY 2020

RANK	ISP	SPEED Mbps	PREVIOUS Mbps	RANK CHANGE	TYPE (Fiber / Cable / DSL / Satellite / Wireless)
1	EOLO	4.25	4.39		Wireless
2	Vodafone Italy	4.19	-		Fiber, Cable, DSL
3	Telecom Italia	4.14	4.30		Fiber, Cable, DSL, Satellite
4	Fastweb	4.09	4.24		Fiber, Cable, DSL
5	Wind	4.03	4.18		Fiber, Cable, DSL
6	Tiscali	3.80	3.98		Fiber, Cable, DSL
7	Linkem	3.25	3.41		Wireless

The only pure wireless company in top 7

- Eolo has led the chart for the past 7 months in a row.
- Most recently, they have seen spike in network traffic by 60%, and a much larger emphasis on the uplink (due to COVID-19).

Cambium 450 Platform

- Flagship PMP product family from Cambium Networks
  - *Over 1 Gbps per sector possible*
  - *Continuous platform evolution and advanced radio design*
  - *Extreme site capacity, and spectral efficiency*
- OFDM MIMO provides near Line-of-Sight (nLOS) and LOS
- *Software defined radio design* allows for rapid expansion of frequency bands, both licensed and unlicensed
- Utilizes *GPS synching capability* to maximize spectral efficiency and very low latency *supporting VoIP and video*

- Continual platform evolution and expansion: 450, 450i, 450m, 450b

cnMedusa Solution Paper

- **Solution Paper released**
  - Evolution of the technology
  - Steps toward achieving the benefits
  - Operating Modes
  - Benefits including
    - Capacity
    - Spectral Efficiency
    - Interference Reduction
    - PPS Improvements

- **Download here:** https://www.cambiumnetworks.com/resource/mu-mimo-solution-paper/

3 GHz 450b

Form Factor

- High Gain integrated antenna (20 dBi), similar to 5 GHz 450b High gain
- Up to 29 dBm Tx Pwr, or 49 dBm EIRP

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

High Gain Released March, 2020

450 MicroPoP

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, targeting 32 dB FB

Integrated GPS on all models

- External GPS antenna port
- Supports sync over power method with cnPulse accessory

Physical default method

- Push button on rear, long press variations to reboot / reset to defaults

MSRP $999

Limitations

- 2 Miles Range / Up to 20 SMs connected
- Limits can be removed with License Key (MSRP of key $1799)

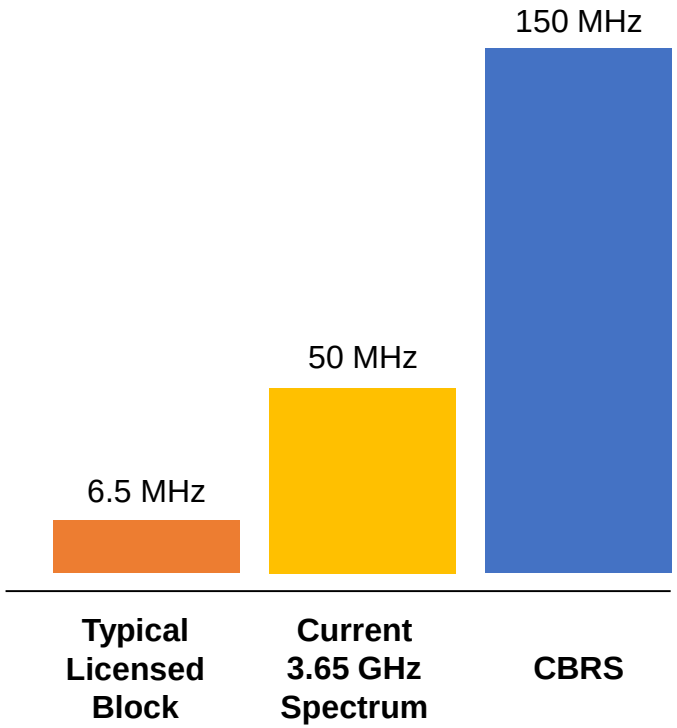
Release targeted for June, 2020

Omni

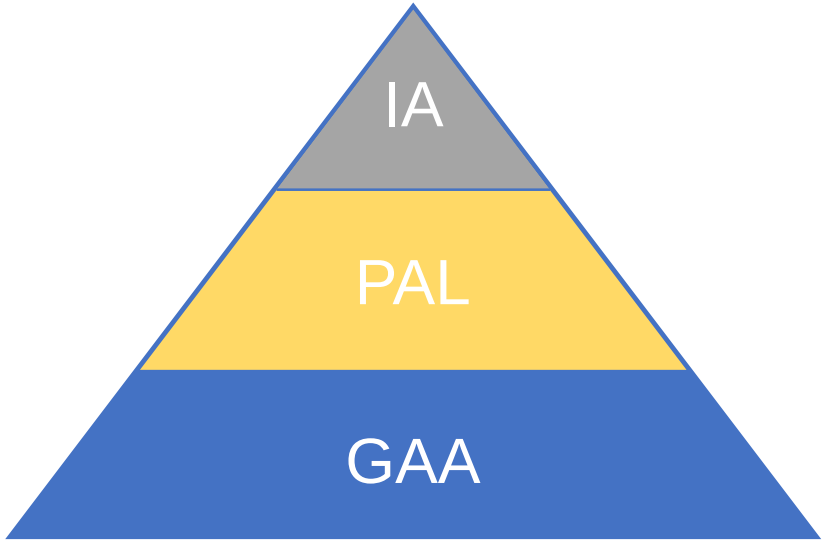
Sector

CBRS and New 3 GHz Spectrum

Opportunity



Tiered Flexible Use



Incumbents

- DoD Radars (coastal areas)
- Satellite Earth Stations

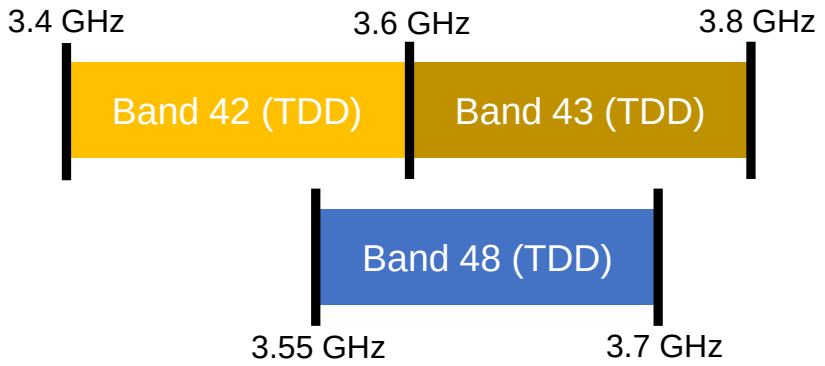
Priority Access Licenses (PAL)

- Up to 70 MHz of spectrum licensed by auction

General Authorized Access (GAA)

- At least 80 MHz nationwide

Establishing a New Common Band



Cambium Strategy for CBRS

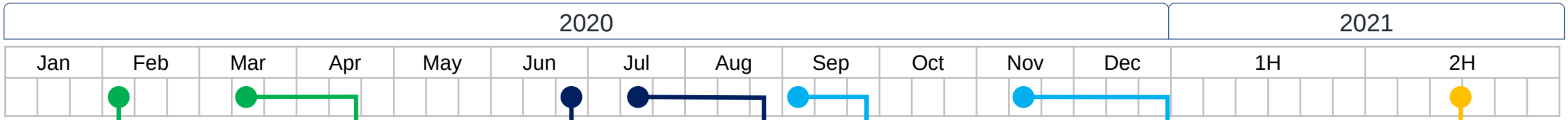
- Offering Operators their choice of SAS Admin:

federated wireless Google COMMSCOPE®

- cnMaestro required as the Domain Proxy to SAS
  - $3 per SM per month
  - Direct Billing to End Users for this service
  - Eliminates need for device digital certificates, provides tools to ease migration of existing equipment and deploying new gear
  - Metering begins April 1, first invoices in May

- Complete 3 GHz portfolio capable of graceful migration to CBRS
  - Continue to operate under Part 90 subpart Z until license expires
  - Louis Peraertz reported on Monday that WISPA is working on a 6-month waiver for transition due to COVID-19 concerns
  - **HOWEVER – Cambium is READY TODAY!**

Cambium 450 Plan of Intent 2020



R16.1.1 – Feb
- 3 GHz 450b High Gain

R16.2 – March 17, 2020
- CBRS Full Commercial Release*
- 4.9 GHz Support on 450m

R20 – Jun, 2020
- IPv6 (DNS/DHCP/Management)
- SSH / SCP / TLS 1.2
- AES w/SNMPv3
- Intermediate Modulation Modes
- BPDUGuard/Filter
- 450i/450b 100k PPS

20.1 – July, 2020
- 450 MicroPoP (Omni)
- 450 MicroPoP (Sector)

R20.2 – Sep, 2020
- 5 GHz 450b Retro SM
- 450 MicroPoP (Connectorized)
- 5 GHz 450b – Connectorized

R20.3 – Nov, 2020
- Nomadic Mode / Rapid Re-ranging
- 40 MHz 5ms frame support (450m)
- Multiple Groupings per frame (450m)
- CBRS – Coexistence Optimization
- MAC Filtering

R21 – 2H, 2021
- Split Sector Mode (450m)
- Out of band management (AUX)
- 3 GHz Carrier Aggregation
  - New CA capable SM
  - CA on 450m

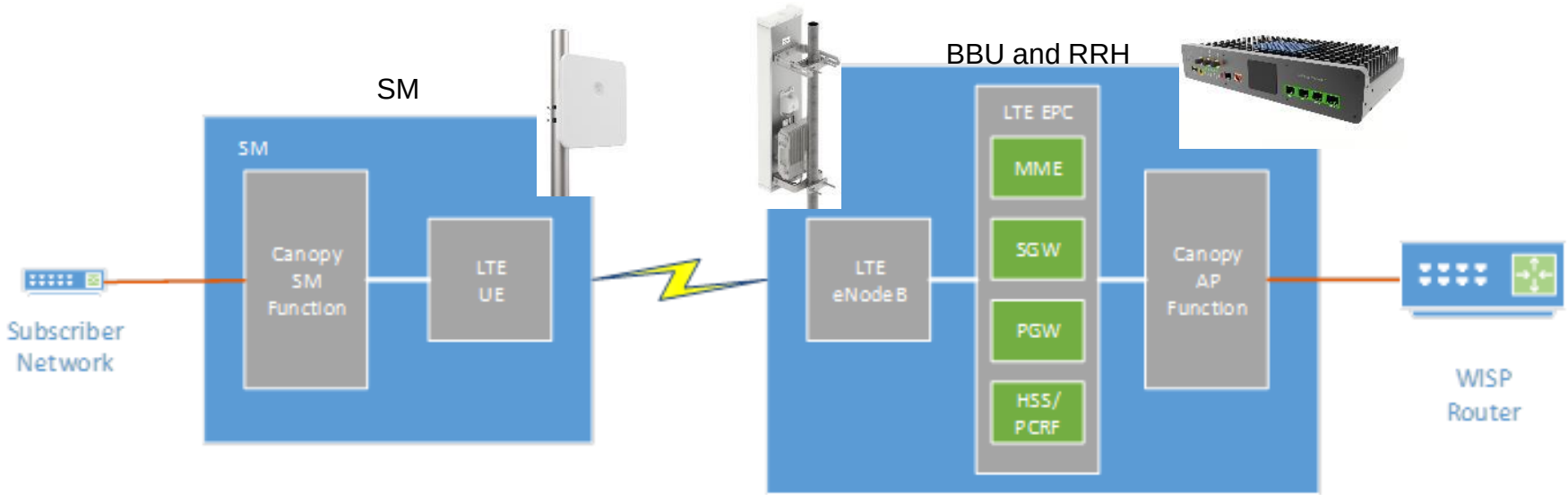
Completed	Gate 2
Committed	Gate 7
In Planning	Gate 10
Evaluating	Gate 13
Candidate	Gate 15

PLAN OF INTENT
SUBJECT TO CHANGE
March, 2020

*Pending Implementation of rules by FCC

What Is cnRanger?

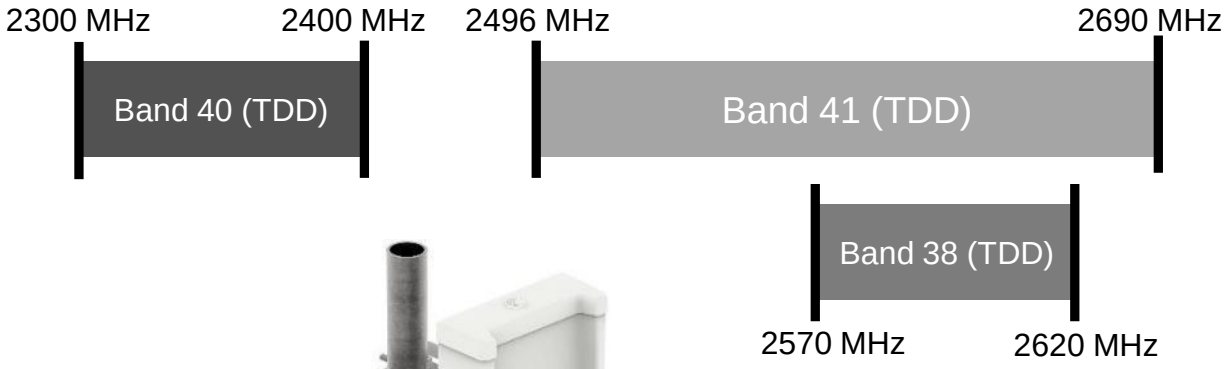
- cnRanger is a complete, simple, fixed LTE solution
- The BBU (Baseband Unit) and RRH (Remote Radio Head) handle *both* RAN (Radio Access Equipment) and EPC (Evolved Packet Core) functionality
  - Canopy networking (e.g. Layer 2) and management functionality are present, too
- cnRanger provides an SM with Canopy networking and management
  - Third party LTE UEs also function with the BBU and RRH



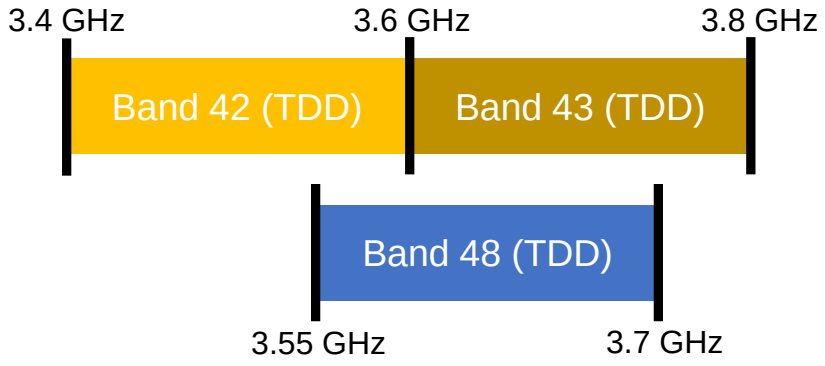
cnRanger Fixed LTE Solution

Planned Spectrum Coverage

First Release, Q4, 2019

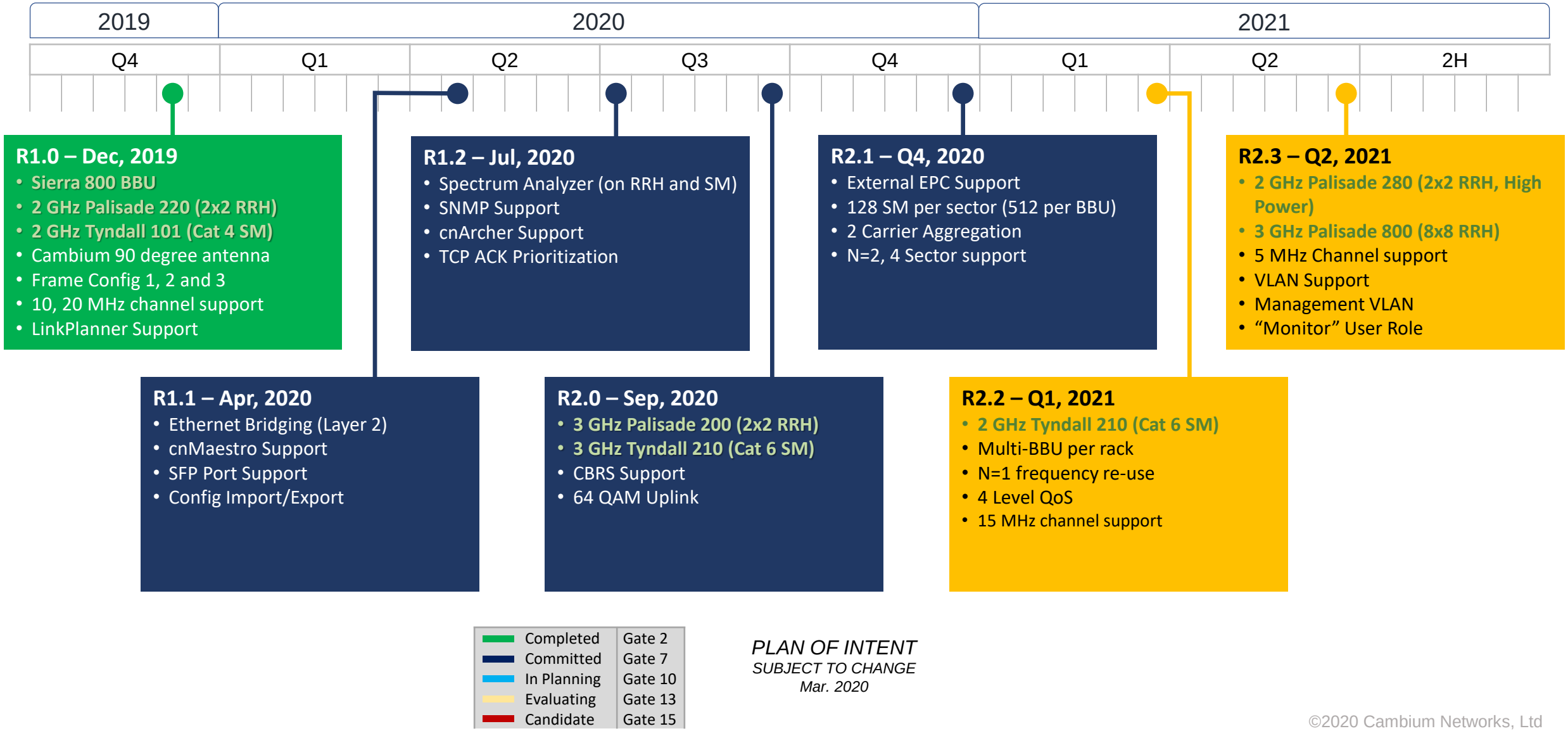


2nd Release, Q3, 2020



Insert 450b High Gain picture – describe RRH and CPE

Cambium cnRanger Plan of Intent



Completed	Gate 2
Committed	Gate 7
In Planning	Gate 10
Evaluating	Gate 13
Candidate	Gate 15

PLAN OF INTENT
SUBJECT TO CHANGE
Mar. 2020

ePMP

Bruce Collins

Cambium Networks™

Why ePMP?

1. **802.11ac Wave 2 for up to 5X performance**
   - 4x4 MU-MIMO
   - Wider Channels
   - Higher Modulation
2. **Leader in scalability and interference tolerance**
   - Uplink beam-steering and Dynamic Filtering
   - Synchronization
3. **Protects your investment**
   - Compatibility with 11n devices and Elevated devices
   - Improved performance (LDPC and MRC)
4. **Lowers TCO (Total Cost of Ownership)**
   - 3-year hardware warranty
   - Support direct from the channel and the supplier

Why MU-MIMO Delivers More in the Real World

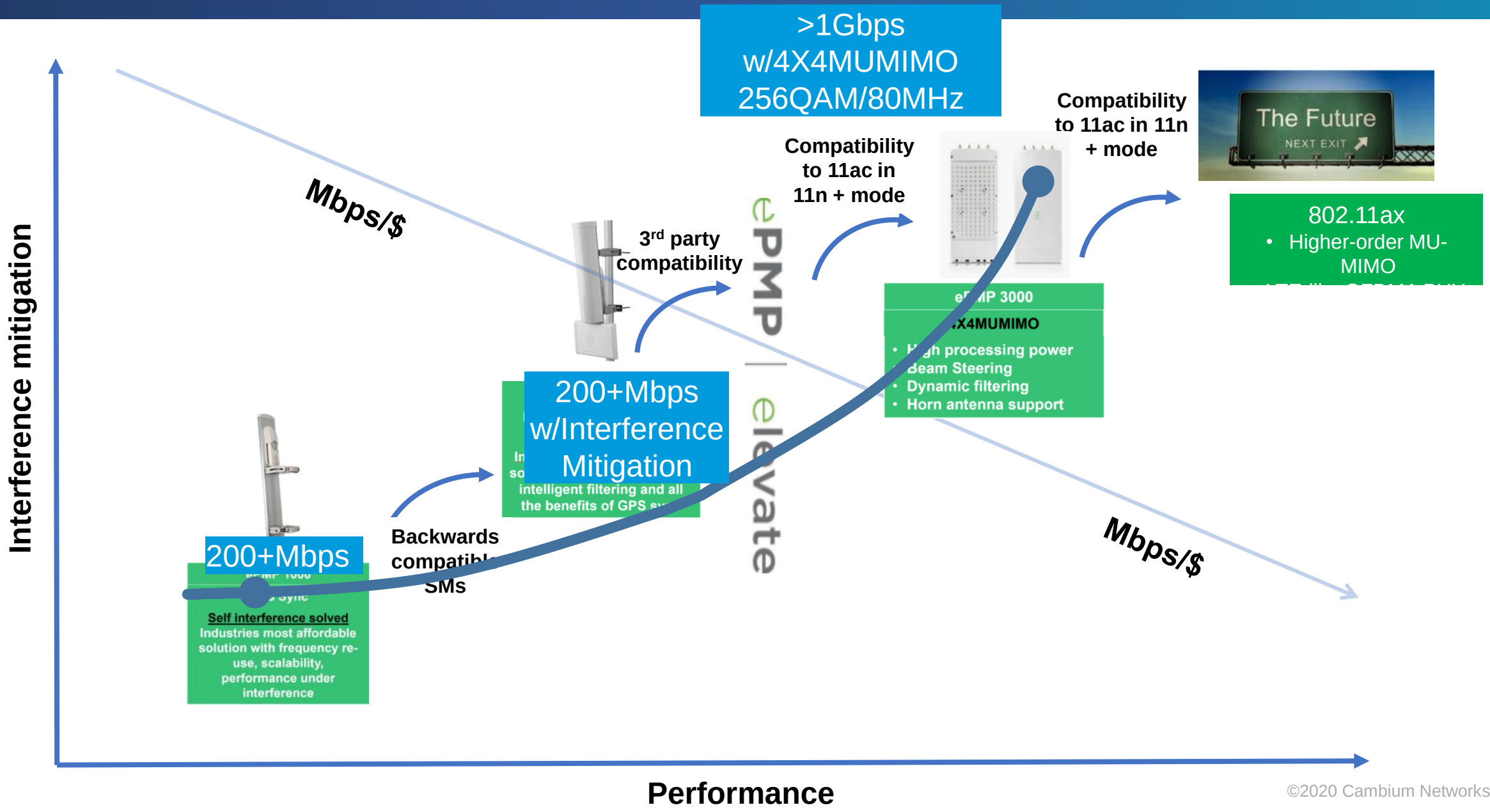
AP Capacity 80MHz	MIMO 802.11ac Wave1/Gen2	min SNR	High QAM Modulation	min SNR	4x4 muMIMO 802.11ac Wave2/Gen3	min SNR
500Mbps	64 QAM	**27dBi**	64 QAM	**27dBi**	16 QAM	**21dBi**

Cambium Networks is making considerable investment in MU-MIMO Technology for PMP

Here is why

ePMP Evolution

Cambium Networks™



ePMP Portfolio – Access Points

ePMP 3000

- 5 GHz
- 4x4 MU-MIMO
- 802.11ac Wave 2
- 120 SM’s
- Dynamic Filtering
- Opt. UL Beam-Steering

ePMP 3000L

- 5 GHz
- 2x2 MIMO
- 802.11ac Wave 2
- 64 SM’s

ePMP 2000

- 5 GHz
- 2x2 MIMO
- 802.11n
- Full (120 SM) or Lite (10 SM)
- Dynamic Filtering
- Opt. UL Beam-Steering

ePMP 1000

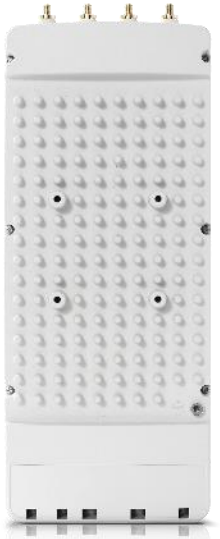
- 5.x, 2.4, 2.5, 6.4 GHz
- 2x2 MIMO
- 802.11n
- Full or Lite

Omni Micro-POP
5 GHz
2x2 MIMO
802.11ac Wave 2

Access Point topologies to fit the Application

ePMP 3000L

ePMP 3000



MU-MIMO Dual Horn Antenna

Features

- MU-MIMO
- Lower cost than 90 degree sector
- Small form factor / Easy to deploy

Applications

- Narrow-beam Sector
- Micro-POP
- Video Surveillance AP

Specifications

- 60 degree dual horn sector
- 12 dBi gain

Part Number	Description
C050900D025A	ePMP Dual Horn MU-MIMO Antenna, 5 GHz, 60 degree

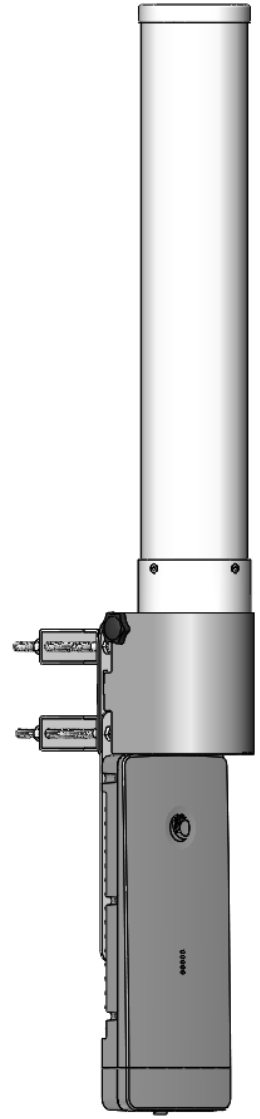
Available from Channel Partners in May

ePMP – Industry first MU-MIMO Omni Antenna

KP Performance + Cambium Networks collaboration

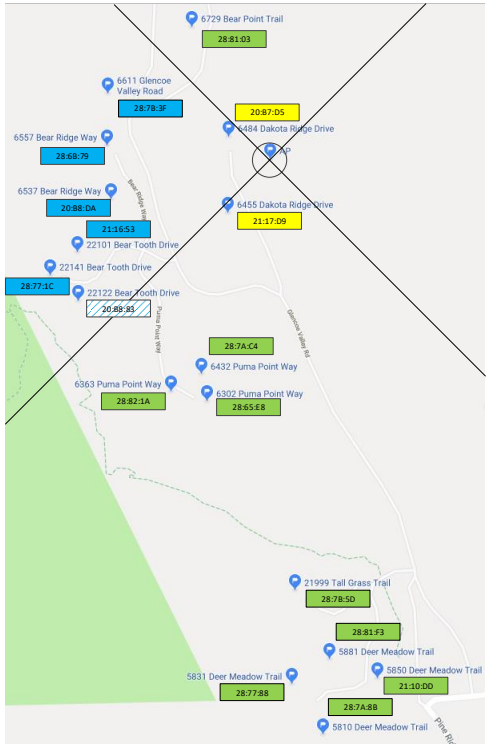
Available Now
from KP Performance

- Industry first true 4X4 MU-MIMO antenna
- Opposing sectors inter-connected to provide MU-MIMO grouping
- True MU-MIMO vs Mimosa offerings
- 13 dBi gain



First trial in Colorado

MU peak throughput:	**313 Mbps**
SU peak throughput:	**220 Mbps**
MU average throughput:	**275 Mbps**
SU average throughput:	**193 Mbps**
MU gain:	**143%**



Using Horns to Narrow the Sectors with ePMP 3000L

150Mbps x 20 Mbps service plan

40 MHz Channel

Combines 3 Horn Antennas

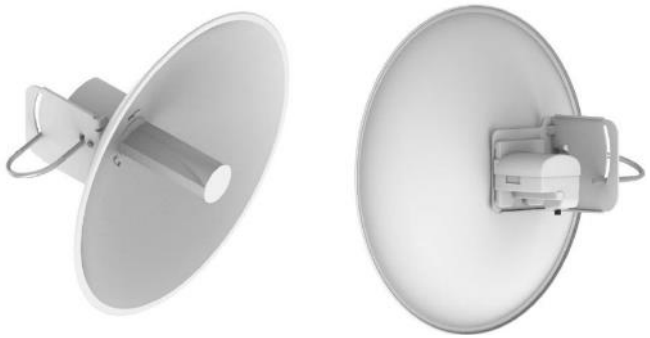
ePMP 3000L from Cambium

Ultra Horns from RF Elements

Consider MU-MIMO Horns in future

Courtesy of: E-Vergent – Illinois, USA

ePMP Force 300 (802.11ac Wave 2) Subscriber Module Portfolio



F300-25

- 25dBi gain
- Gigabit Ethernet
- Real time spectrum analyzer

F300-16

- 16dBi gain
- Gigabit Ethernet
- Real time spectrum analyzer
- Small form factor
- 15 degree Azimuth/Vertical orientation

F300 CSM (IP67)

- 2X2 Wave 2 Connectorized SM
- Support for external horns and dishes

F300-19 (IP55)

- 2X2 Wave 2 SM
- 19 dBi gain flat pane antenna

F300-19R (IP67)

- 2X2 Wave 2 SM
- 19 dBi gain flat panel antenna
- Adds 5/10 MHz channels
- Enterprise SW Plan of Intent

F300-13 (IP55)

- 2X2 Wave 2 SM
- 13dBi gain

7 Ways to Expand Your Network with ePMP

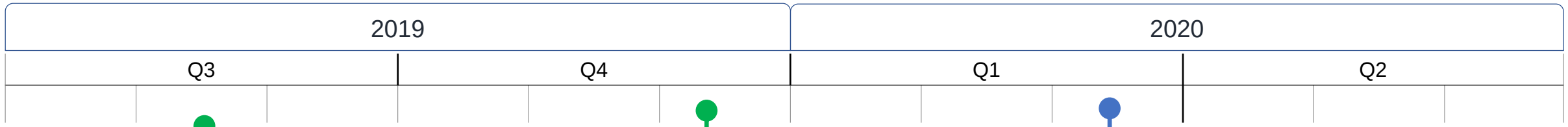
Cambium Networks™

	Antenna Gain	Range	Coverage	Max # of Subs	Headline Capacity	Relative Price
4 Sectors of ePMP 3000 with MU-MIMO Sectors	17 dBi	6-8 km	360 degrees	480	4.8 Gbps	100%
4 Sectors of ePMP 3000L with 90 Degree	17 dBi	6-8 km	360 degrees	256	2.4 Gbps	52%
1 Sector of ePMP 3000 with MU-MIMO Omni	13 dBi	3-5 km	360 degrees	120	1.2 Gbps	25%
1 Sector of ePMP 3000 with MU-MIMO Sector	17 dBi	6-8 km	90 degrees	120	1.2 Gbps	25%
1 Sector of ePMP 3000 with MU-MIMO Dual-Horn	12 dBi	3-5 km	60 degrees	120	1.2 Gbps	23%
1 Sector of ePMP 3000L with 60 degree Horn	13 dBi	3-5 km	60 degrees	64	600 Mbps	12%
1 Sector of ePMP MicroPOP	9 dBi	1-2 km	360 degrees	64	600 Mbps	7%

1. What is the subscriber density? (consider MU-MIMO)
2. What are my service plans? (consider MU-MIMO)
3. What are my expansion plans? (deploy a full tower now and be done)
4. What is the noise floor? (consider directional antennas)
5. Do I need synchronization? (consider sectors)
6. How much of the horizon do I need to cover (Azimuth)? (consider horns)

ePMP 3000 / Force 300 / PTP 550 Software Plan of Intent

Cambium Networks™



Release – 4.4 (August)
- QoS
- MIR (ePMP 3000)
- Try Config
- cnMaestro Zero-Touch (DHCP Options)
- Force 300-13/-19/-19R support
- Force 130 -2.4 GHz
- Force 130 - DFS
- Integrated Release Line for 11n and 11ac
- Additional bug fixes, performance improvements

Release – 4.4.3 (December)
- Stability Improvements

Release – 4.5 (March)
- ePTP low latency mode support (Force 300, E550/Single channel)
- Beam-steer antenna
- 10 MHz support on 300-19R, ePMP 3000 and PTP 550
- 2.5 ms frame size on e3K
- Reliable Multicast (e3K)
- Omni Support in GUI (e3K) – KP Performance
- DCS (Dynamic Channel Selection) - (PTP)
- Spanish/Turkish Language Support in GUI

Release – 4.6
- Flexible Frame (PTP/PMP)
- SNMPv3 (Force 300-19R)
- Remote Spectrum Analyzer
- ACS (Automatic Channel Selection) - (PMP)

Release Feature Funnel
- e3K tiered subscriber count
- Traffic shaping
- Additional DL/UL ratio support
- Air Fairness
- Fast DFS

PLAN OF INTENT

SUBJECT TO CHANGE

March 2020

New to ePMP? Let's Get Started!

Limited Time Promotion for WISP's new to ePMP and Cambium Networks

- $1,995 – ePMP 3000 Starter Bundle
- $1,595 – ePMP 3000L Starter Bundle

Includes:

- ePMP 3000 with 4x4 MU-MIMO Sector OR ePMP 3000L
- Twelve ePMP Force 300-25 Subscriber Modules
- Force 300 Connectorized Subscriber Module
- cnHeat Trial
- One RF Elements Twist-Port Adaptor and Horn Antenna
- Six months of VISP.net billing and automation services
- Two hours of one-on-one consulting with an ePMP Network Engineer

- **North America ONLY**
- **All requests must be registered by the end user WISP at: www.cambiumnetworks.com/na-epmp-newcustomer-promo**

WISP Referral Program – Earn Free Equipment

https://www.cambiumnetworks.com/wisp-bring-a-friend-registration/

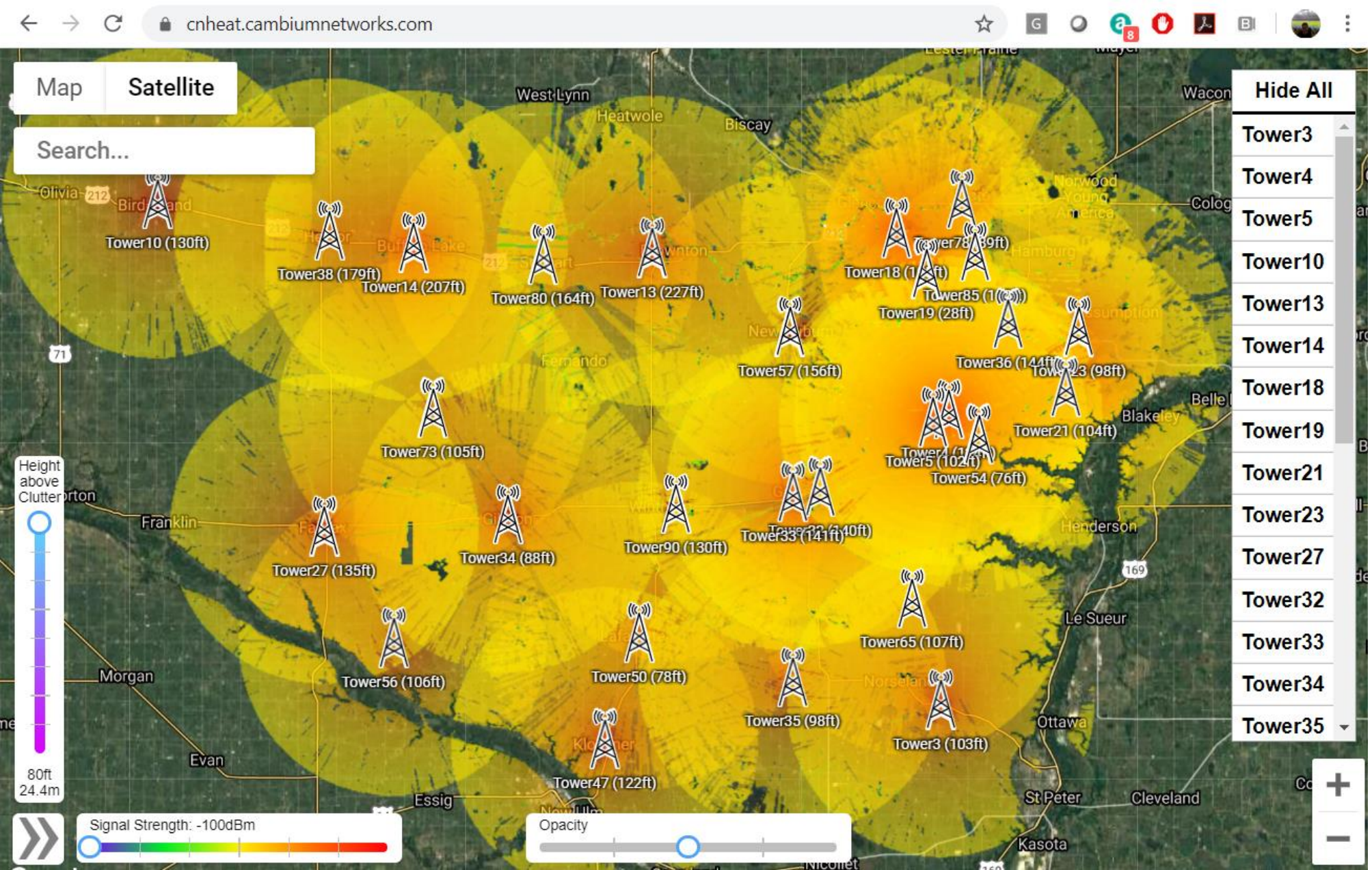
cnHeat with Hiawatha Broadband

Joseph Glende
And Dan Sullivan

Cambium Networks™

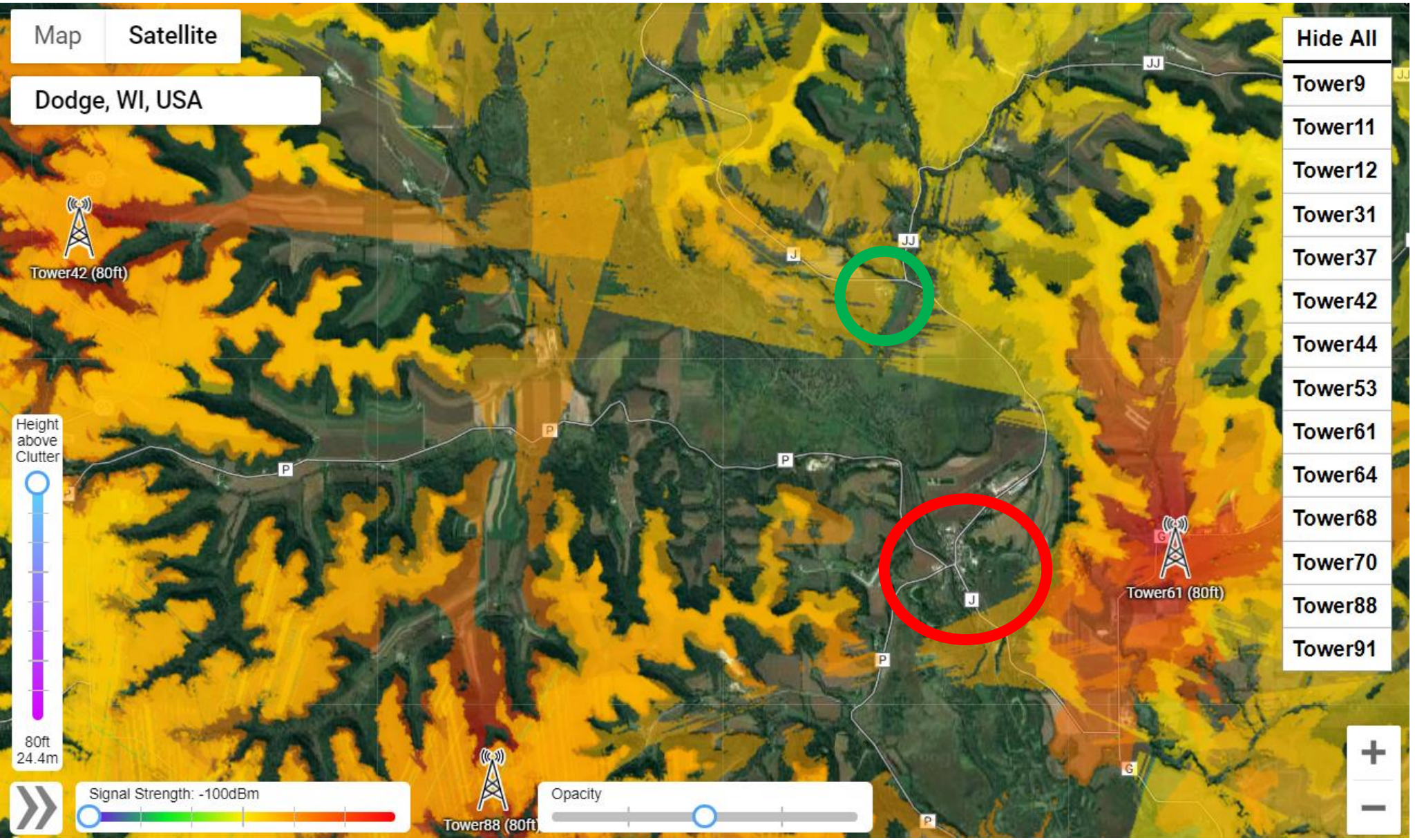
Hiawatha Broadband 98 Site Solution

Cambium Networks™



- **Western 28 sites shown**
- **Control Height above Clutter (0’ to 80’)**
- **Control RSSI (-100 to -40 dBm)**
- **Choose view in either Height above Clutter or RSSI**

Find the Town in the Valley

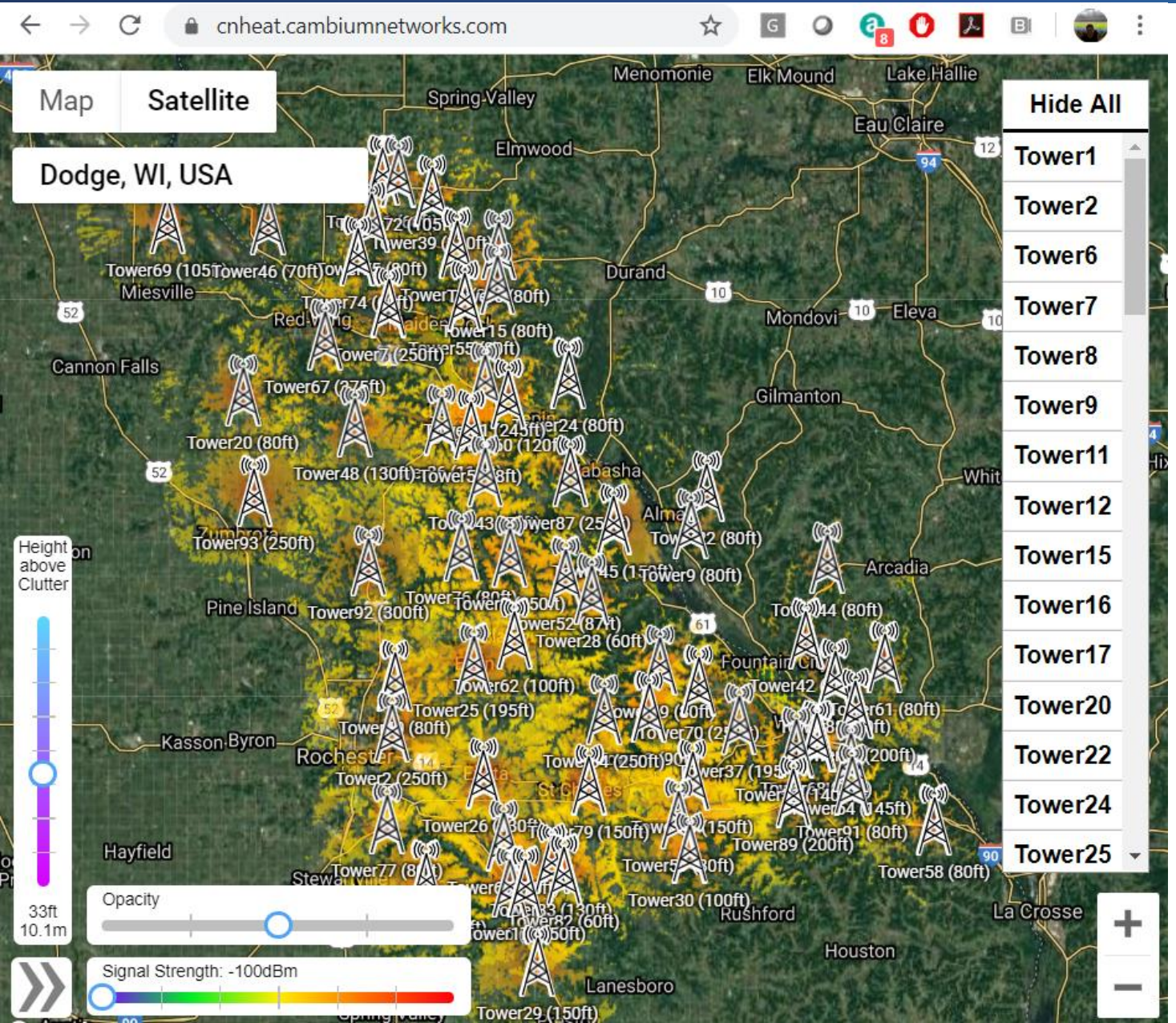


- **Dodge, WI has no coverage**
- **But, the farm to the north in the sightline of Dodge does!!**

Find the Town in the Valley

- **Heat map shows coverage at farm at 33’**
- **Selecting possible install spot shows a tower at 30’ realizes coverage**
- **Relay over to Dodge**
- **40 new customers**
- **Now let’s take a quick live tour with Joseph**

Hiawatha Broadband 98 Site Solution



Experience cnHeat at:

- **cnheat.cambiumnetworks.com**

- **Account Name: “smheight”**
- **Password: demo**

Unified Wired/Wireless Wi-Fi Solutions

Daran Hermans

Cambium Networks™

Service Provider Home Router Portfolio - 2020

Cambium Networks™

		MSRP (USD)	Radio 2.4GHz	Radio, dual band 11ac	Voice	PoE Out	FE ports	GE ports	USB
	R190	$40	✓				✓		
	R190V	$60	✓		✓		✓		
	R200P	$90	✓		✓	✓	✓		✓
	R195	$55	✓	✓				✓	
	R201	$100	✓	✓	✓			✓	✓
	R201P	$120	✓	✓	✓	✓		✓	✓
 *Under development*	R195P	$120	✓	✓	✓	✓		✓	

New Service Provider Home Routers

cnPilot R195W Residential & Small Business Router

- 802.11AC, 2x2, External high gain antennas
- Hardware accelerated NAT Firewall
- Managed by cnMaestro; Cloud, MSP, On-Premises
- 1 x GE WAN, 4 x GE LAN, USB2.0
- MSRP: $55 USD

Released October 2019…

30%+ greater range than r201

Extend Cambium Broadband indoor; managed by cnMaestro

Upgrade Small Medium Business, Apartments, Dormitory, MDU

Add Telephony Service to existing Broadband small business and consumer subscriber

cnPilot R195P Premium Small Business & Residential Router

- 802.11AC, 2x2, Internal high gain antennas
- Hardware accelerated NAT Firewall
- Managed by cnMaestro; Cloud, MSP, On-Premises
- 1 x GE WAN, 4 x GE LAN, 2 x RJ11 ATA ports, USB2.0
- MSRP: $120 USD

Release target summer 2020…

Enterprise Wi-Fi for SMB to large Venues

Cambium Networks™

cnPilot & cnMaestro

Cloud Managed Access
Target < 500 employee enterprise
Broadband → Ethernet → Enterprise Wi-Fi

Dual Radio, 2x2 and 4x4, 802.11AC wave 2
Enterprise RF, Single Cloud Dashboard
Small form factor Indoor / Outdoor

Xirrus & XMS-Cloud

Scalable Capacity & Advanced Services
Target > 500 employee enterprise
App Policy control, multi-tenant Command Ctr, EasyPass BYOD

Software Defined DUAL / QUAD Radio, 802.11AC wave 2
High to Ultra High Density, 2x2, 3x3, 4x4
Segmented IOT, BYOD, WIFI, App Ctrl, Security

Intelligent PoE Switches

SCALABLE SOLUTIONS AS USER AND DEVICE DENSITY INCREASES

Hospitality / Hotspot

SME / Enterprise / Retail / Education

Large Venues

What about Wi-Fi 6?

Stay Tuned for more information on future webinars!

Ethernet Switching with cnMatrix

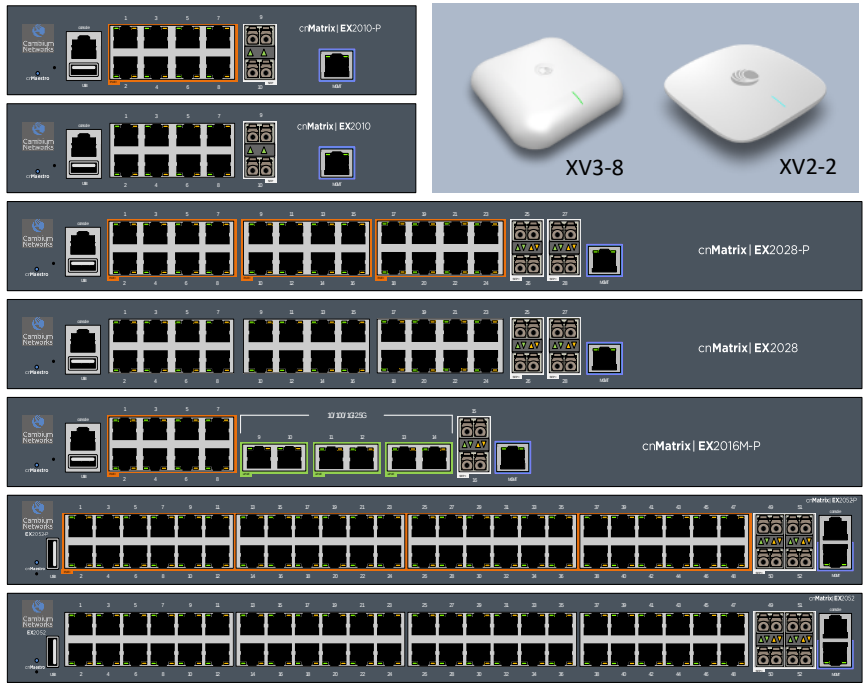
John Mead

Cambium Networks™

The Power of Unified Wired-Wireless Networks

Cambium Networks™

Kick-Ass Portfolio for the Enterprise Edge



cnMaestro

XMS

Coming soon

Fully Featured

- Enterprise Grade, L2/L3 Switching
- QOS, Filtering, ACLs, Security
- Intelligent PoE – 802.3af/at/bt
- 802.3bz - 2.5Gbps ports
- 4x10Gbps fiber uplinks

Fully Managed

- CLI, Web GUI, SNMP
- Comprehensive Network Management System
    - Cloud based or On-Premise

Policy Based Automation

- Automates Device Adds, Moves, & Changes

A true Zero touch experience – Secure & Simple

- Initial Deployment & Day to Day Operations

Limited Lifetime Warranty & Best in Class Support

Best in Class TCO

Simplifying Operations with Policy Based Automation

Cambium Networks™

Policy Based Automation

Simple

- Zero Touch for Initial Deployment
- Zero Touch for device Adds, Moves, & Changes
- All Ports Created Equal–A port is a port is a port

Secure

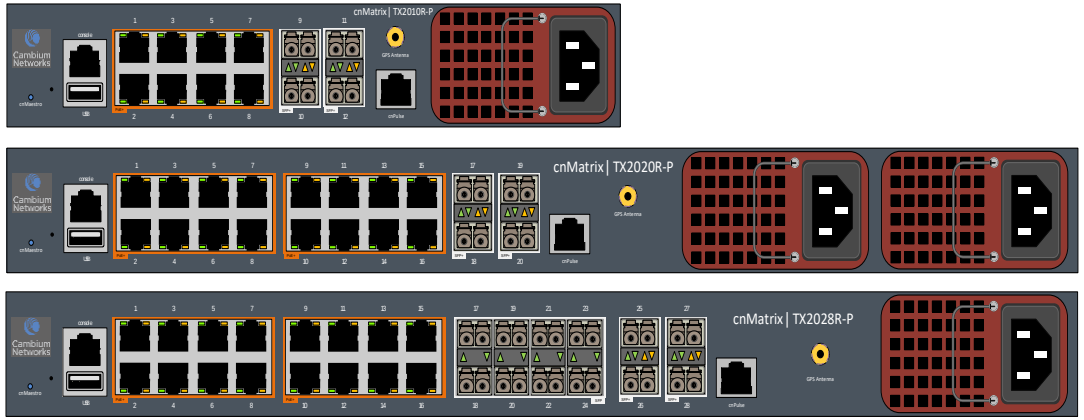
- Automatic Device Profiling
- Automated Device Segmentation
- Automated Policy Enforcement
- Auto Configuration Clean up

TCO

- Elimination of error prone & time-consuming manual configuration
- Little or no IT required for Adds, Moves and Changes of devices
- Reduces time, energy and costs required for network management
- Competitively Priced!

cnMatrix
WISP/Tower Switches
Sneak Peak

Cambium Networks™

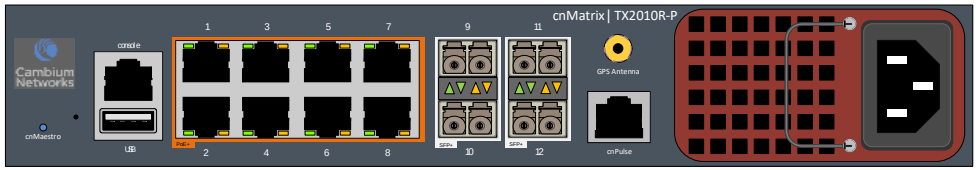


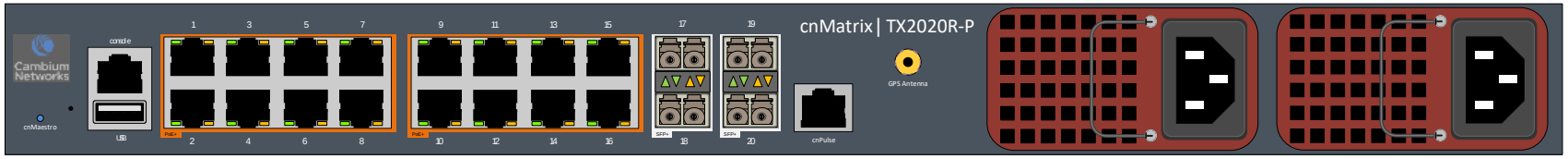
TX 2K Switches

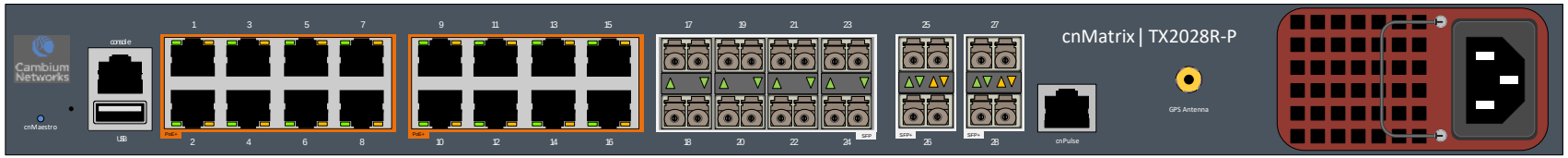
cnMatrix TX-2K Portfolio

		Access Ports					PoE Capability		
Model	Power Supply	Total Access ports	RJ45 1Gbps Access ports	SFP ports	SFP+ Ports	Cambium Sync	802.3 af/at	4-Pair High-Pwr PoE	Low Voltage (24V) Passive PoE
TX2012R-P	CRPS	8	8	0	4	8	8	4	4
TX2020R-P	CRPS*	16	16	0	4	16	16	8	8
TX2028R-P	CRPS	24	16	8	4	16	16	8	8

* - 2 power supplies



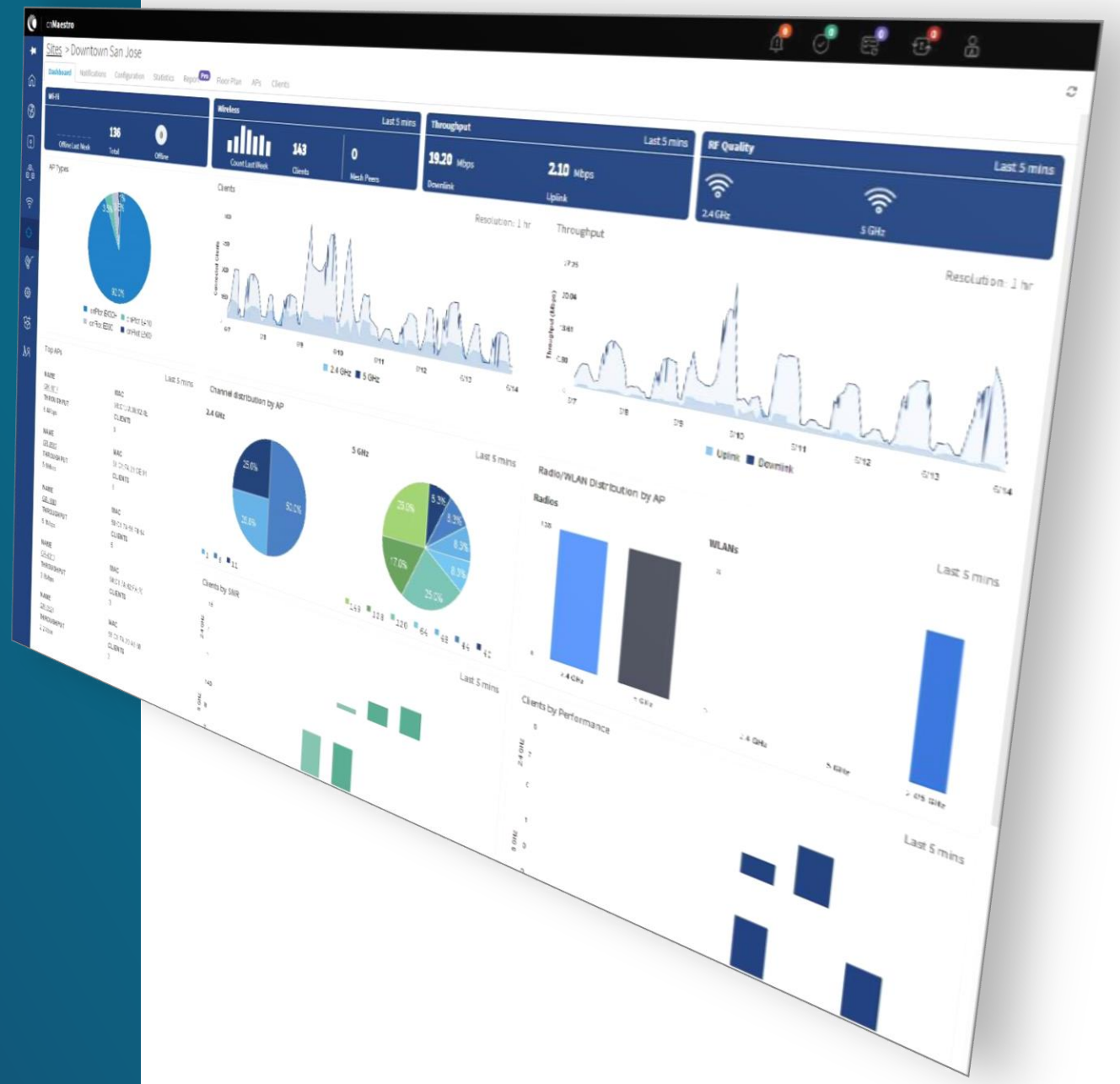




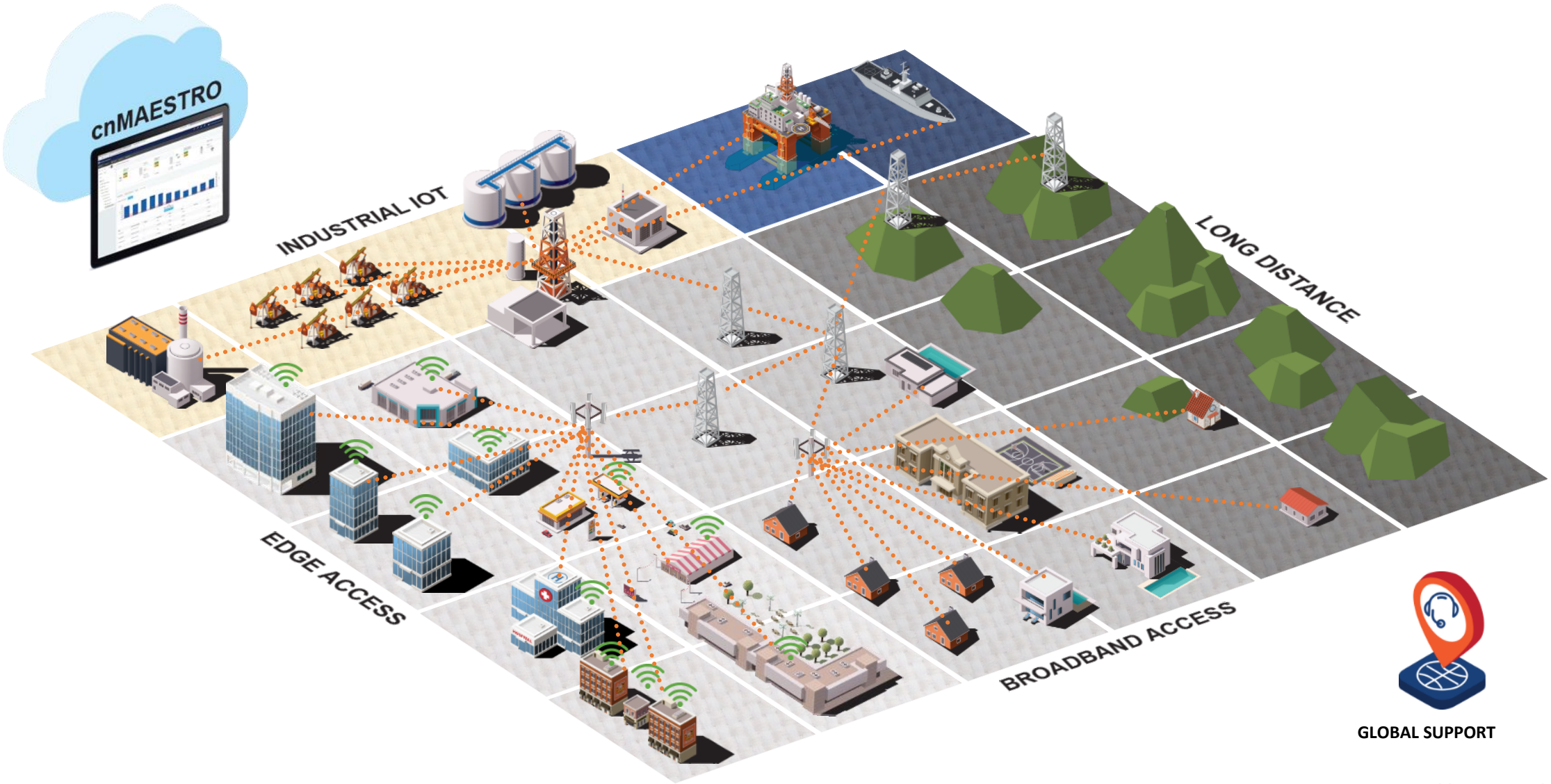
cnMaestro Updates

Azif Abdulsalam

Cambium Networks™



cnMaestro: Managing the Wireless & Wired Fabric



cnMaestro – Unified Dashboard

Zero-Touch

Pre-adopt, Pre-assign, Pre-configure network
Automated RF management
Seamless and Enhanced Roaming

Dashboard

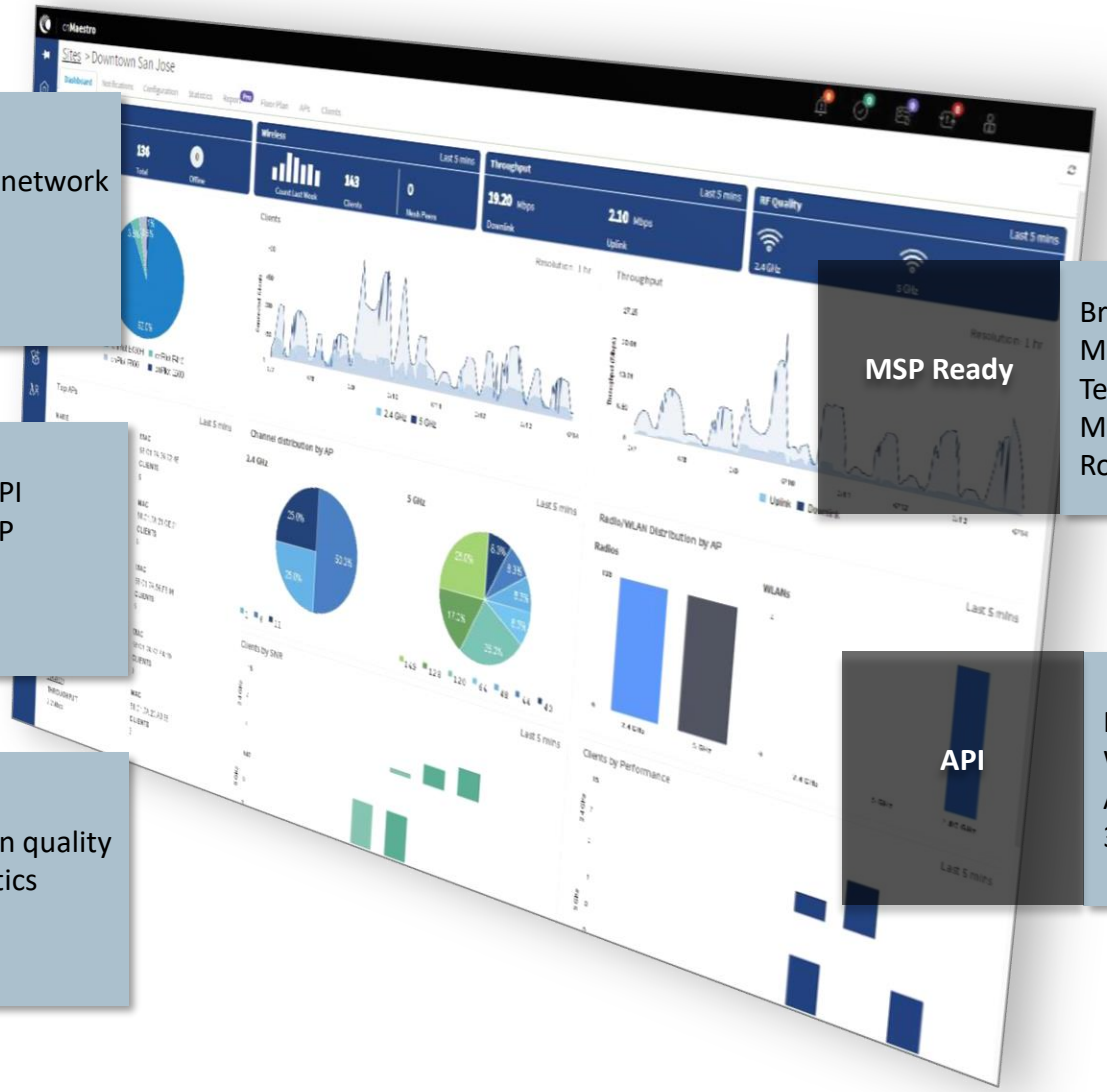
KPI, and qualitative metrics

End-to-end system, per site, or AP KPI
RF Quality by System, Site, Group, AP
Key Performance metrics
Customer experience

Drill down

Statistics, qualitative metrics, reports

Drill into Network, Client, Application quality
Security Intrusion reports and statistics
RF and Packet diagnostic tools



MSP Ready

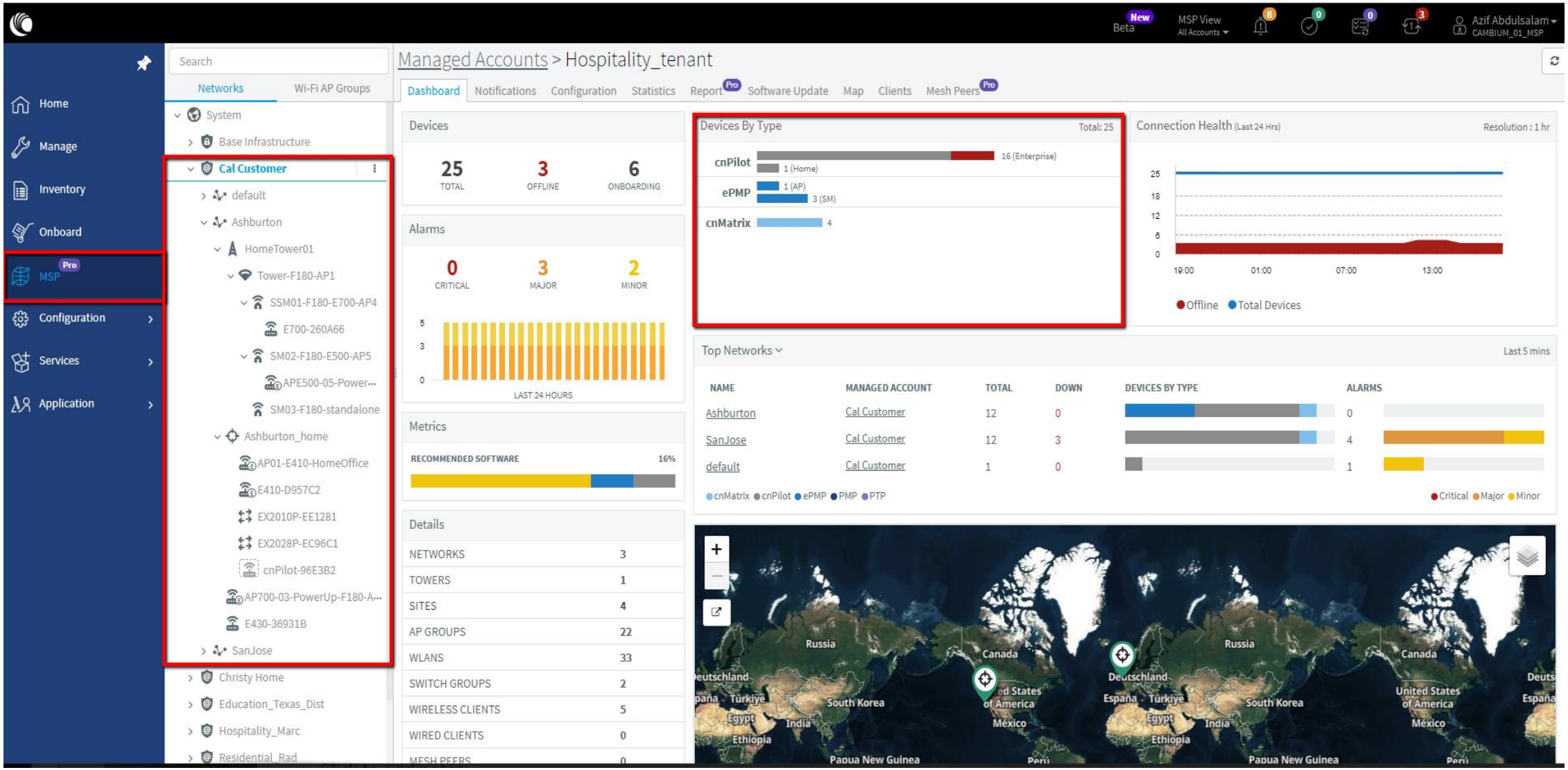
Branded MSP pages for tenants
MSP view of all accounts
Tenant specific daashboaard
Multi-tenancy
Role based access

API

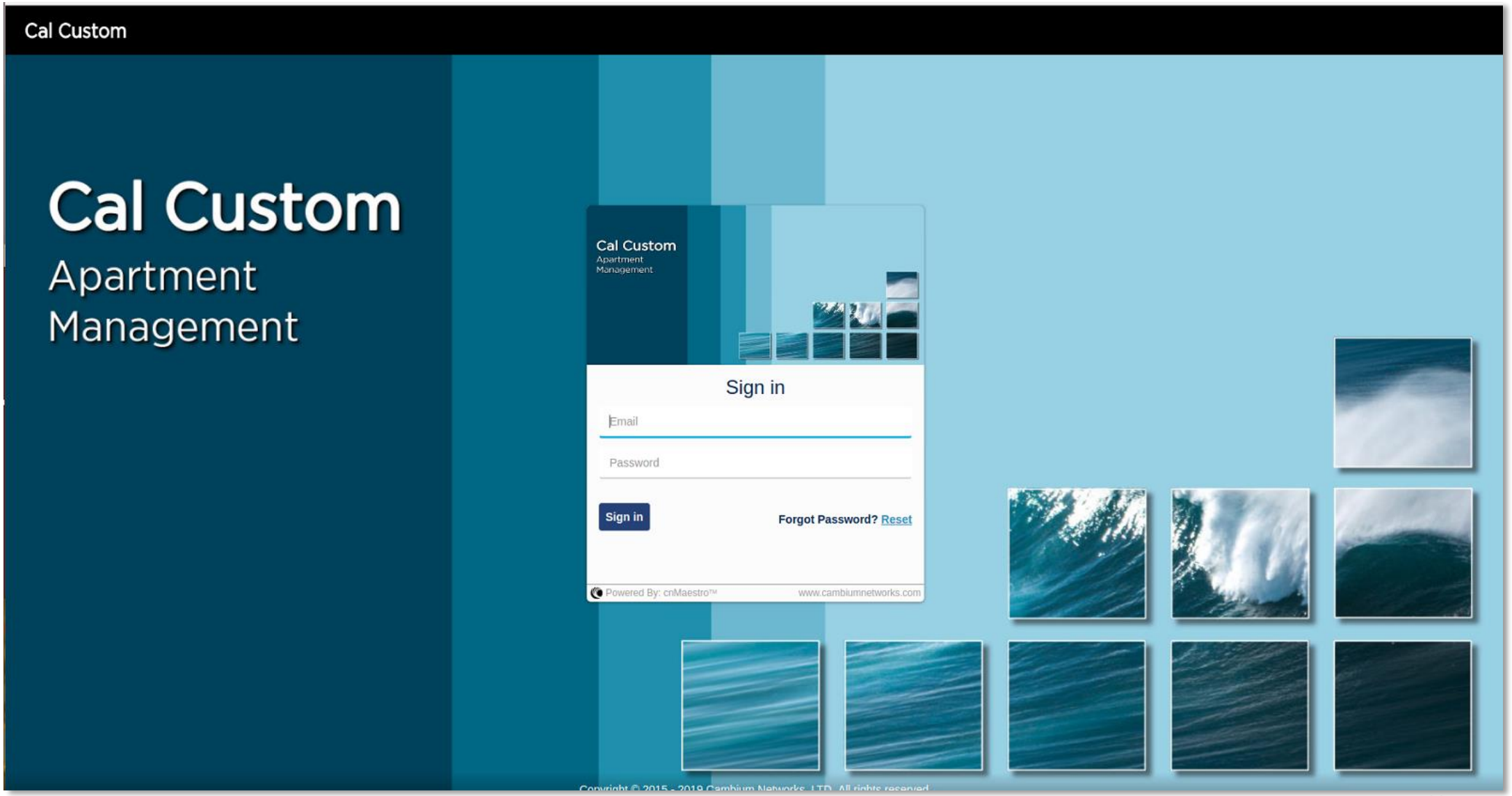
RESTful API's for Telemetry
Webhooks for Real-time events
Automation API's for configuration
3rd Party Ecosystem

58

cnMaestro: Unified Dashboard and MSP

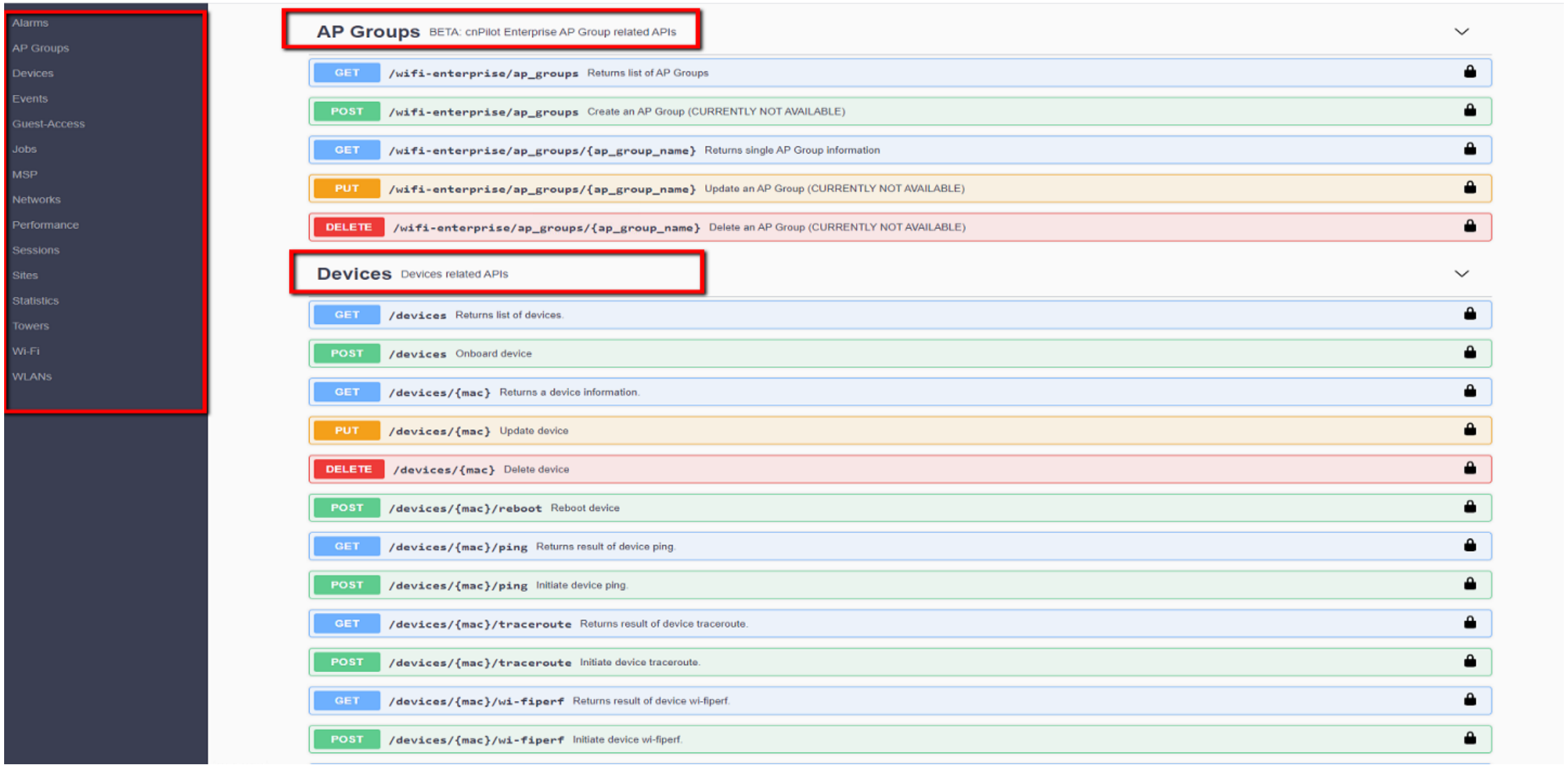


MSP Branded Experience



cnMaestro: Swagger support for NBI API Documentation

Cambium Networks™

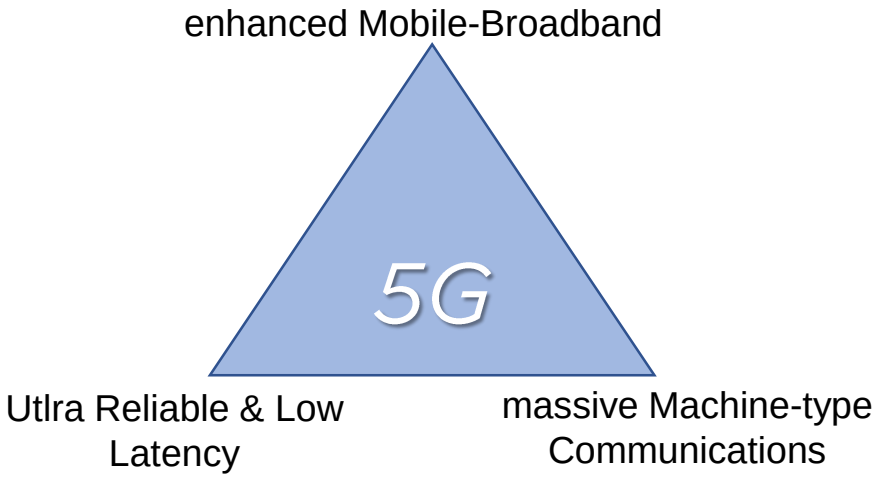


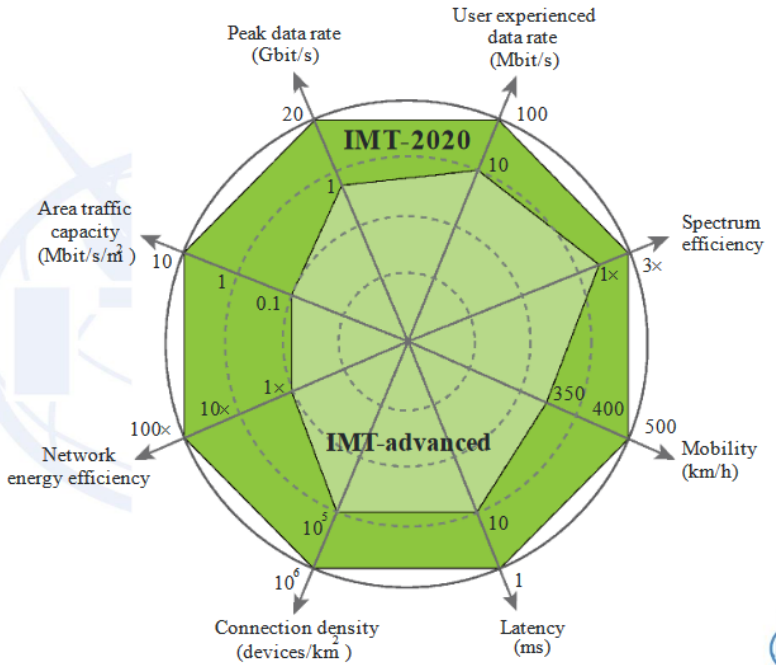
5G

Matt Mangriotis

Cambium Networks™

5G and 5G NR





- **5G mobile communication standard requirements**
  - IMT-2020 published by the ITU-R in 2012
    - enhanced Mobile Broadband
    - Ultra Reliable Low Latency Communications
    - massive Machine-type Communications

- **3GPP's 5G NR standard**
  - Part of composite standard to meet IMT-2020 requirements
  - New air interface required
    - Higher frequency/bandwidth operation
    - Beam centric design/multi-antenna transmission
    - Ultra lean design/forward compatibility
    - Flexible duplex scheme/Dynamic TDD
    - Lower latency

Why 5G-NR for Cambium?

- **3 GPP Release 15 (5G-NR) finally completed in June 2018**

- **Future proof investment**
  - Standard based 5G NR air interface
  - SDR architecture enable future enhancement
  - Enables support for low cost 5G chipset CPE when available
  - Third-party CPE support in future
    - AP supports third party 5G NR CPEs
    - Multiple types of CPE can co-exist in same sector

Why use the 28 GHz for Access?

- **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
- **Commercially**
  - Provides the security of having a licensed spectrum
  - Limited risk of in-band interference
  - High channel bandwidth availability
- **Technically**
  - Propagation conditions still allow a reasonable cell radius even in heavy rain condition
  - The release of the 28 GHz band for 5G has triggered investment in cost optimized, integrated RF front-end modules.

Cambium Key differentiators

- **Optimized End-to-End for Fixed Wireless Access**
  - Benefits for cnMedusa™ world-class Massive MU-MIMO expertise
  - Mobility not supported: lower cost & complexity than competition
  - Optimized to operate with good signal quality (MU-MIMO, Line-Of-Sight…) & high throughput
- **Simple to deploy and operate**
  - AP can operate stand-alone
  - Mobile operator core network not required!
  - 24 to 29 GHz with either polarization in a single SKU

Optimized for FWA

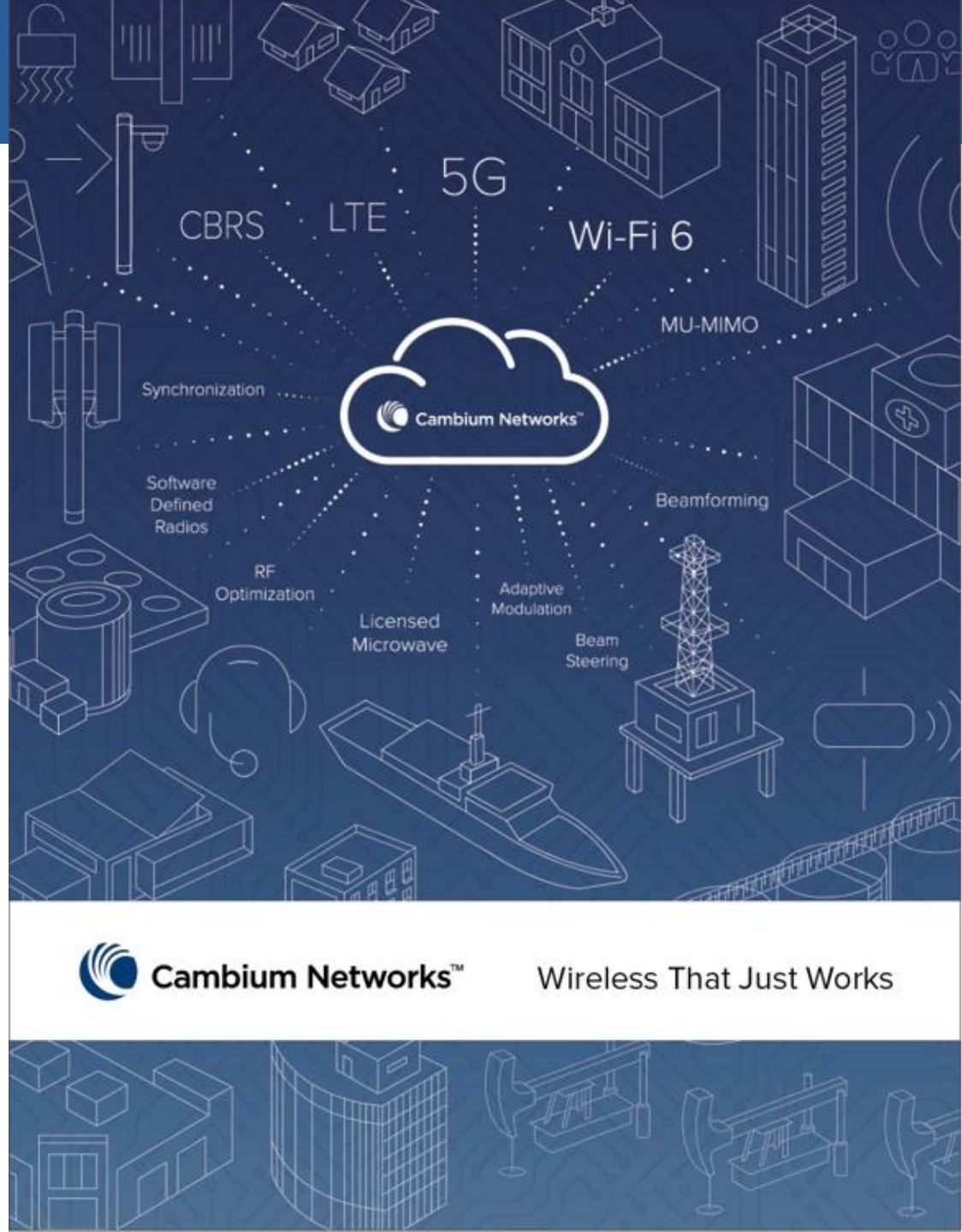
- **Optimized for long range access**
  - Typically 3km, but can support up to 10km cell size
  - Cell size depends on availability target and rain region of deployment
- **Optimized for Line-Of-Sight, professional installation**
  - CPE has high gain dish antenna
  - Beam steer capability to ease installation (Patent submission pending)
- **AP beam steers in azimuth only**
  - Elevation beam steer adds complexity but does not improve performance
- **Design for CPEs to be operating at high throughput in clear-sky conditions**

Cambium 5G and Beyond

28 GHz is the first 5G NR–based platform from Cambium Networks

mmWave platforms combined with advances to the latest standards (like WiFi 6) make true Gigabit to the home possible

Cambium Networks is ready to help network operators achieve their goals and grow together long into the future



Q & A

Ask Anything

Cambium Networks™


Cambium Networks™