Cambium Networks™

Cambium Networks and Oil/Gas Solutions

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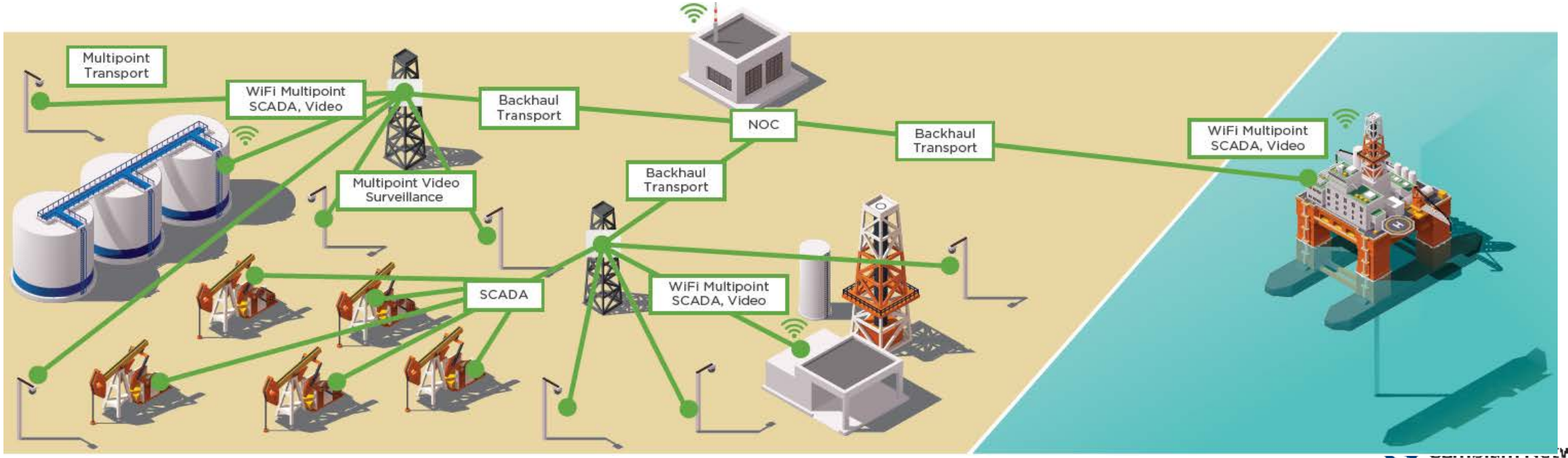
Oil/Gas/Petrochemical Applications

- SCADA Process Control/Monitoring
- Remote Access Control / Video Surveillance
- Leased Line Replacement
- Remote Office Connectivity
- Metering
- Physical Security
- Leak Detection – Pipeline
- Rapid Deployment for Drilling Applications
- IT/OT Convergence
- Analytics



IIoT (Industrial Internet of Things) and Cambium Networks

IIOT Applications

- SCADA data, controls and sensors
- Remote office access including wi-fi hotspots
- Video surveillance and security
- Leased Line Replacement
- Metering Infrastructure



Fixed Wireless Broadband

- Wide Geographic Area
- Multiple Points of Presence
- Need to move data confidently and confidentially across the network

- Electric Utilities
- Oil & Gas
- Rail
- Water Management
- Intelligent Transportation

Cambium Networks IIOT Portfolio

*cn*Maestro and LINKPlanner (Management/Planning)				
Licensed Microwave Backhaul	**Sub-6 GHz Backhaul**	**Aggregation, Access, Video Surveillance**	**Wi-Fi Access Hotspot**	**Narrow-Band Control and Monitoring**
PTP 820	PTP 650 PTP 450i	PMP 450i	*cn*Pilot E500	*cn*Reach N500
6 – 42 GHz	900 MHz, 3 GHz, 5 GHz	900 MHz, 3 GHz, 5 GHz	802.11ac	700 MHz, 900 MHz

- Extreme Capacity, Unparalleled Scalability
- Low-Cost, Low-Complexity, Low-Maintenance Infrastructure
- Scalable from small to region wide deployments
- Consistent throughput and low latency
- Rapid Deployment
- Supports Video, Data, Voice and Control Applications
- NLOS, nLOS and LOS performance

Well-Site Automation

Pumpjack

Yagi Antenna

RTU
(Remote Terminal Unit)

cnReach Radio Module

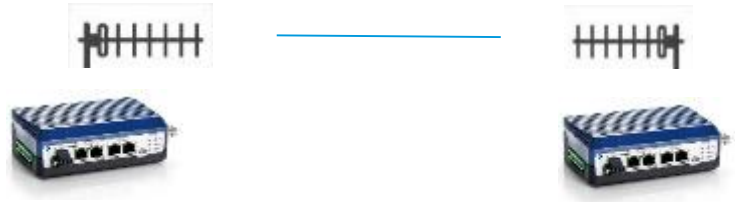
Private Network Solutions

	Private Networks	Public Networks	Carrier Networks
Examples	cnReach from Cambium Networks	LORA, Proprietary	3G/4G
Spectrum	Licensed and Unlicensed	Unlicensed	Licensed
Coverage	Tailored to Application	Opportunistic	Opportunistic
Availability	Suitable for Critical Infrastructure	Metering / Consumer	Metering / Consumer
Funding	CAPEX	Recurring OPEX	Recurring OPEX
Devices	Buy once	Subscription-based	Subscription-based
Capacity	Exclusively Dedicated	Shared Access	Shared Access
Security	Tailored to IT/IA requirements	One size fits all	One size fits all

*cn*Reach™ Narrow-Band Platform

Deployment Flexibility	PTP/PMP/Store-and-Forward Relay Optional Digital / Analog I/O Dual-band 900 MHz (MAS / ISM) Dual-radio options
Reliable	100% factory testing over temperature ATEX/HAZLOC Made in the U.S.A.
Low Power Consumption	Simple integration with existing power (including solar)
Scalable	Access Point Synchronization Adaptive Modulation
Secure	128/256-bit AES encryption
Manageable	Cloud or NOC-based cnMaestro LINKPlanner planning and BOM's

Deployment Topologies



Point to Point

Point to Multi-Point

Access Point (AP)

Store-and-Forward Repeater (Single Radio)

End Point (EP)

Back to Back Repeater (Dual-Radio)

End Point (EP)

End Point (EP)

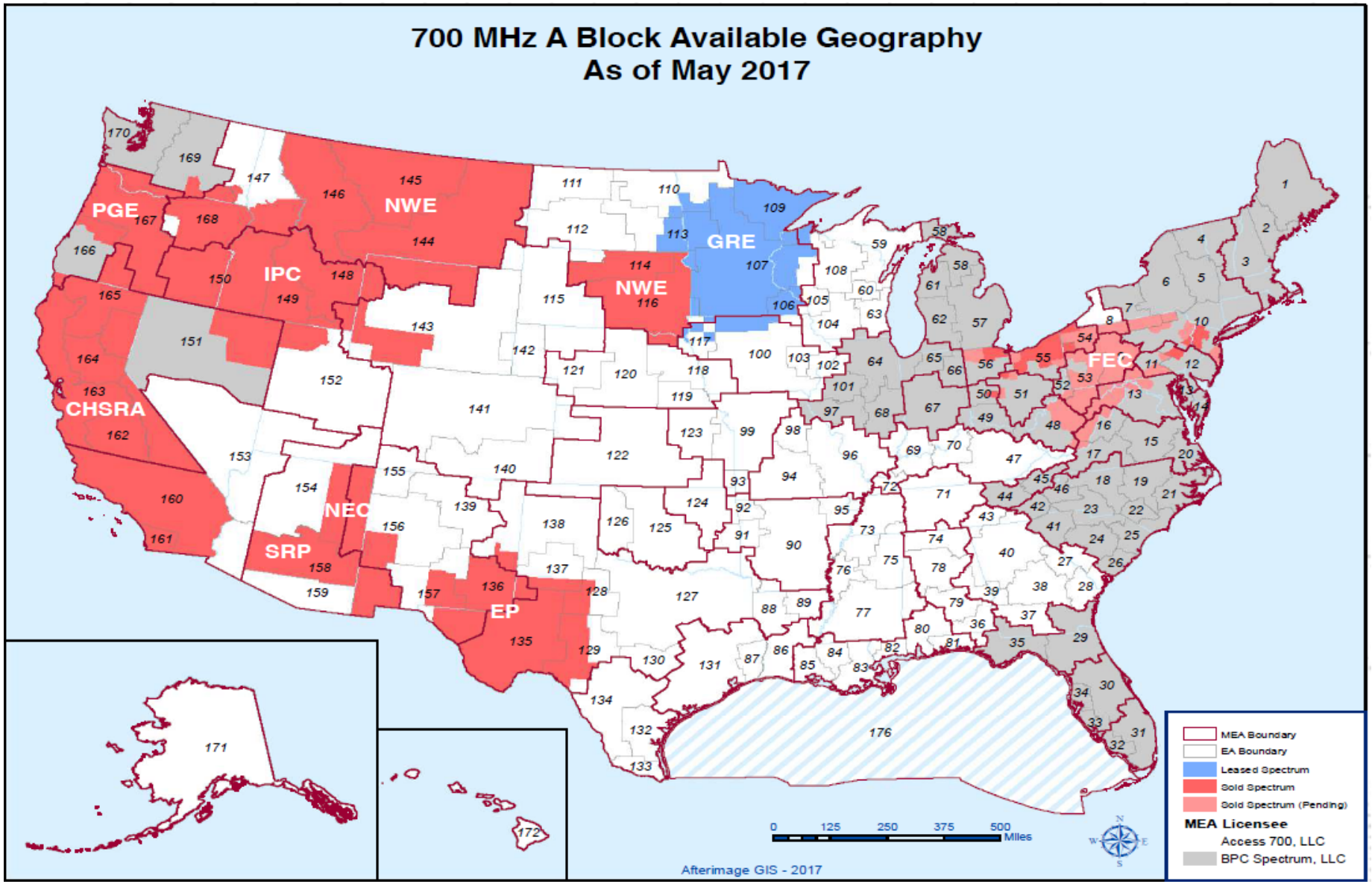
*cn*Reach™ 900 MHz Narrow-Band Radio

	MAS Licensed	ISM Unlicensed
Frequency	928 – 960 MHz	902 - 928 MHz
Power	10 mW to 3W	10 mW to 1W
Channel Sizes	12.5 / 25 / 50 kHz	76 / 154 / 207 / 310 / 600 / 900 / 1200 kHz
Capacity	10 kbps – 210 kbps	57 kbps – 4.4 Mbps
Modulations	Up to 32QAM	Up to 64QAM
Range	Up to 70 miles	
Encryption	128/256-bit AES	
I/O	2 x 10/100 Ethernet 2 x Serial Port Optional Digital/Analog I/O	

*cn*Reach™ 700 MHz Narrow-Band Radio

	Licensed
Frequency	757-758 MHz & 787-788 MHz
Power	100 mW to 10 W (20 dBm to 40 dBm)
Channel Sizes	12.5 / 25 / 50 / 100 / 200 / 250 kHz
Capacity	9.6 kbps to 1.0 Mbps
Modulations	Up to 32QAM
Range	Up to 70 miles
Encryption	128/256-bit AES
I/O	2 x 10/100 Ethernet 2 x Serial Port Optional Digital/Analog I/O

700 MHz Spectrum Availability Map



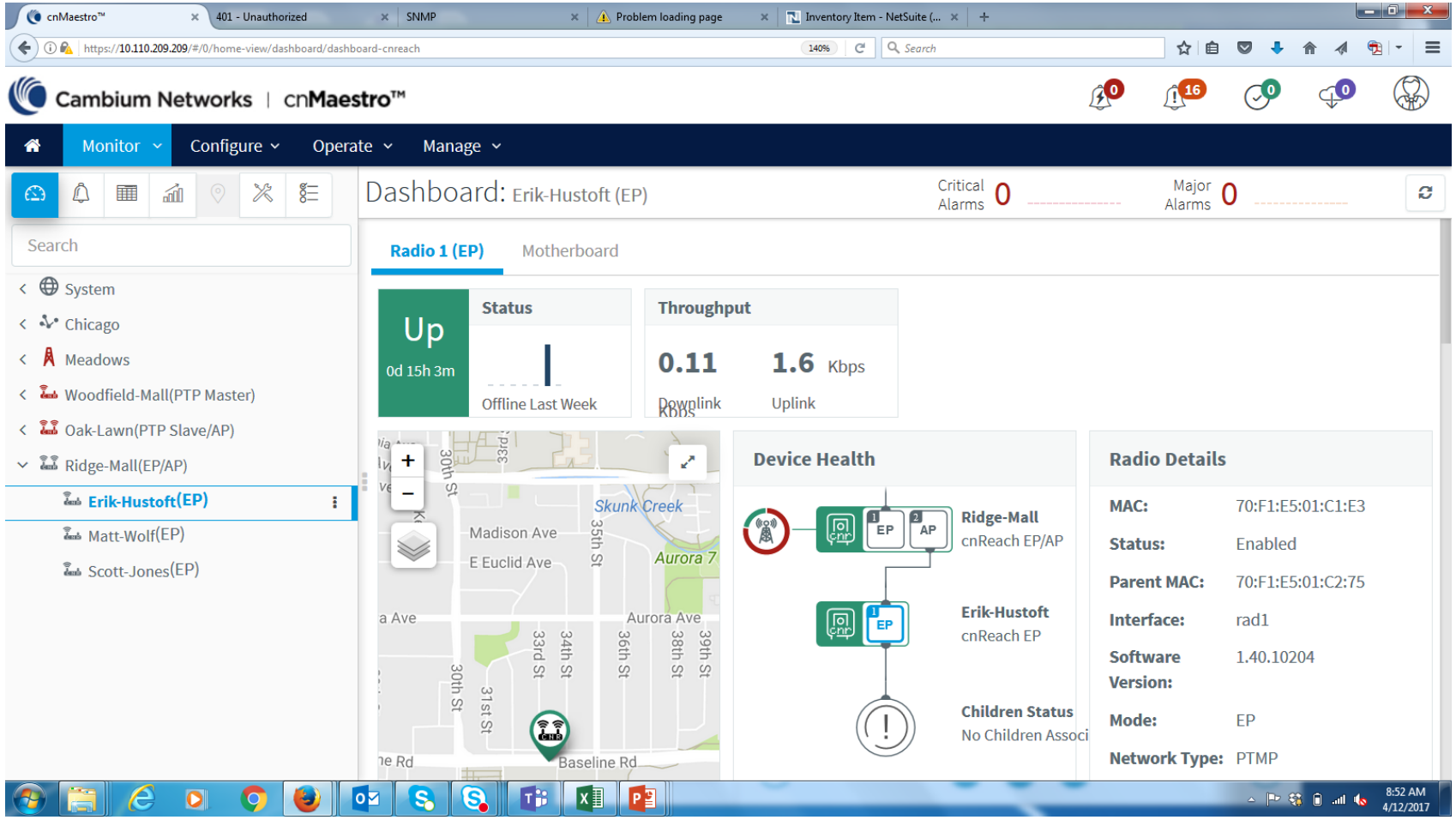
*cn*Reach™ 450 MHz Narrow-Band Radio

	Licensed
Frequency	406 – 430 MHz & 450 – 470 MHz
Power	50 mW to 8 W (17 dBm to 39 dBm) FCC 50 mW to 2 W (17 dBm to 33 dBm) ETSI
Channel Sizes	12.5 / 25 / 50 / 100 / 200 / 250 kHz
Capacity	10 kbps to 76 kbps FCC 9 – 102 kbps ETSI
Modulations	Up to 32QAM FCC Up to 64QAM ETSI
Range	70 miles
Encryption	128/256-bit AES
I/O	2 x 10/100 Ethernet 2 x Serial Port Optional Digital/Analog I/O

*cn*Reach™ I/O Expander

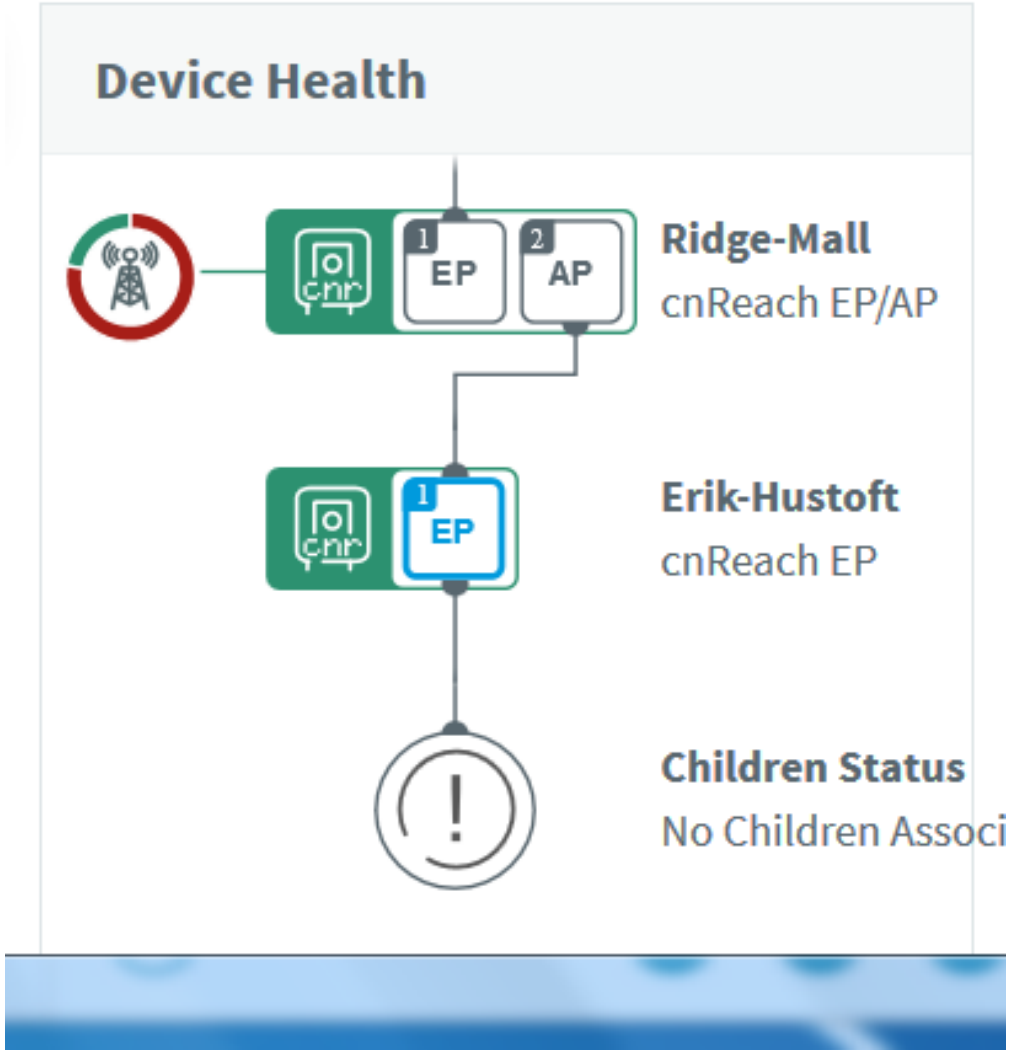
Application	No radio included. Used to add serial and/or I/O connectivity to a broadband SM or PTP radio via an Ethernet connection.
Power	10-32 VDC
I/O	2 x 10/100 Ethernet 2 x Serial Port Optional Digital/Analog I/O

cnMaestro – End-to-End Management



- Single Pane of Glass
- Map location of devices
- Auto-discover topology
- Push password updates
- Performance and Statistics tracking
- Alarms – Critical, Major & Minor
- Roadmap
  - Configuration management
  - Firmware upgrades

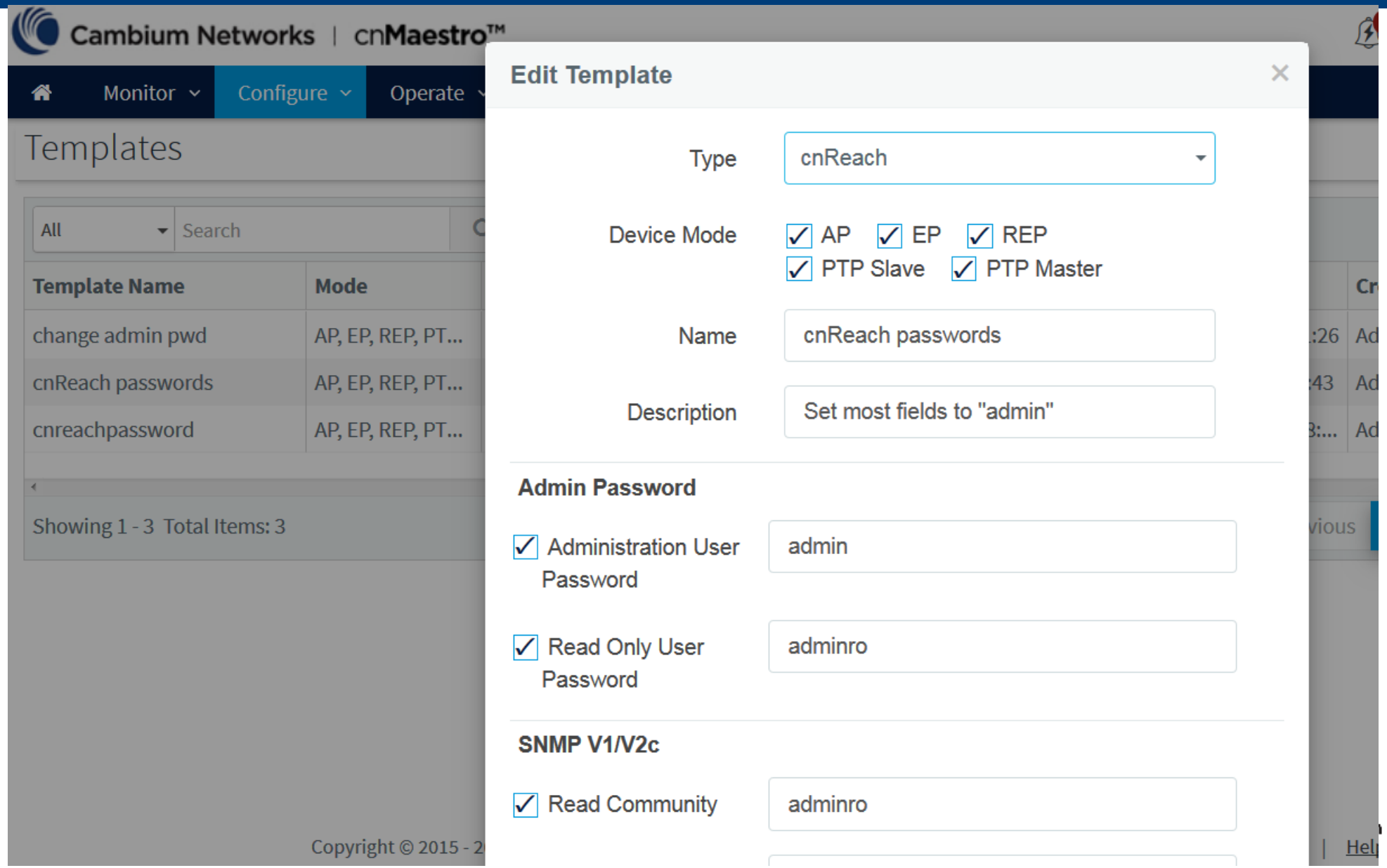
cnMaestro – Topology Discovery and Deep Dive Details



Radio Details

MAC:	70:F1:E5:01:C1:E3
Status:	Enabled
Parent MAC:	70:F1:E5:01:C2:75
Interface:	rad1
Software Version:	1.40.10204
Mode:	EP
Network Type:	PTMP

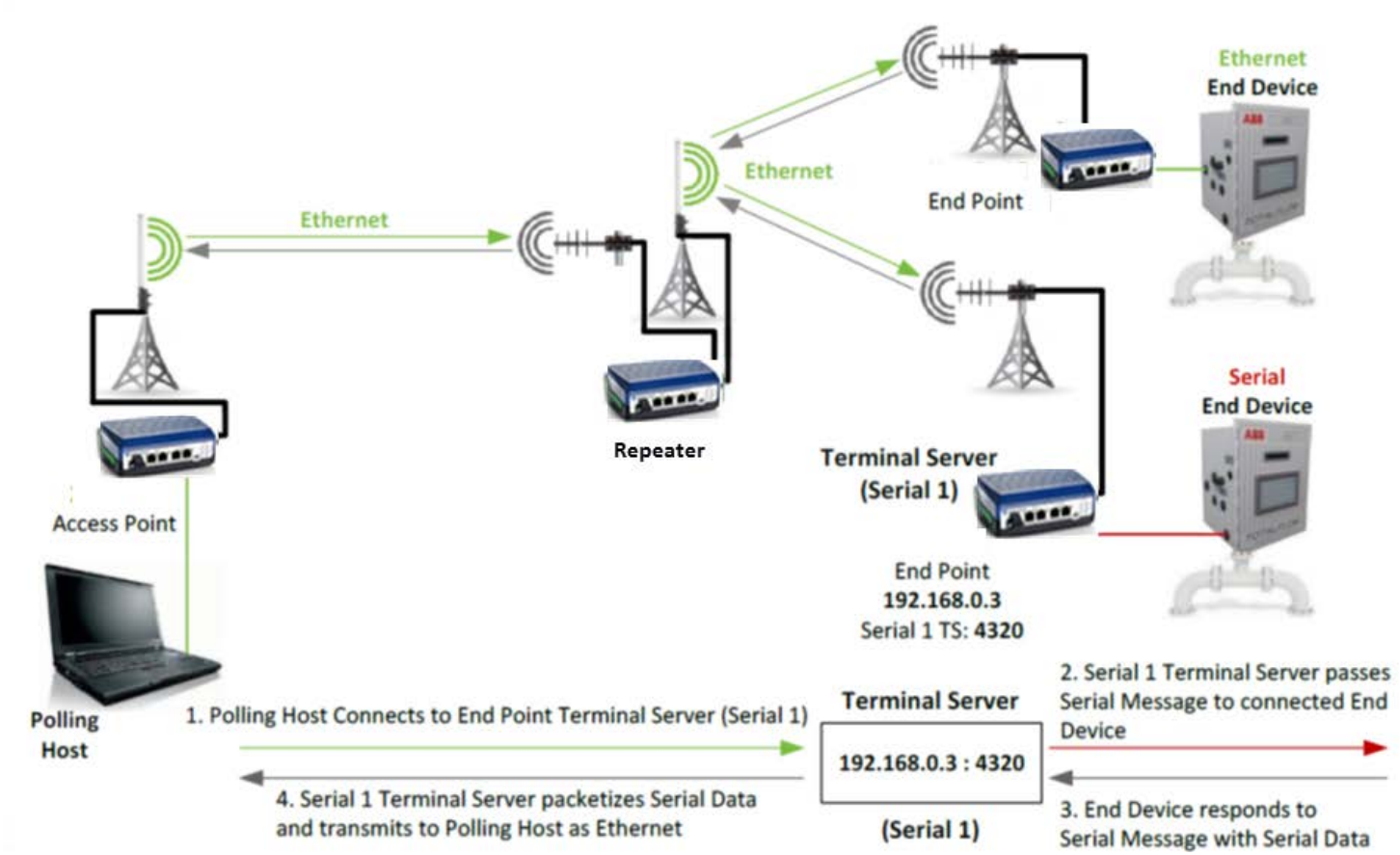
Setting cnReach Passwords in cnMaestro



Connectivity

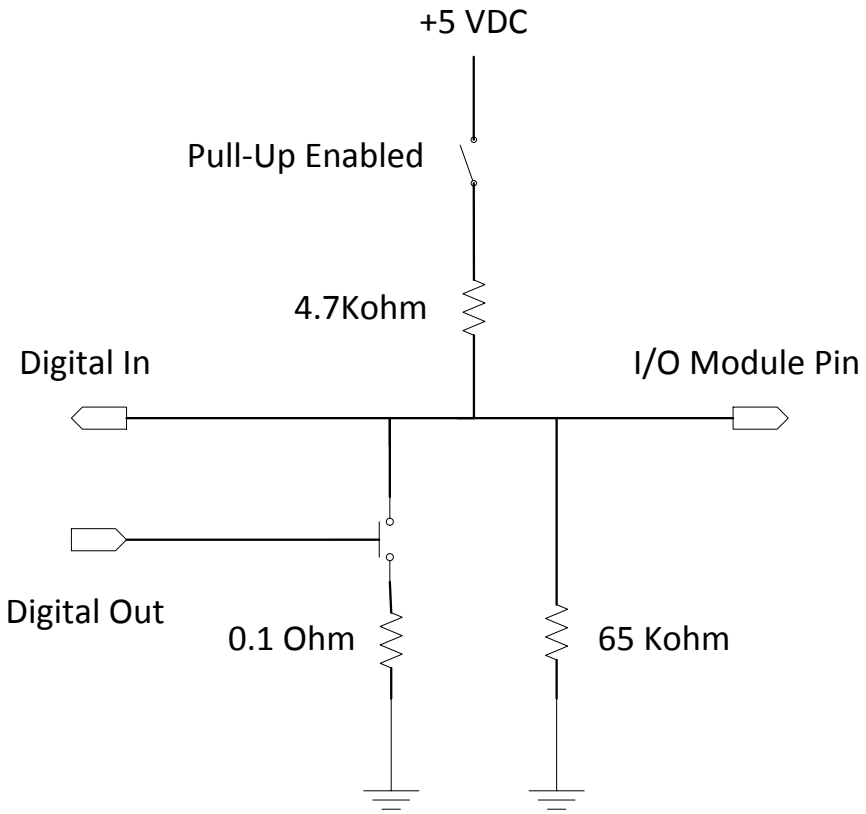
- RS-232 Serial ports with command line interfaces
- RS-422/485 Serial bus sensors
- SCADA control systems (DNP3, MODBUS RTU, MODBUS TCP protocols)
- Terminal Server/Client Interfaces
- Ethernet ports for TCP/IP comms
- Analog input signals
- Digital I/O signals

Serial Service (Terminal Server)

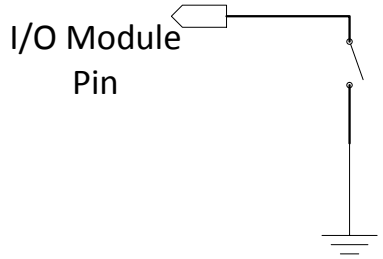


- Allows Serial and Ethernet radios to talk to the same AP
- Migrate old serial multipoint on new Ethernet RF network
  - Single serial port or terminal server at AP
  - Serial data is delivered to any participating seamless remote
  - Remote data is brought back to AP serial port or terminal server
- Example – Production and Midstream
  - Each with own unsynchronized, overlapping RF network
  - Multiple polling hosts (2+), multiple serial radio networks
  - Combined into a single RF network, and adds Ethernet

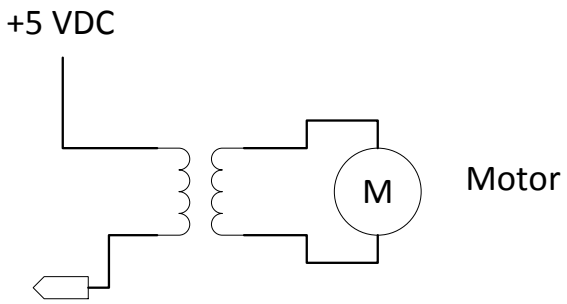
Digital I/O Representative Schematic and Examples



Example: Digital In

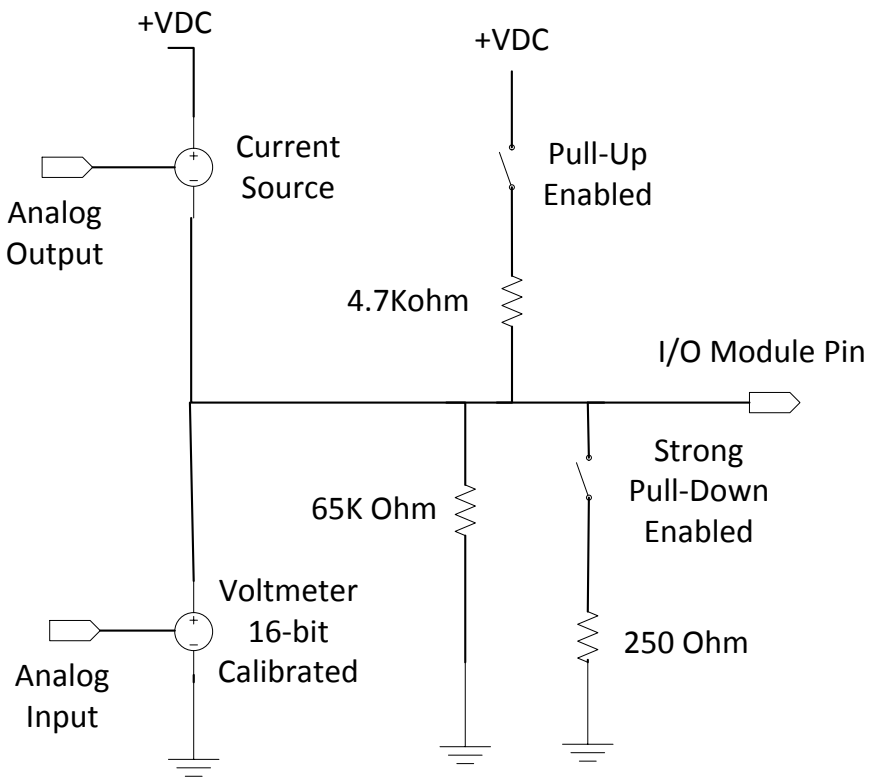


Example: Digital Out

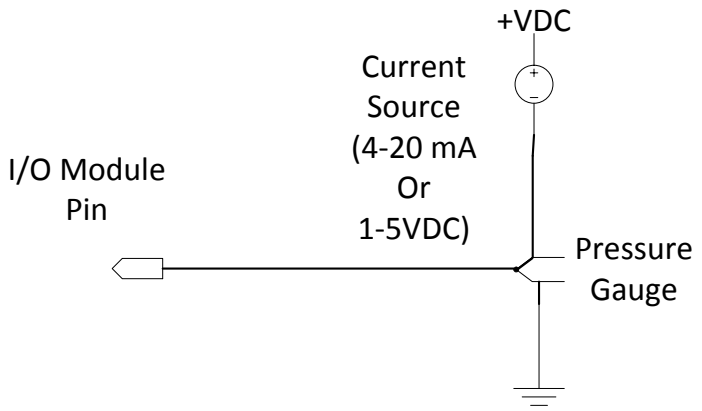


- Sense switch closing/openings with Digital Inputs
- Drive motor contacts or actuators with Digital Outputs
- Count low-frequency or high-frequency occurrences with Digital Inputs
- Pull-up resistor used to keep DO either normally ‘low’ or normally ‘high’
- Digital In can sink maximum 2A

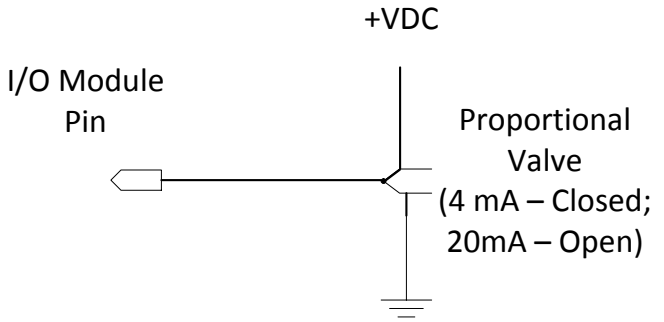
Analog I/O Representative Schematic and Examples



Example: Analog In



Example: Analog Out



- Measure pressures and levels with Analog inputs
- Drive variable valves or pump rates with Analog outputs
- Measurements use 16-bit A/D circuitry

Physical Interfaces

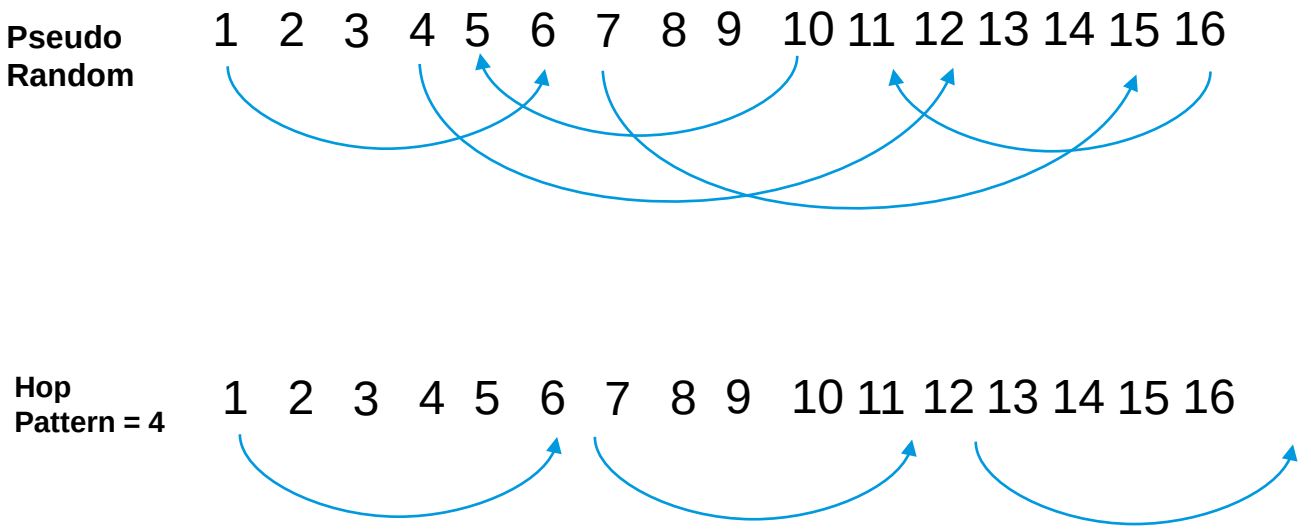
- 2 x 10/100 Ethernet
- 2 x Serial Interfaces
  - RS-232/-422/-485
- 1 or 2 Radios
- Optional 8-ports Analog/Digital I/O

Licensed Band vs. Unlicensed Band

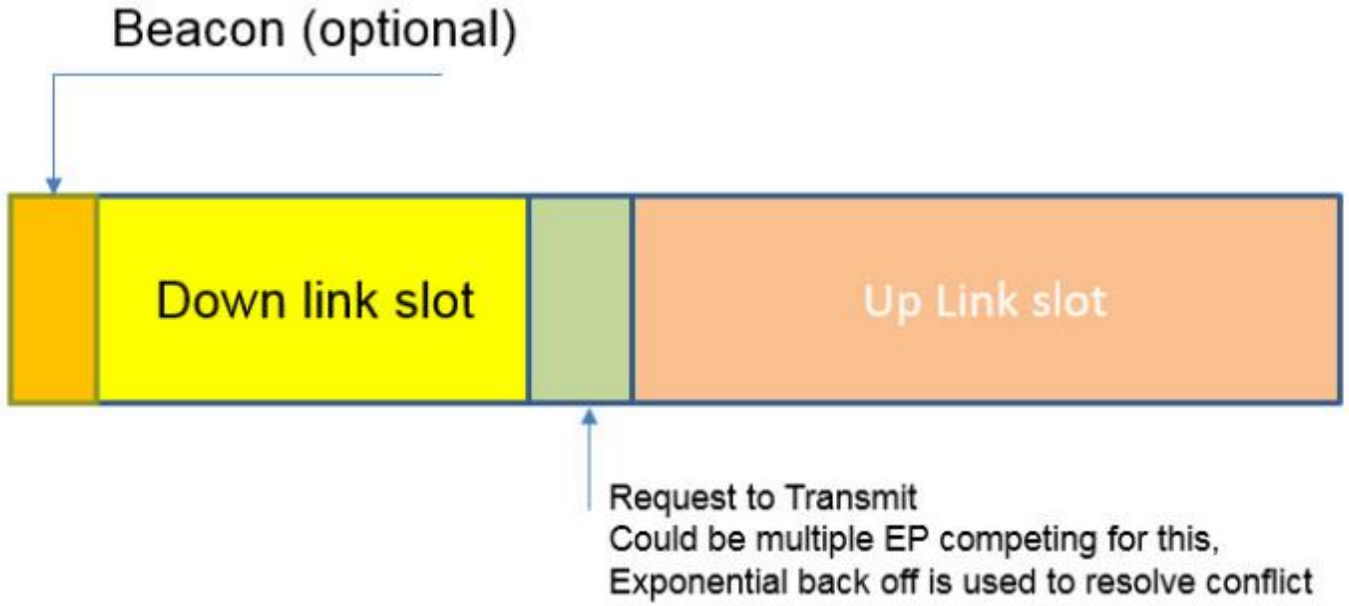
	Unlicensed	Licensed
Frequency Hopping	Yes	No
Channel Size	variable	Fixed per licensed
Multi-rate support	Yes	Yes
AP/EP Tx frequency	Same Frequency	Different Frequency (licensed)
AP and EP Transmit at the same time	No	No

Frequency Hopping – Hop Pattern

- Frequency Hopping is only used in unlicensed band
- Hop Pattern = 0 means no hopping
- Hop Pattern = 1 means pseudo-random hop pattern
  - Pseudo-Random is a fixed hop pattern, meaning it looks like it is random, but it is NOT
- Hop Pattern = 1 means skip one channel, 2 means skip 2 channels etc.

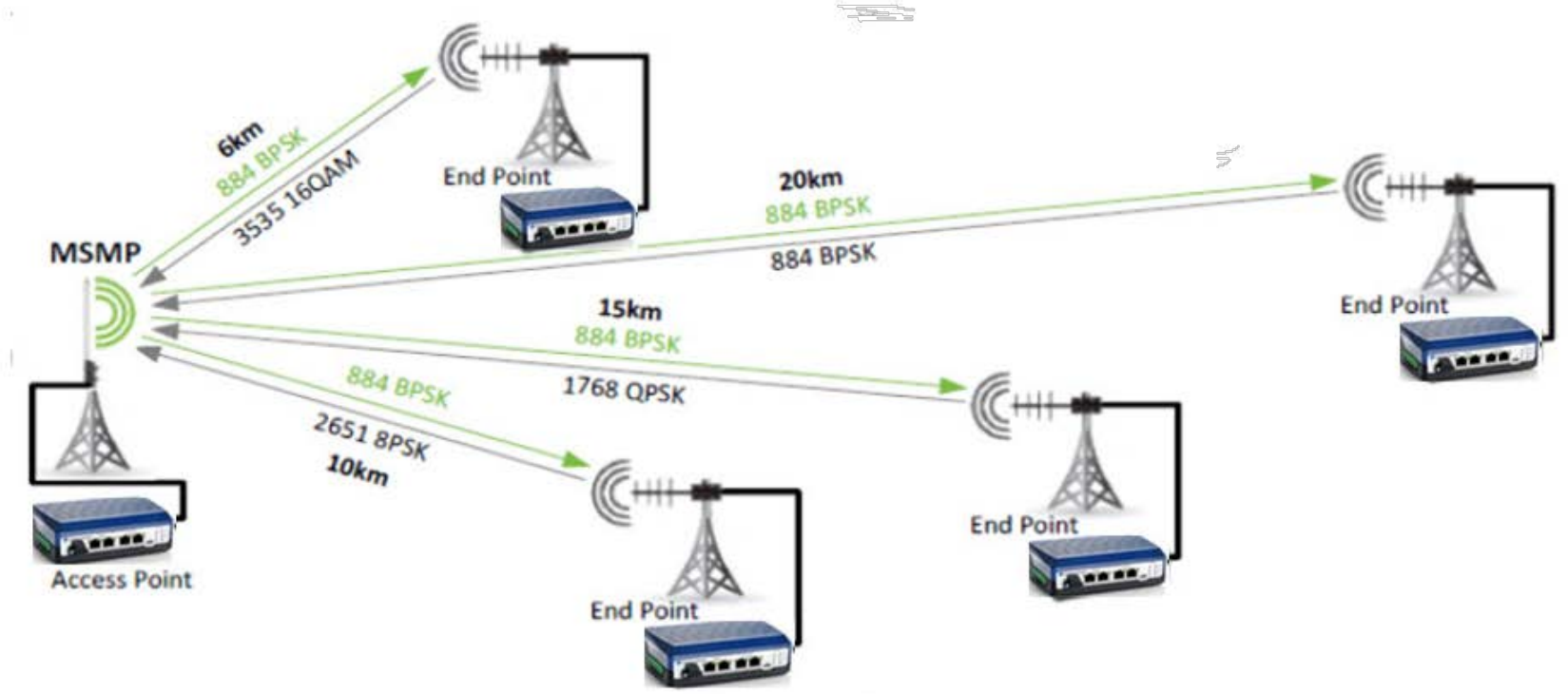


cnReach MAC and Air Interface



1. TDD MAC
2. Scheduled unicast or broadcast downlink transmissions based on queue
3. EP uplink requests are made in a contention slot and then scheduled by the AP
4. Optionally, each transmission can result in repeats if an ACK is not received
5. Frame duration is dictated by payload bytes and max modulation

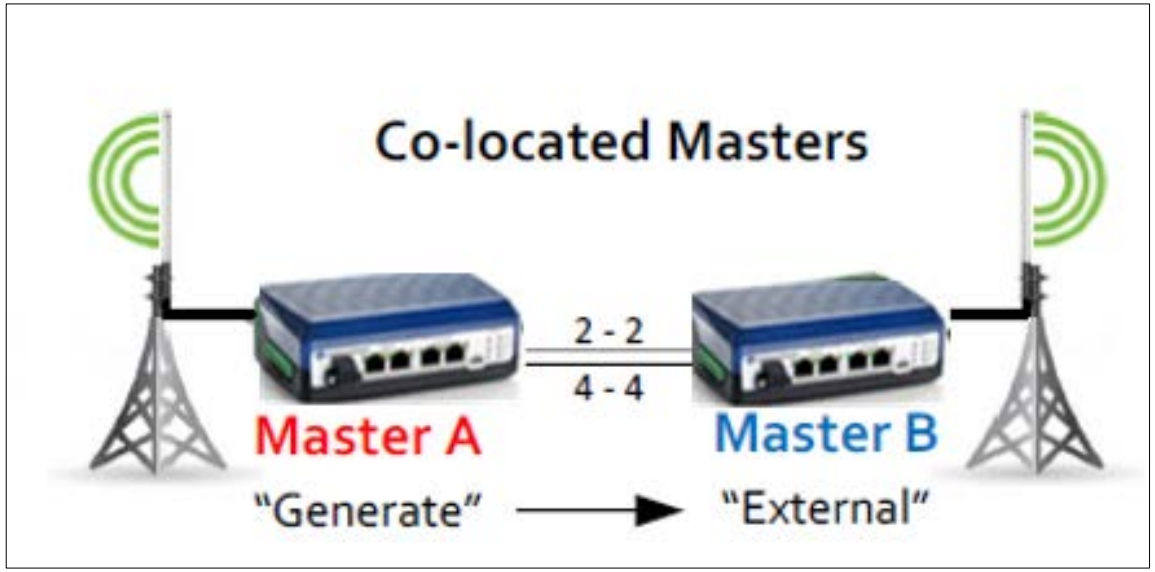
Adaptive Modulation – Higher Spectral Efficiency



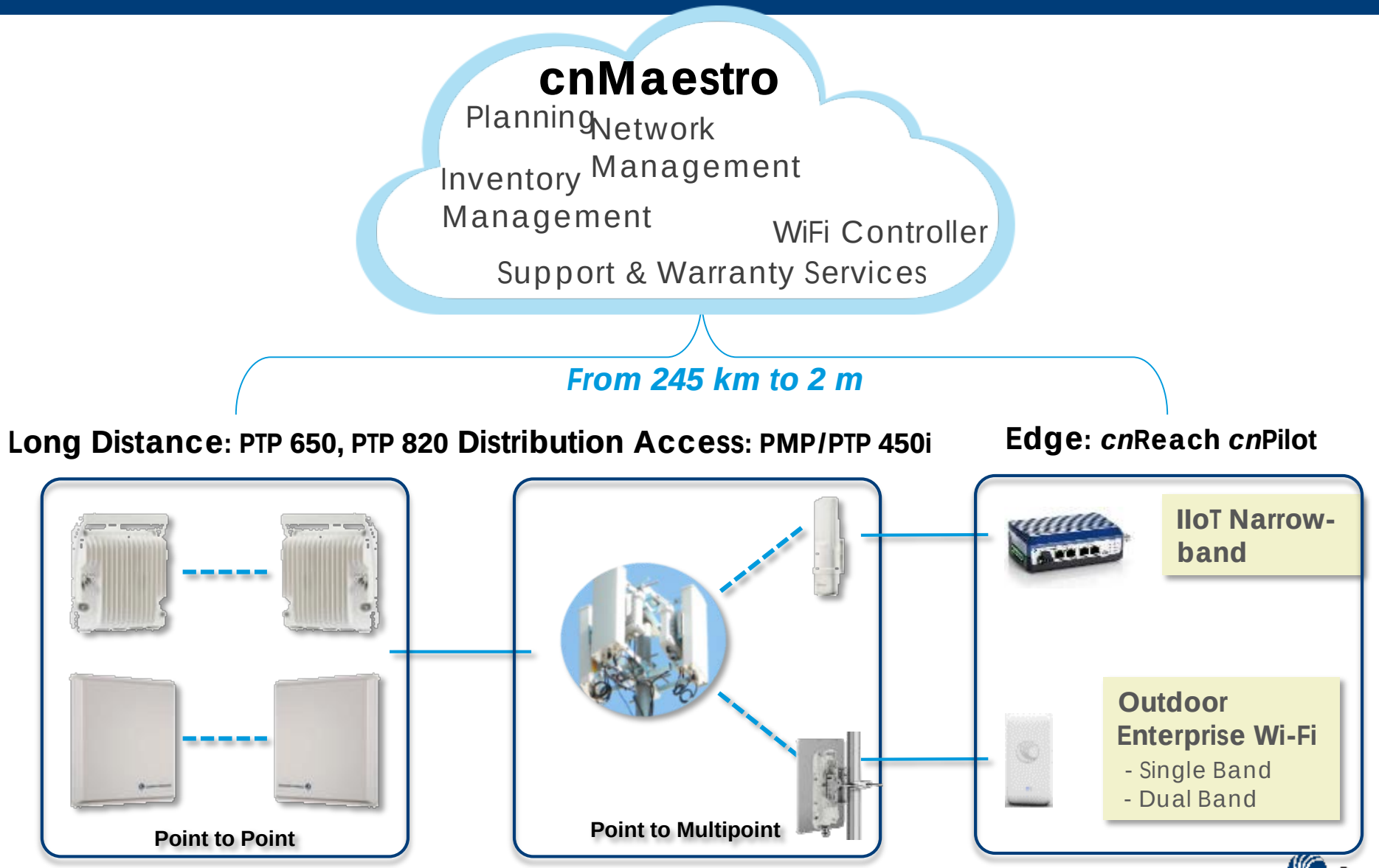
- Each EP sends upstream data at optimal modulation or speed
- Access Point to End Point direction must always be the same modulation and one achievable by the farthest EP in the sector
- End Point->Access Point: can vary with network conditions and the distance or RSSI
- For PTP, both Access Point and End Point can send with at optimal modulation

Access Point / Master Synchronization – Avoid Self Interference

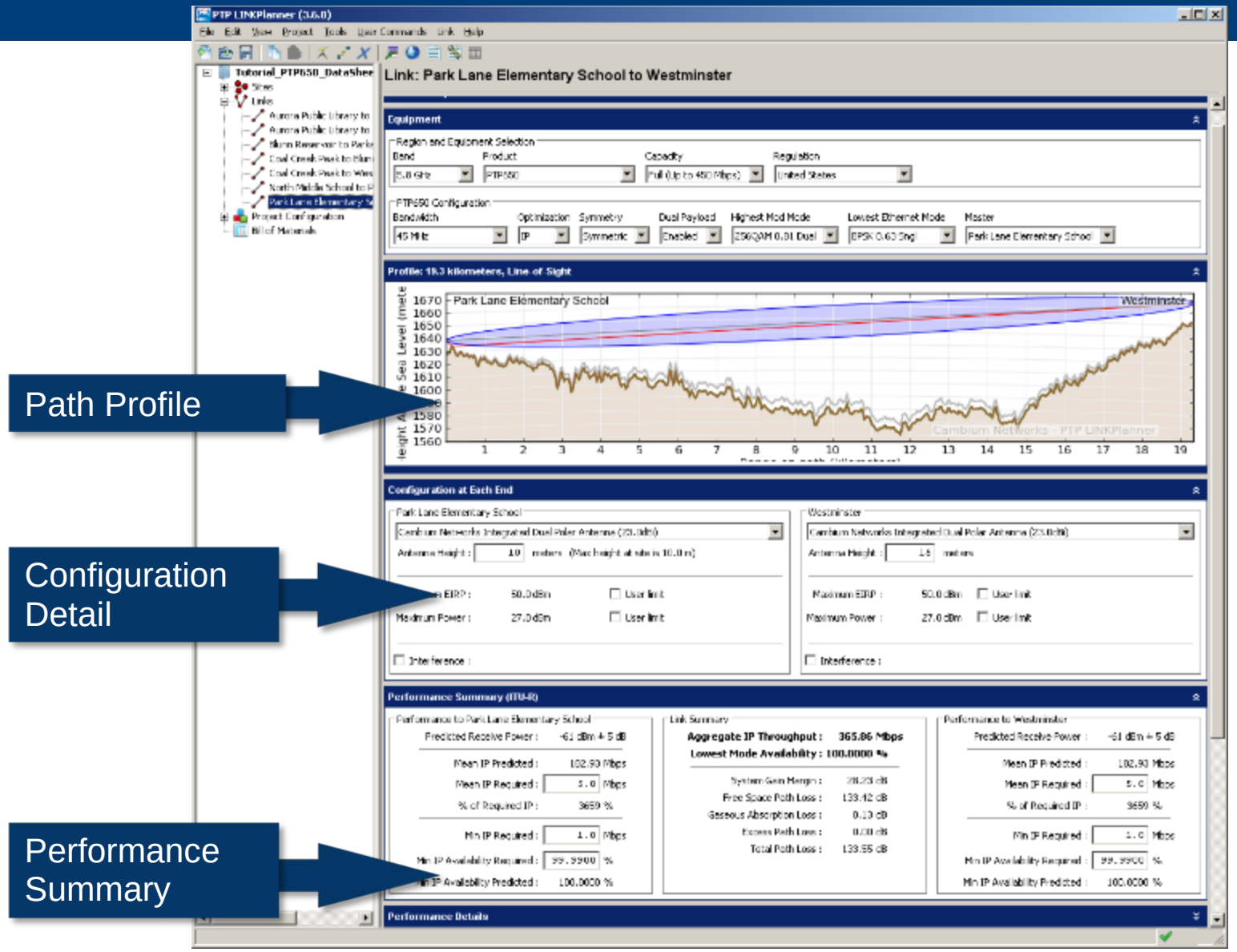
- Radios are synchronized to transmit and receive at the same time.
- For 900 MHz ISM band, radios also use a ‘hop offset’ to avoid the same channel in the same transmission.
- Used single radio products and dual radio modules.
- Synchronization can be ‘self-generated’ or from an external 1 Pulse Per Second (PPS) input signal. (e.g.. Cambium Networks uGPS)



Complete Network Lifecycle Management



LINKPlanner – Planning Made Easy



Cambium Support Capabilities

- Global Sales Team
  - Regional Sales Managers
  - Regional Technical Managers
  - Inside Sales
- Global Channel and Distribution network

- Support
  - Call Center (Voice/E-mail)
  - Tier 3 Engineering Support
  - Community Forum
- Training
  - Weekly webinar series
  - Certified System Engineering Program
- Warranty
  - Standard and Extended Warranty Options

A Cambium Networks Program
ConnectedPartner

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- Business Issues

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