

WIRELESS BACKHAUL FOR

LTE and Small Cell Networks



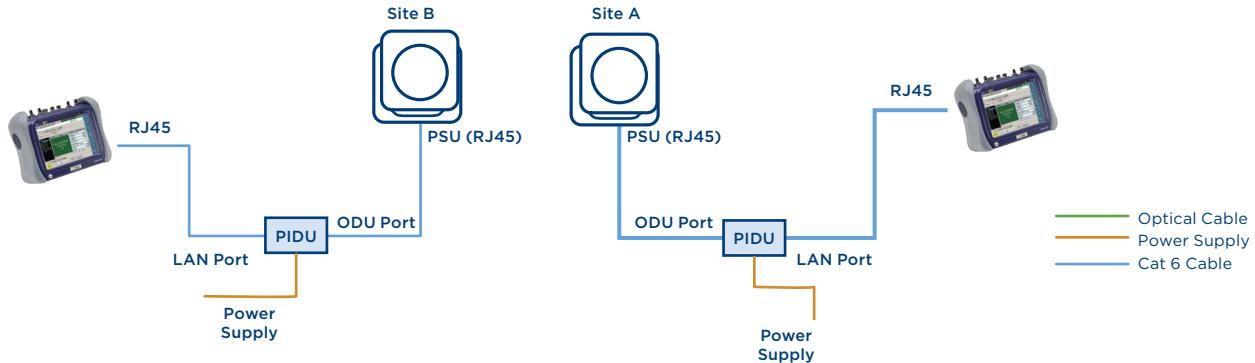
As network operators continue to build deployments that connect people in urban locations, the inherent advantages of wireless technology are compelling. Networks depend on reliable high-capacity backhaul at street level to support edge access solutions such as LTE or small cells. Without needing to trench or install cable, wireless systems can be deployed much faster and at a fraction of the total cost of a wired or fiber solution. However, in many cases – and particularly in urban locations – a clear Line of Sight (LoS) path for the wireless system is difficult to find. The objective is a reliable, cost effective wireless solution that performs well not only in LoS conditions, but also near Line of Sight (nLoS) and Non-Line of Sight (NLOS) applications.

A Malaysian network operator needed to provide LTE and small cell edge access at distances of 1 km or less in an urban location where there was no access to the fiber backbone. There was no LoS possible in the dense environment at street level, so the backhaul needed to perform in nLoS and NLoS conditions while meeting strict frame loss and throughput requirements.

The operator recently conducted field tests on alternative wireless solutions for connecting LTE and small cell networks, determining that Cambium Networks' PTP 670 provided consistently reliable performance in urban applications, and particularly when confronted with NLoS configurations.

ARCHITECTURE

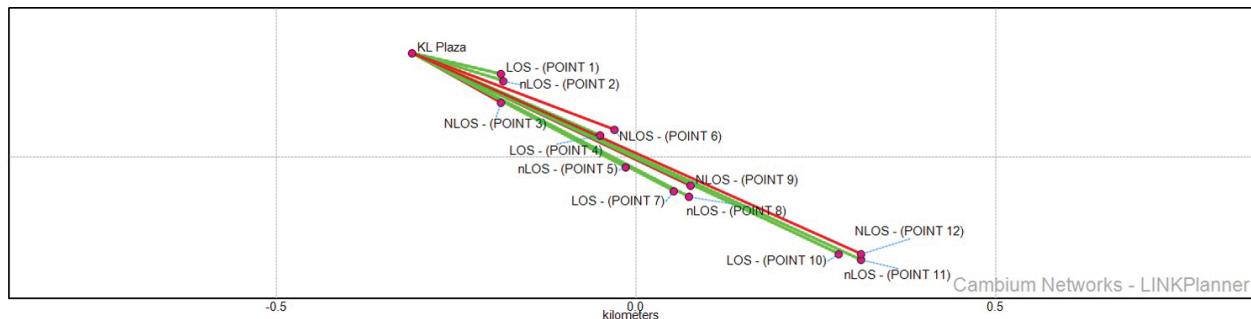
After having several wireless systems fail in either lab or field tests, the operator knew the exact application to test, collecting 30 days of experimental data evaluating LoS, nLoS, and NLOS performance over a distance of 1 km in the heart of a major urban area.



The location of the link end points was consistent and representative of the actual field deployment:

PTP MASTER SITE	SITE 1	SITE 2	SITE 3	SITE 4
90 M height on rooftop	Height 2m Range 300 m LoS – point 1 nLoS – point 2 NLoS – point 3	Height 2m Range 400 m LoS – point 4 nLoS – point 5 NLoS – point 6	Height 2m Range 600 m LoS – point 7 nLoS – point 8 NLoS – point 9	Height 2m Range 700 m LoS – point 10 nLoS – point 11 NLoS – point 12

For each location was planned using the free LINKPlanner software from Cambium Networks. LINKPlanner uses the exact GPS location of the source and destination elements, identifies obstructions, and estimates path performance of each link.



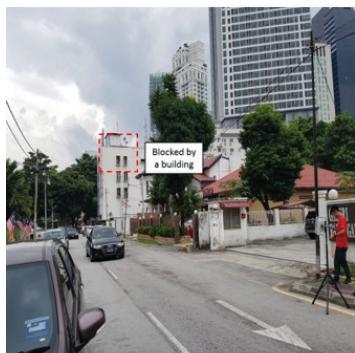
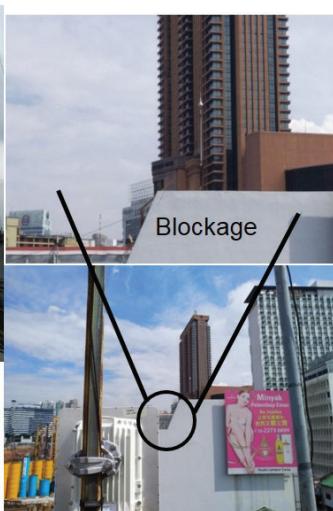
LINKPlanner software also provides a Google Earth overlay of the links to show the exact location of the links in the actual environment.



Master location



Remote Sites



PTP 670 TECHNOLOGY

Cambium Networks PTP 670 backhaul includes the following core technologies to improve performance in noisy or obstructed environments:

- Dynamic Spectrum Optimization™ (DSO) – a unique capability offered by Cambium Networks that enables optimization of link performance by automatically sampling and changing channels to avoid interference without affecting link service. See the DSO White Paper for full details.
- High Capacity Multipoint Connectivity (HCMP) – allows for up to 8 nodes (in roadmap) to connect a single master radio, opening new deployment models that simplify planning, enable rapid deployment, and provide a rapid return on investment.
- Security – PTP 670 has multiple layers of security to protect traffic.
 - 128-bit AES encryption
 - 256-bit AES encryption
 - Multi-level user authentication
 - Audit trail of security activity
 - RADIUS authentication
 - OOBM (Out-of-Band Management)
 - SNMPv3
 - Remote Password Maintenance
- Rugged Design
 - 200 mph wind survivability
 - IP 66/67 dust and water intrusion compliant
 - Salt Fog Environment test (MIL-STD-8010G)
 - Shock and Vibration test (MIL-STD-810G)

TEST RESULTS

The tests on all of the above configurations were conducted, yielded the following observations:

- PTP 670 provided coverage for LOS, nLOS and NLOS conditions up to 1km from street level deployment.
- PTP 670 covers effectively for both diffractive and reflective NLOS conditions.
- PTP 670 met the customer's minimum requirement with regards to capacity, latency and frame loss below 0.005% at various deployment conditions (12 x Test points)
- LOS: **100Mbps FD** is achieved as per minimum requirement with 99.995% availability
- nLOS: **100Mbps FD** is achieved as per minimum requirement with 99.995% availability
 - Freznel zone blocking from 20- 40% considered nLOS (near line of sight)
- NLOS: **50Mbps FD** is achieved as per minimum requirement with 99.995% availability
 - Freznel zone blocking 50% and above is considered as NLOS (Non line of sight)

BUSINESS CONCLUSIONS

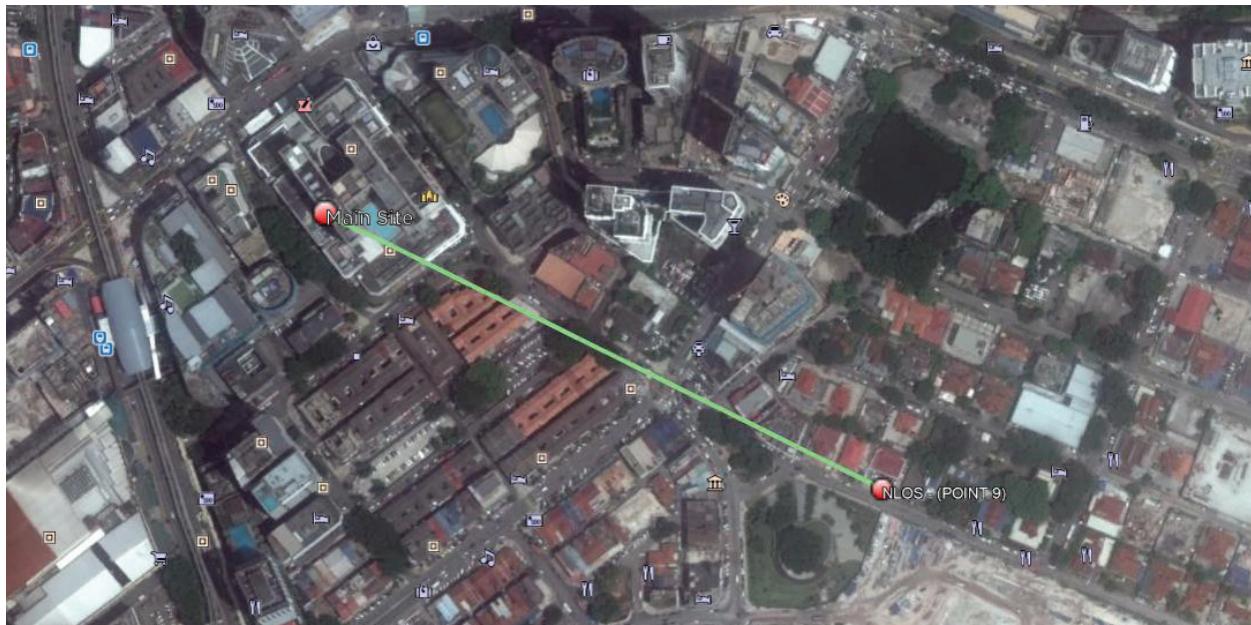
Based on the above measurements in a standard performance test, the evaluation team calculated the value to the business of deploying PTP 670 for edge access network backhaul:

- Estimated site acquisition time is reduced by 50% vs traditional microwave backhaul
- Estimated deployment/site turn up time is reduced by 70%
- Overall cost reduction for the equipment of 30%

DETAIL FIELD PERFORMANCE TEST RESULTS

Site #3, at a distance of 600 meters, provided the most challenging NLoS conditions, particularly point 9 from the table above, for which the path between the master and the site was completely blocked by a building.

- The instance is shown on Google Earth – from above and from street level. This situation is typical for any major urban area.
- Also shown are the path predictions given by the LINKPlanner software.
- The results from the PTP 670 onboard Spectrum Analyzer depict the noise and available spectrum.
- Throughput tests exhibit no frame loss at any frame length tested.





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Link: A to B Site: Unit: A Master

Home Status

- » System
 - Configuration
 - Spectrum Expert
 - Statistics
 - Diagnostics Plotter
 - Cable Diagnostics
 - Software Upgrade
 - Reboot
- » Installation
- » Management
- » Security
- Change Password
- Logout

System Status - Master

Equipment			Wireless		
Attributes	Value	Units	Attributes	Value	Units
Link Name	A to B		Wireless Link Status	Up	
Unit Name	A Master		Wireless Link Up Time	00:00:08	
Site Name			Wireless Encryption	None	
Software Version	50670-02-50		Maximum Transmit Power	27	dBm
Hardware Version	BOP01_01-I-FPS		Remote Maximum Transmit Power	27	dBm
Unit ESN	0004565807D0		Transmit Power	27.0, 23.2, -15.0,	24.0 dBm
Unit MSN	U9TE00HQ9NGS		Receive Power	-49.7, -77.6, -110.0,	-52.9 dBm
Regulatory Band	8 - 5.4 GHz - Other		Vector Error	7.2, -1.6, -29.6,	-27.7 dB
Elapsed Time Indicator	00:00:51		Link Loss	123.1, 22.2, 0.0,	123.0 dB
Ethernet / Internet			Transmit Data Rate	99.27, 11.97, 0.00,	58.95 Mbps
Aux Port Status	Copper Link Up		Receive Data Rate	58.95, 9.89, 0.00,	58.95 Mbps
Aux Port Speed And Duplex	1000 Mbps Full Duplex		Link Capacity Variant	Full	
MAC Address	00:04:56:58:07:d0		Link Capacity	126.73	Mbps
Remote Identification			Wireless Link Availability	100.0000	%
Remote Unit Name	B Slave		Data Bridging Availability	100.0000	%
Remote MAC Address			Transmit Modulation Mode	64QAM 0.92 (Single) (30 MHz)	
Remote Internet Address			Receive Modulation Mode	64QAM 0.92 (Single) (30 MHz)	
TDD Synchronization			Link Symmetry	Adaptive	
TDD Synchronization Interface	Disabled		Receive Modulation Mode Detail	Running At User-Configured Max Modulation Mode	
			Range	0.5	km
Status Page Refresh Period	3600	Seconds	<input type="button" value="Update Page Refresh Period"/> <input type="button" value="Reset form"/>		

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Link: A to B Site: Slave Unit: B Slave

Home Status



- Alarms
- » System
- » Installation
- » Management
- » Security
- Change Password
- Logout

System Status - Slave

Equipment			Wireless		
Attributes	Value	Units	Attributes	Value	Units
Link Name	A to B		Wireless Link Status	Up	
Unit Name	B Slave		Wireless Link Up Time	00:00:31	
Site Name	Slave		Wireless Encryption	None	
Software Version	50670-02-50		Maximum Transmit Power	27	dBm
Hardware Version	BOP01_01-I-FPS		Remote Maximum Transmit Power	27	dBm
Unit ESN	000456580887		Transmit Power	27.0, 25.8, -15.0,	24.0 dBm
Unit MSN	U9TF0046755H		Receive Power	-49.6, -75.2, -110.0,	-53.2 dBm
Regulatory Band	8 - 5.4 GHz - Other		Vector Error	7.2, -6.9, -29.8,	-28.3 dB
Elapsed Time Indicator	00:01:33		Link Loss	125.2, 45.4, 0.0,	123.2 dB
Ethernet / Internet			Transmit Data Rate	58.95, 21.10, 0.00,	58.95 Mbps
Main PSU Port Status	Copper Link Up		Receive Data Rate	76.93, 21.93, 0.00,	58.95 Mbps
Main PSU Port Speed And Duplex	1000 Mbps Full Duplex		Link Capacity Variant	Full	
Aux Port Status	Down		Link Capacity	126.73	Mbps
Aux Port Speed And Duplex			Wireless Link Availability	100.0000	%
MAC Address			Data Bridging Availability	100.0000	%
Remote Identification			Transmit Modulation Mode	64QAM 0.92 (Single) (30 MHz)	
Remote Unit Name	A Master		Receive Modulation Mode	64QAM 0.92 (Single) (30 MHz)	
Remote MAC Address			Link Symmetry	Adaptive	
Remote Internet Address			Receive Modulation Mode Detail	Running At User-Configured Max Modulation Mode	
			Range	0.5	km



THROUGHPUT TEST

Frame Length (Bytes)	Cfg Rate (L1 Mbps)	Measured Rate (Mbps)	Measured L1 (% of Line Rate)	Measured Rate (frms/sec)	Pause Detected
64	50.00	L1 50.02 L2 38.11 L3 27.39 L4 15.48	5.002	74430	No
128	50.00	L1 50.02 L2 43.26 L3 37.18 L4 30.42	5.002	42247	No
256	50.00	L1 50.02 L2 46.40 L3 43.13 L4 39.51	5.002	22652	No
512	50.00	L1 50.02 L2 48.14 L3 46.45 L4 44.57	5.002	11753	No
1024	50.00	L1 50.02 L2 49.06 L3 48.20 L4 47.24	5.002	5989	No
1280	50.00	L1 50.02 L2 49.25 L3 48.56 L4 47.79	5.002	4810	No
1518	50.00	L1 50.02 L2 49.37 L3 48.78 L4 48.13	5.002	4065	No

No Frame Loss at any Frame Length



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