



AeroNet



Cambium Networks™

60 GHz cnWave Field Results

Gino Villarini, Founder & President, AeroNet Wireless Broadband

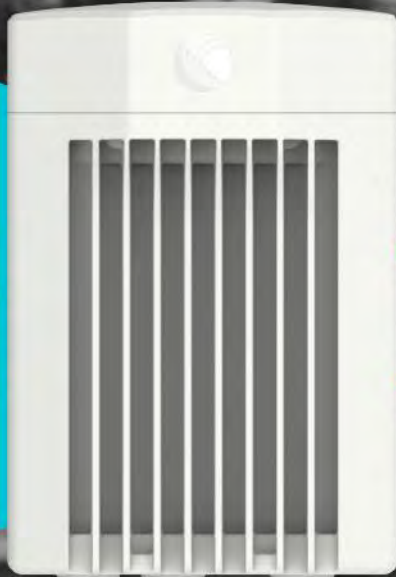
Allen Yu, Director - Product Management, Cambium Networks

Antony Holmes, VP - Engineering, Cambium Networks

Cambium 60 GHz cnWave



Distribution
Node
V5000



terragraph
certified



Client
Node
V1000

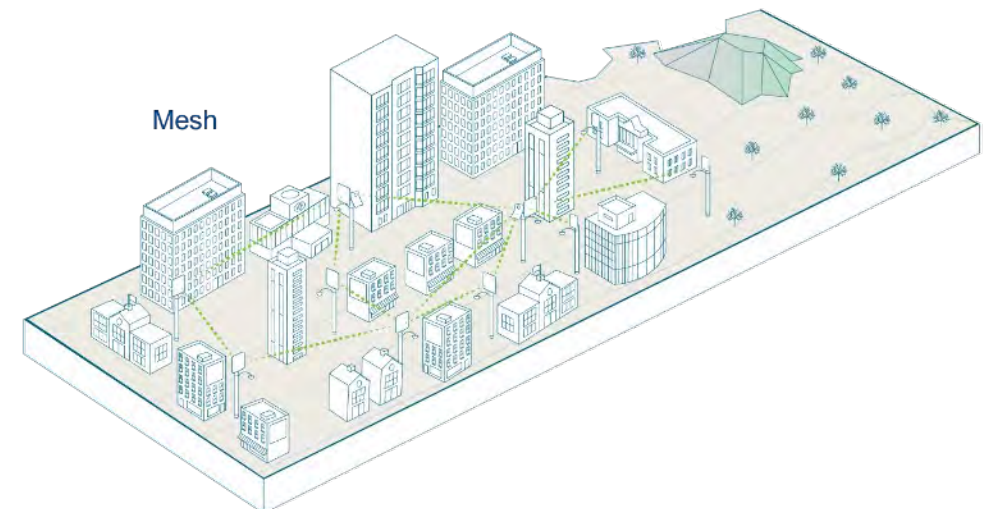
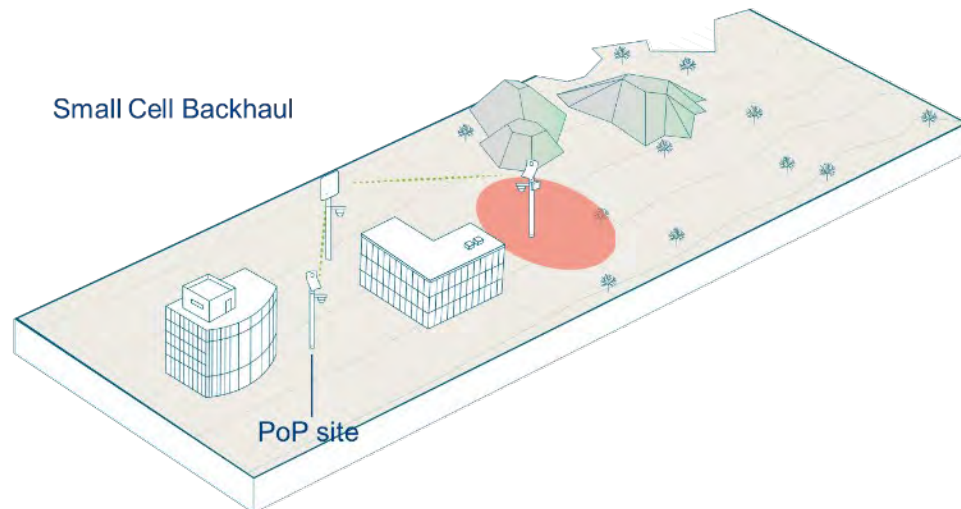
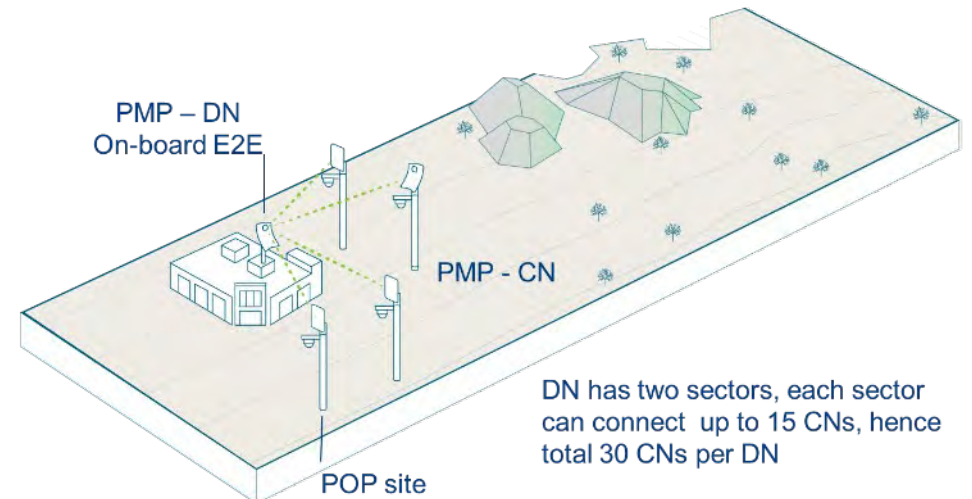
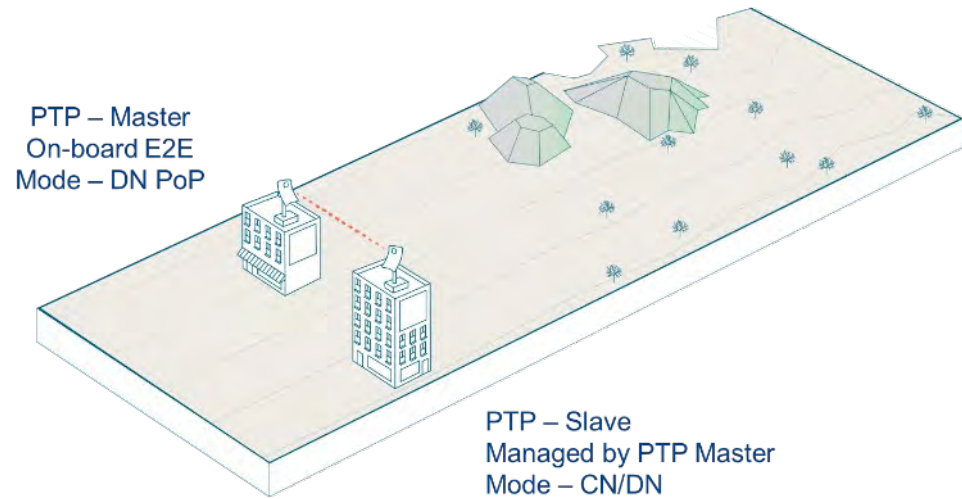


Client
Node
V3000

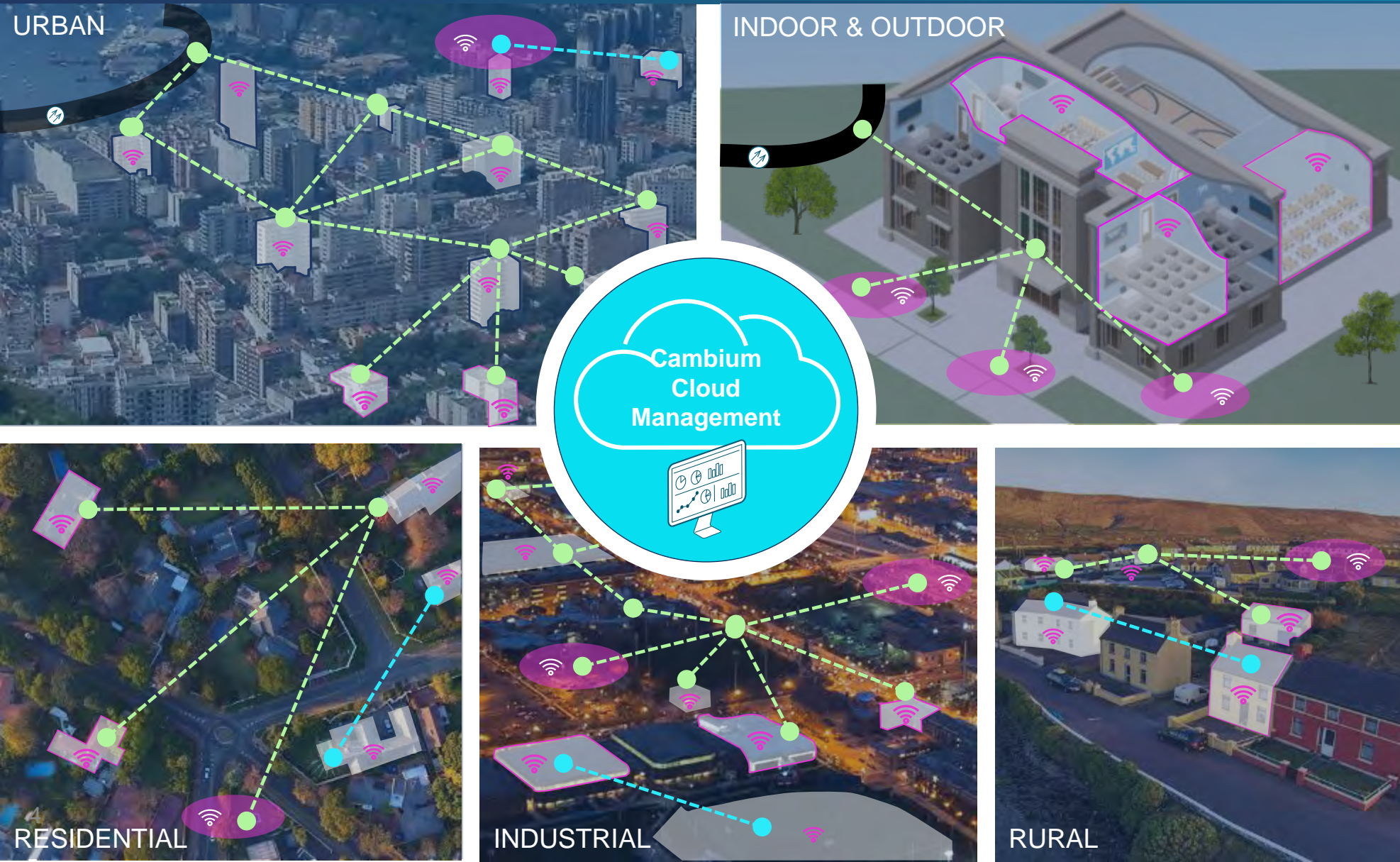


- **Standards:** 802.11ay standard, Mesh support, Terragraph certified
- **Performance:** Up to 15.0 Gbps with channel bonding
- **Installation:** Bi-directional auto beam forming
- **Operation:** Auto expansion, auto healing with Mesh support
- **Configuration:** Point-to-Point, Point-to-MultiPoint,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

Configuration



Cambium Networks Multi-Gigabit Wireless Fabric



Multi-Gig Wireless from Broadband to the Edge

Proven Lowest Cost per Mbps

One Dashboard for Wi-Fi, Switching and Broadband

- Fixed Wireless 60 GHz Distribution
- Fixed Wireless 60 GHz PTP
- Wi-Fi
- Fiber Ring

15+ cnWave Trials Deployed



MY SPEEDTEST RESULT

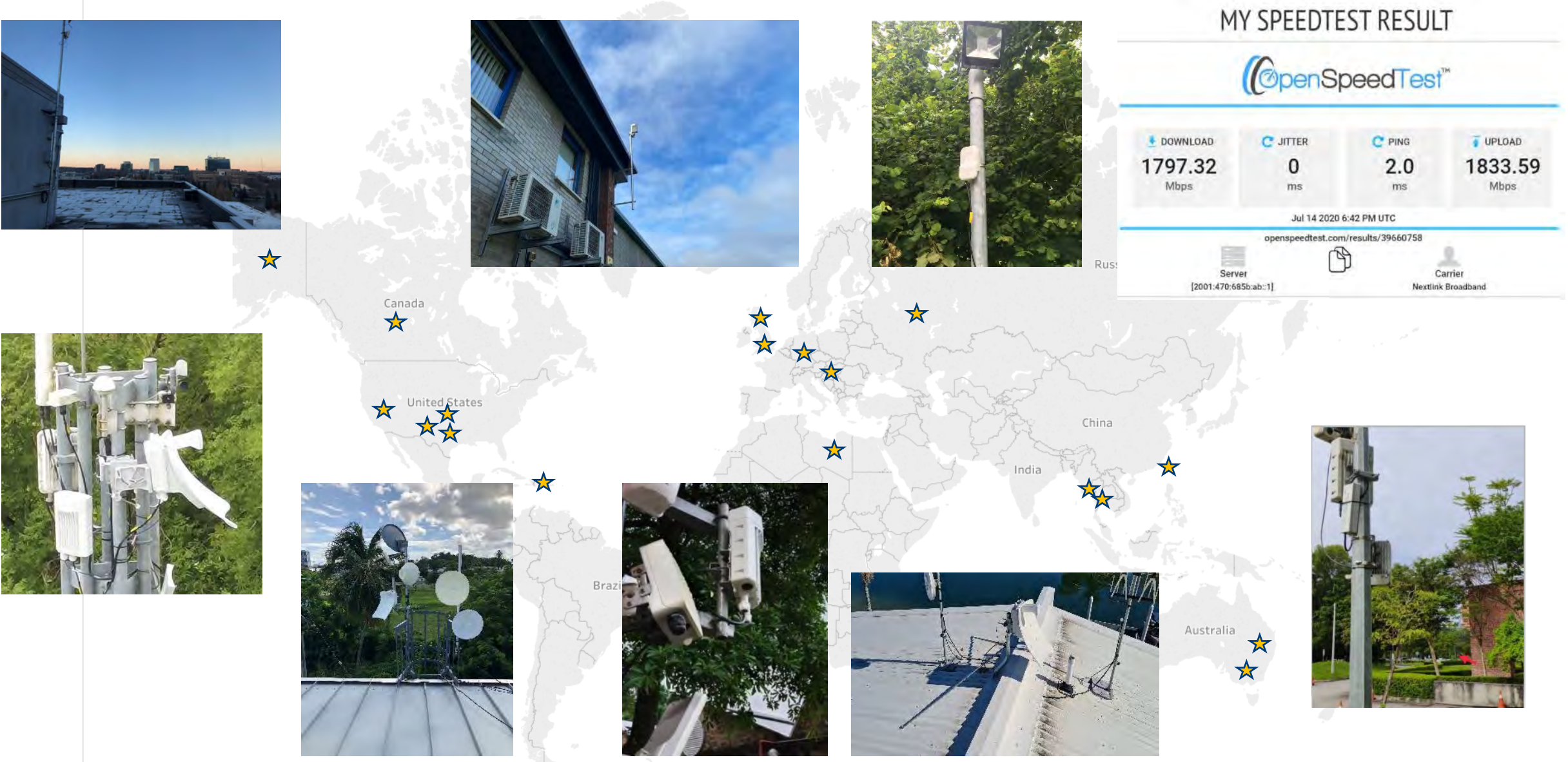
OpenSpeedTest™

DOWNLOAD	JITTER	PING	UPLOAD
1797.32 Mbps	0 ms	2.0 ms	1833.59 Mbps

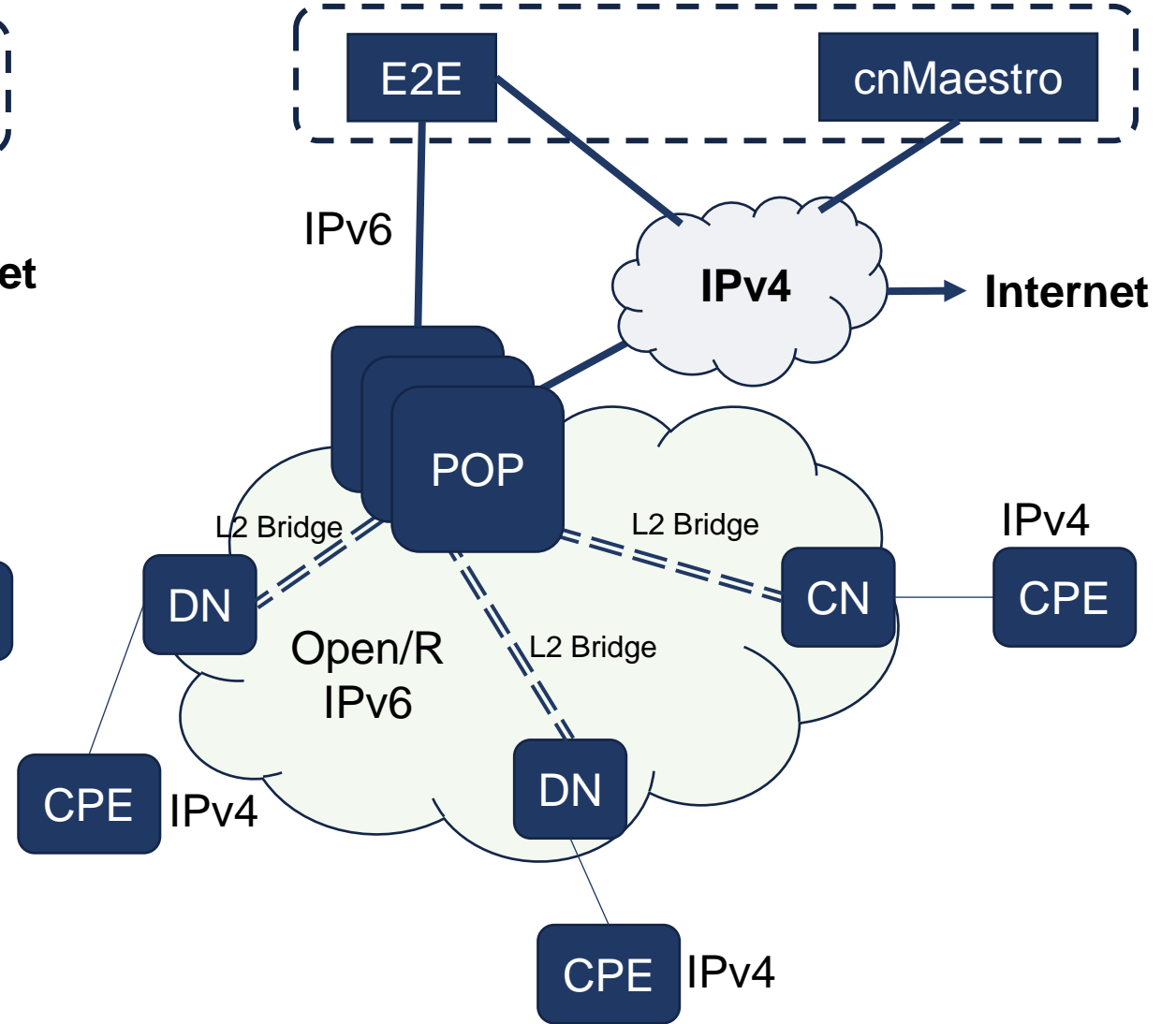
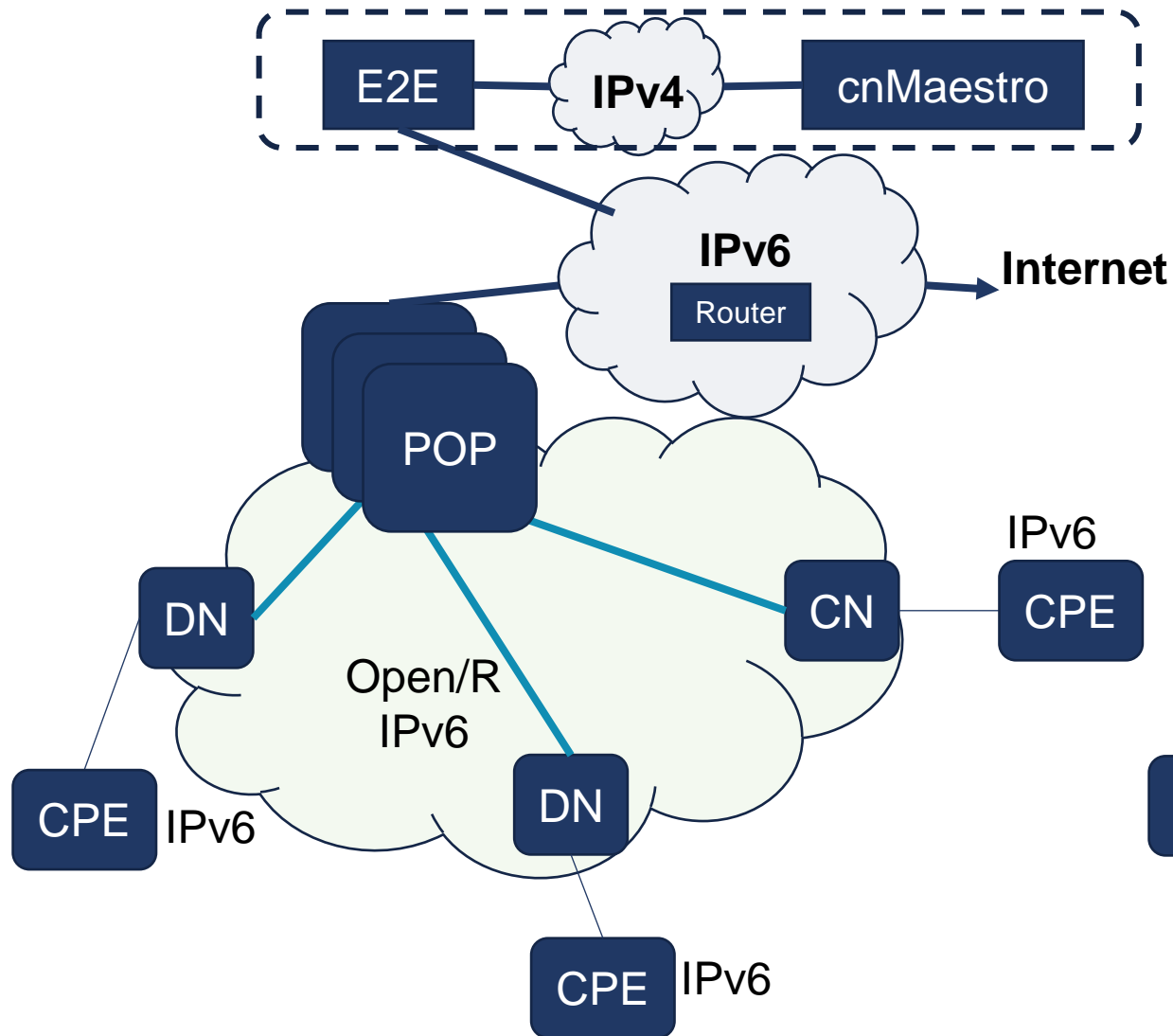
Jul 14 2020 6:42 PM UTC

openspeedtest.com/results/39660758

Server: [2001:470:685b:ab::1] Carrier: Nextlink Broadband



IPv6 and IPv4 support



1.2km PTP link in operation



60GHz cnWave™ V3000

Dashboard

Links	Nodes	Sites	Wireless Th
1 Total	1 Online	2 Total	48.37 Mb RX

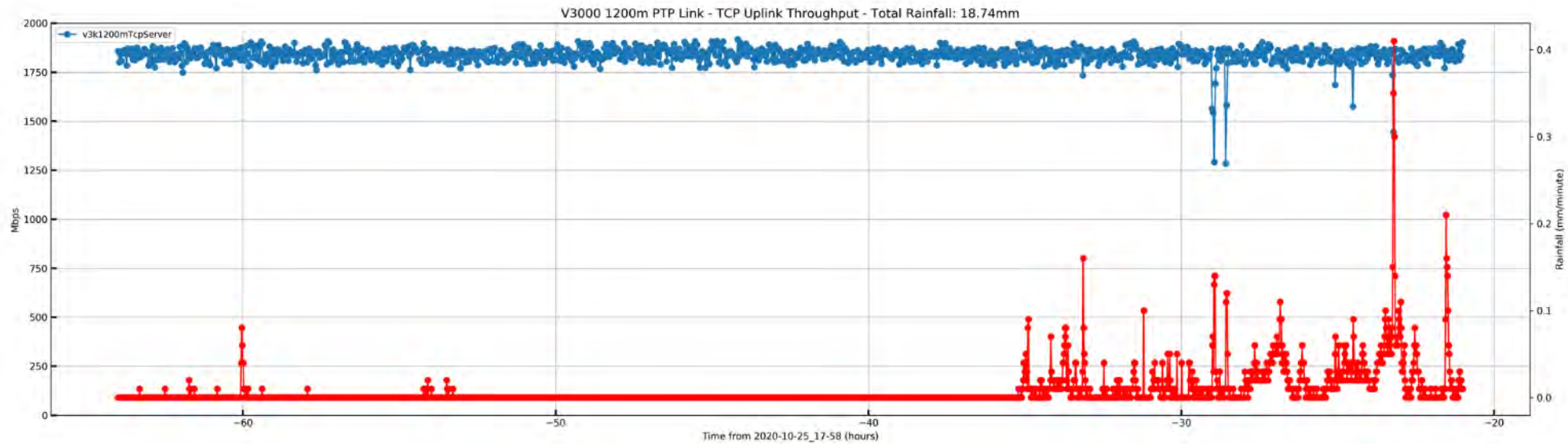
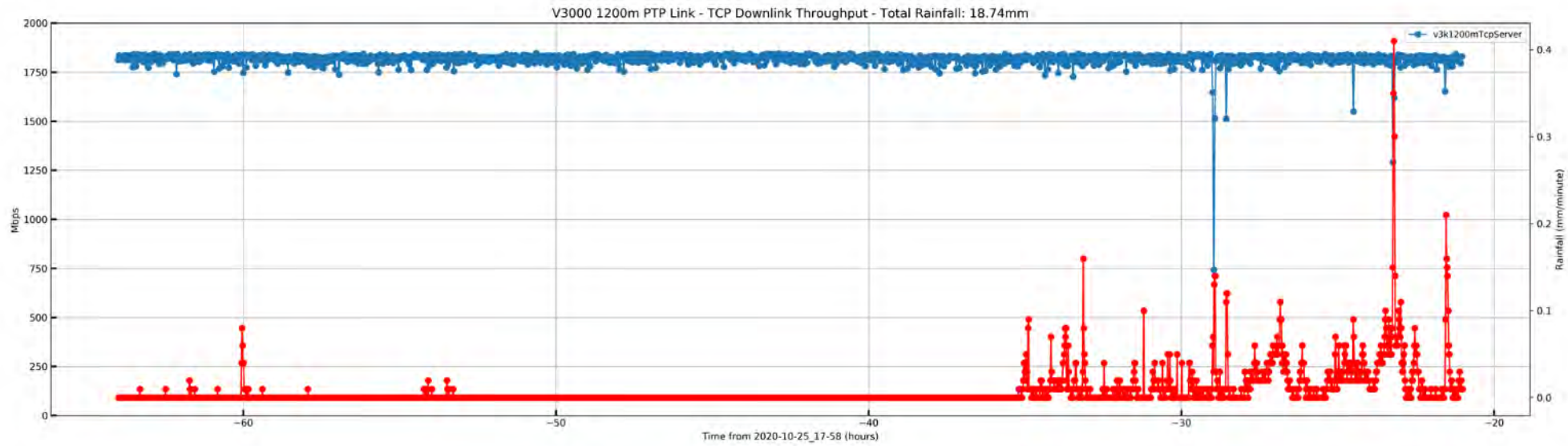
Device Information

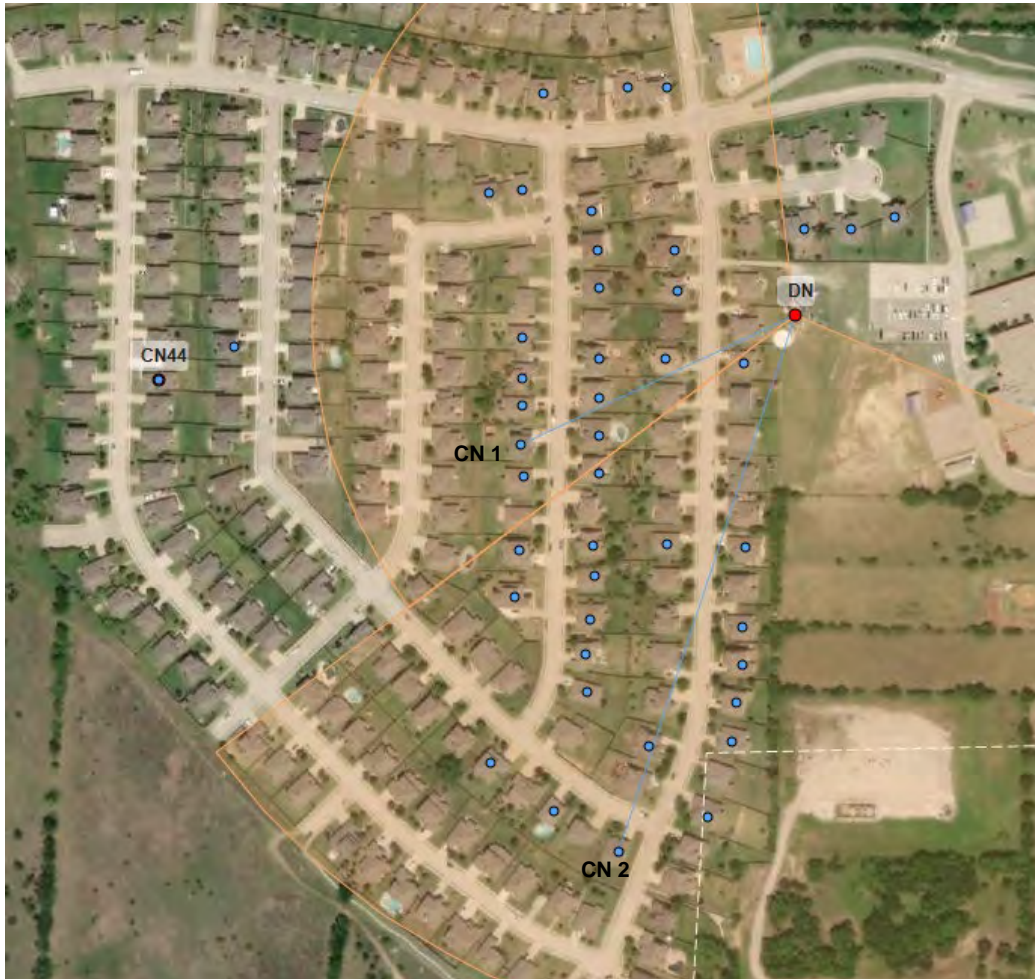
Type	POP
Name	PopNode
E2E Controller	Running Onboard
MAC Address	00:04:56:aa:bf:7b
Serial Number	V5WA0031F7BJ
Model	V3000
Software Version	0.1-dev306
Firmware Version	10.11.0.11225396
Wireless Security	None
System Time	18 Sep 2020 14:10:58 GMT
Uptime	6d 22h 4m

GPS

Fix Type	3D
----------	----

PTP - Rain Fade





MY SPEEDTEST RESULT



DOWNLOAD
1797.32
Mbps

JITTER
0
ms

PING
2.0
ms

UPLOAD
1833.59
Mbps

Jul 14 2020 6:42 PM UTC

openspeedtest.com/results/39660758

Server
[2001:470:685b:ab::1]



Carrier
Nextlink Broadband



	DN - CN1		
	Downlink only	Uplink only	Both Direction
UDP	1026 Mbps	1026 Mbps	995/999 Mbps
TCP	959 Mbps	960 Mbps	851/899 Mbps
	DN - CN2		
	Downlink only	Uplink only	Both Direction
UDP	1945 Mbps	1968 Mbps	1805/1851 Mbps
TCP	1785 Mbps	1514 Mbps	1209/849 Mbps
	DN - CN1+CN2 simultaneously		
	Downlink only	Uplink only	Both Direction
UDP	812 + 1105 Mbps	1025 + 1966 Mbps	(756+971)/(971+1836) Mbps
TCP	897 + 812 Mbps	961 + 1514 Mbps	(44+345)/(948+1348) Mbps

Terragraph NMS CAMBIUM_1

Link 1 130m
Link 2 190m
Link 3 140m
Link 4 80m

Overview
Map Layers
link CAM_CP_KLPAC_1_1 CAM_POP_1_1
Status Online
Azimuth 81.5°
Length 191.7 meters
Ignition Attempts (1d) 24
Availability 87.95%

CAM_CP_KLPAC_1_1
22:04:56:88:30:10
CAM_POP_1_1
12:04:56:88:30:0d

VIEW ACTIONS...

60GHz cnWave™ v5000

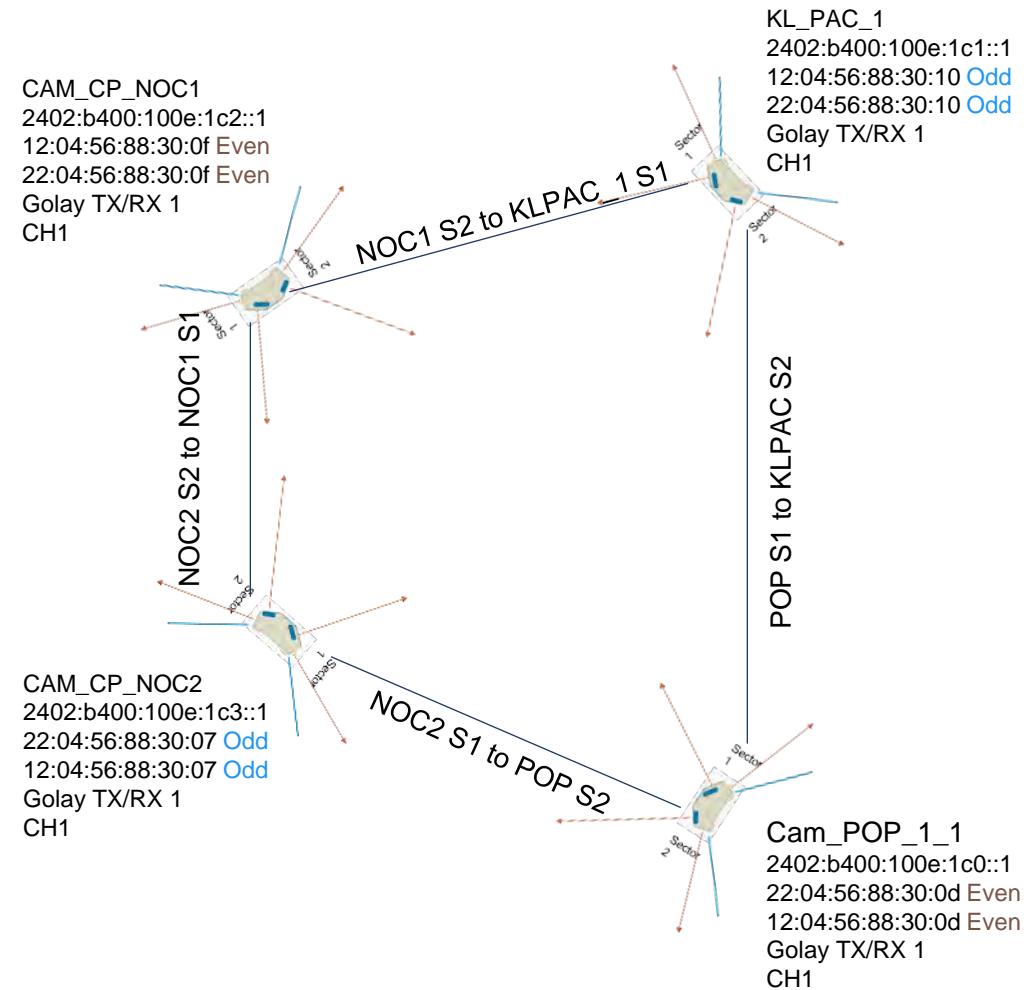
Uptime 0d 1h 40m
Links 2 Total Sectors, 1 Total Links
Channels 2 Sector 1, 2 Sector 2
Wireless Throughput 5.90 kbps RX, 6.98 kbps TX

Device Information
Type DN
Name CAM-CP-NOC-2_1
EZE Connection Status Onboarded
MAC Address 00:04:56:88:30:07
Serial Number X10000885007
Model VS000
Software Version 0.1-dev348
Firmware Version 10.11.0.65
Wireless Security None
System Time 19 Oct 2020 04:35:19 GMT

GPS
Fix Type 3D

Sectors
Sector 1 Sector 2
Channel 2 2
Sync Mode GPS GPS
MAC Address 12:04:56:88:30:07 22:04:56:88:30:07
Active Links 1 0
RX Throughput 5.90 kbps 0 kbps
TX Throughput 6.98 kbps 0 kbps

Ethernet
Aux Main SFP
Status 10 Mbps Down 10 Mbps
RX Packets 0 0 0
TX Packets 0 0 15



Mesh Throughput and Latency

link-CAM_CP_KLPAC_1_1-CAM_POP_1_1

```
[ ID][Role] Interval Transfer Bitrate Retr
[ 5][TX-C] 0.00-30.00 sec 2.81 GBytes 804 Mbits/sec 0 sender
[ 5][TX-C] 0.00-30.05 sec 2.81 GBytes 803 Mbits/sec receiver
[ 7][RX-C] 0.00-30.00 sec 2.86 GBytes 818 Mbits/sec 0 sender
[ 7][RX-C] 0.00-30.05 sec 2.85 GBytes 815 Mbits/sec receiver
```

```
--- 2402:b400:100e:1c0::1 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9179ms
rtt min/avg/max/mdev = 0.353/0.623/1.230/0.277 ms
```

link-CAM-CP-NOC-2_1-CAM_POP_1_1

```
[ ID][Role] Interval Transfer Bitrate Retr
[ 5][TX-C] 0.00-30.00 sec 3.41 GBytes 977 Mbits/sec 19 sender
[ 5][TX-C] 0.00-30.04 sec 3.41 GBytes 975 Mbits/sec receiver
[ 7][RX-C] 0.00-30.00 sec 3.45 GBytes 987 Mbits/sec 0 sender
[ 7][RX-C] 0.00-30.04 sec 3.44 GBytes 984 Mbits/sec receiver
```

```
--- 2402:b400:100e:1c3::1 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9176ms
rtt min/avg/max/mdev = 0.484/0.664/0.706/0.079 ms
```

link-CAM-CP-NOC-1_1-CAM-CP-NOC-2_1

```
[ ID][Role] Interval Transfer Bitrate Retr
[ 5][TX-C] 0.00-30.00 sec 4.26 GBytes 1.22 Gbits/sec 0 sender
[ 5][TX-C] 0.00-30.04 sec 4.25 GBytes 1.22 Gbits/sec receiver
[ 7][RX-C] 0.00-30.00 sec 4.29 GBytes 1.23 Gbits/sec 0 sender
[ 7][RX-C] 0.00-30.04 sec 4.28 GBytes 1.22 Gbits/sec receiver
```

```
--- 2402:b400:100e:1c2::1 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9224ms
rtt min/avg/max/mdev = 0.648/0.698/0.712/0.023 ms
```

link-CAM-CP-NOC-1_1-CAM_CP_KLPAC_1_1

```
[ ID][Role] Interval Transfer Bitrate Retr
[ 5][TX-C] 0.00-30.00 sec 3.35 GBytes 960 Mbits/sec 0 sender
[ 5][TX-C] 0.00-30.04 sec 3.35 GBytes 958 Mbits/sec receiver
[ 7][RX-C] 0.00-30.00 sec 3.05 GBytes 874 Mbits/sec 0 sender
[ 7][RX-C] 0.00-30.04 sec 3.05 GBytes 872 Mbits/sec receiver
```

```
--- 2402:b400:100e:1c2::1 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9020ms
rtt min/avg/max/mdev = 0.788/1.234/1.948/0.282 ms
```

City Coverage with cnWave

- <100 DN's
- Lamp post and Roof tops
- Outdoor Wi-Fi backhaul, >30,000 users
- FWA, >110 local business and government offices
- CCTV backhaul options



The AeroNet logo features a stylized icon of three horizontal lines with a dot on the left, followed by the text "AeroNet" in a bold, italicized sans-serif font. The background is a blue-tinted street scene with a network overlay on the right side.

AeroNet



Cambium Networks

terragraph

About Us



Founded in 2001

Hybrid ISP : 80% FWA, 20% Fiber

Markets: Puerto Rico, USVI, South FL

Segments: Enterprise, SMB, Wholesale, Residential

Only PR ISP in INC 5000

WISPA's ISP of the Year 2012 & Triumph Award 2018

Spectrum Assets: 2.5 GHz & 3.5 GHz



Go Faster!

What happened?

Market trial in Old San Juan connecting friendly customers with premium FWA.
Terragraph was also deployed as a reliable transport solution for Cambium Wi-Fi APs.

Trial Details

- 14 Nodes
- 50+ Total Units
- Deployed in 4 weeks

Why Terragraph?

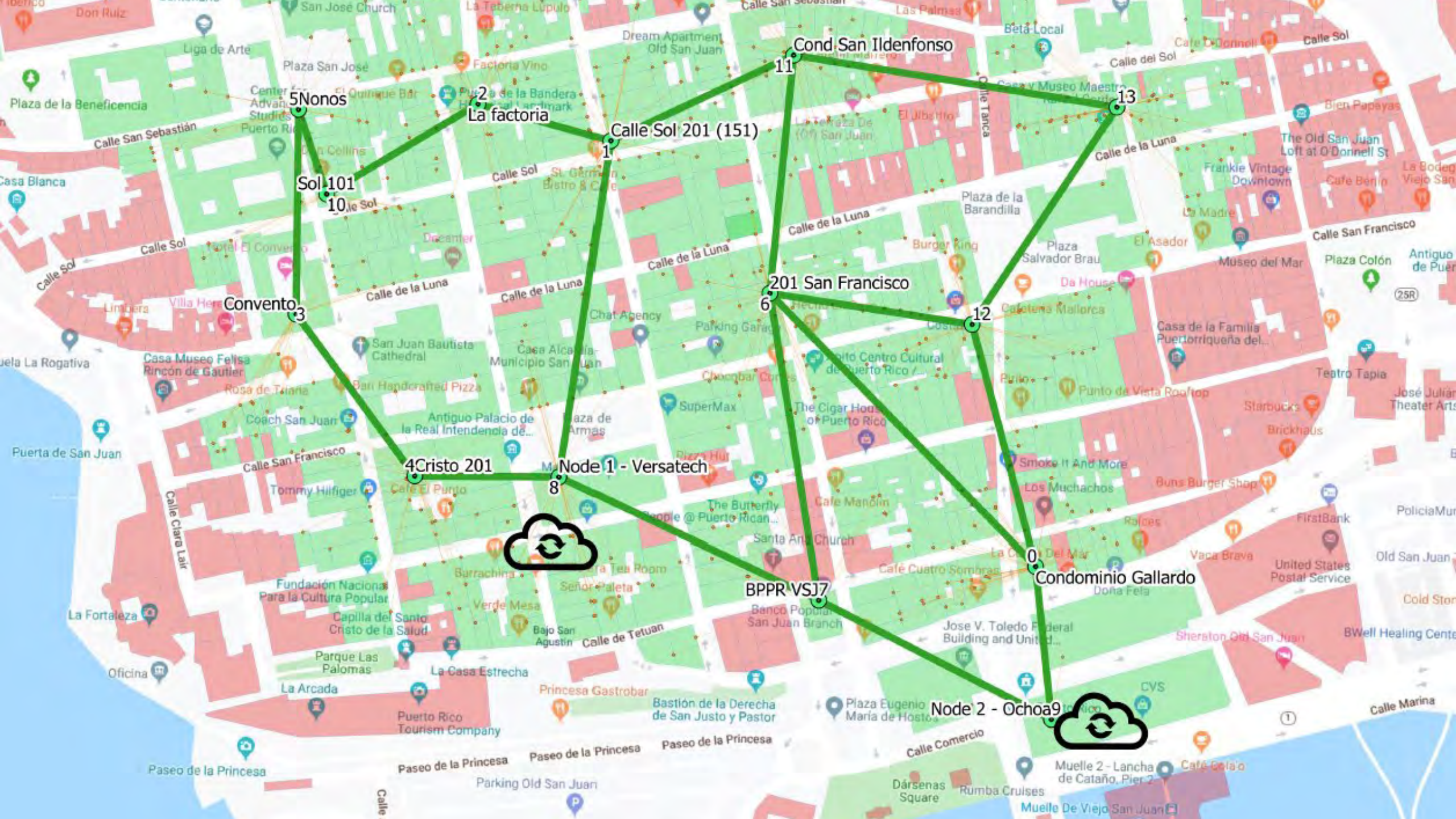
- mmWave technology with fiber like speeds
- Quick time-to-market. Deployments in few days
- Cost effective solution alternative and complementary to fiber
- Increased network resilience through mesh
- Unlicensed spectrum

What's next?

Aeronet was the first Service Provider issuing a PO for a Terragraph certified cnWave.

Aeronet is planning to scale cnWave deployments in the island, focusing on bringing high speed broadband services to thousands of customers.





Cond San Ildenfonso

5 Nonos

2 La factoria

1 Calle Sol 201 (151)

13

10 Sol 101

3 Convento

6 201 San Francisco

12

4 Cristo 201

8 Node 1 - Versatech

7 BPPR VSJ7

0 Condominio Gallardo

9 Node 2 - Ochoa9

cnWave Trial Details:

- V3000 PTP Link between 2 AeroNet facilities
- 660 Meters
- Rain Zone N

Installation Feedback:

- Solid design and hardware
- Standard POE procedure
- Used Shielded CAT5
- Scope Needed, Alignment tone or App would help



60GHz cnWave™ v3000 Reboot admin

Dashboard

Links 1 1 Total Online	Nodes 2 2 Total Online	Sites 2 Total	Wireless Throughput 79.25 Mbps RX 1.76 Gbps TX
---	---	--	---

Device Information	
Type	POP
Name	Rexco-PoP
E2E Controller	Running Onboard
MAC Address	00:04:56:88:30:3d
Serial Number	V5WG00322JTV
Model	V3000
Software Version	0.1-dev306
Firmware Version	10.11.0.11225396
Wireless Security	None
System Time	13 Sep 2020 07:57:57 GMT
Uptime	0d 17h 12m

Performance Experiences:

- RB4011 to RB4011 Mikrotik BW Tool over SFP+
- Asymmetric Bandwidth tests yielded 1.7 Gbps+
- Symmetric Bandwidth test yielded 1.25 Gbps total
- Latency: 1-2ms

Bandwidth Test (Running)

Test To: 172.16.1.2

Protocol: udp tcp

Local UDP Tx Size:

Remote UDP Tx Size:

Direction: both

Connection Count:

Local Tx Speed: bps

Remote Tx Speed: bps

Random Data

User: admin

Password:

Lost Packets: 0

Tx/Rx Current: 651.4 Mbps/647.1 Mbps

Tx/Rx 10s Average: 672.3 Mbps/672.7 Mbps

Tx/Rx Total Average: 714.1 Mbps/708.9 Mbps

Tx: 651.4 Mbps
Rx: 647.1 Mbps

running...

Bandwidth Test (Running)

Test To: 172.16.1.2

Protocol: udp tcp

Local UDP Tx Size:

Remote UDP Tx Size:

Direction: receive

Connection Count:

Local Tx Speed: bps

Remote Tx Speed: bps

Random Data

User: admin

Password:

Lost Packets: 0

Tx/Rx Current: 0 bps/1609.1 Mbps

Tx/Rx 10s Average: 0 bps/1609.5 Mbps

Tx/Rx Total Average: 0 bps/1602.9 Mbps

Tx: 0 bps
Rx: 1609.1 Mbps

running...

Deployment scenarios being evaluated:

- Point to Point
- Multipoint
- Multipoint to Multipoint (All Mesh)
- Industrial Indoor
- Residential Indoor (Last Feet)



Cambium Networks Partnership for Terragraph

- Integration with other Cambium Network Tools: cnMaestro, Link Planner, cnHeat?
- Tested track record.
- Converged Support between platforms.
- Open to Feedback and Suggestions.

What's Next?

- Multipoint Trial – HW expected this week.
- Symmetrical Speed issue ID and resolution.
- Field Deployments





- **Low Total Cost Ownership (TCO)**
 - **V5000** 280-degree coverage with dual sector - No need for site router, simple installation
 - **V1000 + V3000** to meet various range challenge
 - Auto Beamforming for easy installation
- **Super-long range V3000** with beamforming
- **Channel Bonding H/W ready**, double the capacity with F/W upgrade
- **IP 66/67 rated enclosure**
- **High density deployment**, each DN can support up to 30 CNs or 26 CNs + 4 DNs
- **cnMaestro cloud management** – one panel for NMS
- **Easy planning** (Advanced Network Planning + LINKPlanner)



Cambium Networks™