Delivering 1Gbps+ Backhaul with Cambium Networks PTP 820C

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Overview

Wireless Internet Service Providers (WiSPs) are finding it increasingly challenging to cope with the demand for more capacity; and the strain it places on their backhaul networks. WiSPs are seeking solutions that allow them to increase their network capacity quickly, that is highly scalable, that can integrate with existing infrastructure, robust enough to sustain certain levels of failure and continue to provide services; and that can be easily deployed and managed. The introduction of PTP 820C product line fills exactly to these WiSPs' needs.

This paper walk through a real life WiSP use case and explains how a configuration of PTP 820C is implemented to fulfill this WiSP's need.

WISP Customer Backhaul Architecture and Requirements

NETWORK LAYOUT

Figure 1: Case Study's Microwave Backhaul Network Diagram
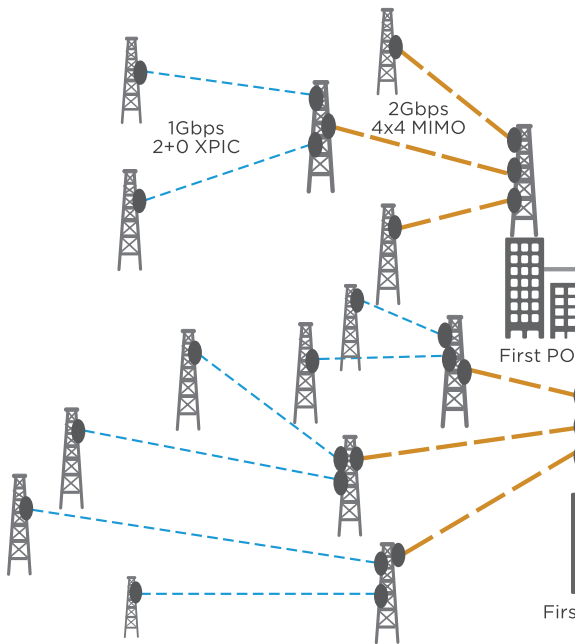
The following is a simplified backhaul network layout for WiSPs.

The wide area network is formed by remote high capacity sites that typically requires up to 1.0Gbps of link capacity and ~2.0Gbps link capacity at the aggregation layer. Redundant microwave paths, using Spanning Tree to prevent network looping, are designed to provide higher network availability.

REQUIREMENTS

Link Capacity. The WiSP used 10Gbps fiber at the network core. They want to use high capacity microwave from the Fiber POP to the first tower. Up to 2Gbps of capacity is expected to maximize fiber capacity utilization. Branching from the first tower, multiple high capacity remote connections are expected with a capacity requirement of ~1Gbps

Compatibility with Existing Infrastructure. The WiSP uses Cisco switches to perform networking functions and is planning on using propriety network controllers to allow for special processing of video traffic. This requires the PTP links to be completely transparent to all payload traffic. Network control traffic such as LACP, UDLD, CDP, STP, LLDP, etc. should be transmitted over the wireless link unaltered. In addition, jumbo frames, Q-in-Q traffic should pass the link without issue.

High Spectral Efficiency. Microwave licenses and tower resources for this WiSP are very expensive so spectral efficiency is a key to the success of the business.

Scalable. The WiSP needs to be able to support a large number of users and be able to expand further on a per site basis; which translates to supporting at least 150,000 simultaneous MAC addresses.

Network Robustness. The WiSP requires the link to continue operating, albeit in a diminished capacity, in the event of partial network component failure. Likewise, such a failure should not cause spanning tree re-convergence.

Radio Configuration. The WiSP wants to be able to configure a large number of radios without as little effort as possible and minimize the opportunity for human error.

The Cambium PTP 820 Solution

Link Capacity. PTP 820C is capable of delivering up to 2.4Gbps layer 2 capacity per link. A 4x4 MIMO configuration is used at the aggregation layer to provide ~1.8Gbps layer2 link capacity; and a 2+0 XPIC configuration is used at the high capacity remote link. In addition, the WiSP used Cisco switches with LACP link aggregation for aggregating the link capacity. Bench test with the WiSP was able to prove the following capacity for PTP 820C:

1. 80MHz channel size, 2+0 XPIC, using 1024QAM modulation, aggregate Layer 2 throughput was greater than 1.2Gbps full duplex with a FPS (Frames Per Second) value of 3,571,524 without packet loss.

Figure 2: 2+0XPIC
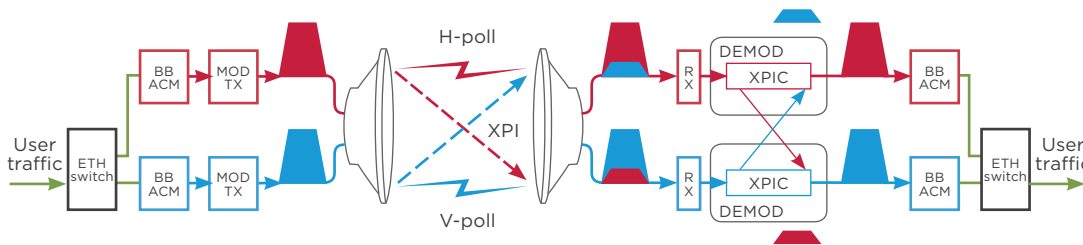
In XPIC technology, two channels are using the same frequency but different polarization. The XPIC mechanism utilizes the received signals from the V and H modems to extract the V and H signals and cancel the cross polarization interference due to physical signal leakage between V and H polarizations.

The H+v signal is the combination of the desired signal H (horizontal) and the interfering signal V (in lower case, to denote that it is the interfering signal). The same happens with the vertical (V) signal reception= V+h. The XPIC mechanism uses the received signals from both feeds and, manipulates them to produce the desired data

2. At 56MHz channel size, 4x4MIMO configuration, using 1024QAM modulation, the link delivered greater than 1.78Gbps layer 2 network capacity. Note that the link can support up to 2.4Gbps capacity if a 4x4 MIMO configuration is used with 80MHz channels; which is scheduled for a forthcoming firmware release.

Figure 3: 4x4 MIMO Link
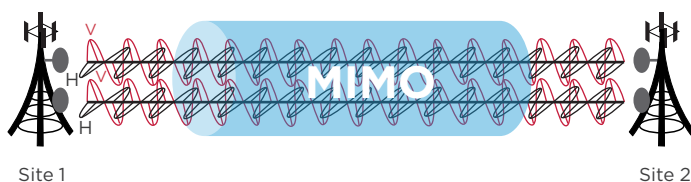
In LOS 4x4MIMO technology, the original data is split into 4 bit streams at each site. There would be two antennas at each site, and each antenna carries signal in two polarization (XPIC). MIMO is achieved via antenna separation. The receiver is able to distinguish between the streams due to a phase difference caused by the antenna separation.

Figure 4: 4x4 MIMO Site

Compatibility with Existing Infrastructure. While supporting a rich Metro Ethernet feature set that enables E-Line and E-LAN services, PTP 820C also supports a transparent Ethernet bridge configuration which allows the PTP 820C link to act as an Ethernet bridge and allow the 3rd party switches to handle complex networking operations. Transparent PIPE configuration was used for this WiSP solution. The WiSP was happy to find that network control traffic such as LACP, UDLD, CDP, VPT, LLDP, etc. were transparently passed through the wireless link. Moreover, VLAN and Q-in-Q traffic, as well as Jumbo frame of up to 9612 bytes are also passed transparently.

High Spectral Efficiency. Using 4x4 MIMO technology, with only a single 56MHz channel at 1024QAM modulation mode, the radio link is able to provide a layer2 capacity of 1.78Gbps (~32bps/hz). If Header-deduplication feature is enabled, the same amount of radio resource can deliver greater than 2Gbps capacity.

Scalable. When the PTP 820 link is configured to be a transparent pipe, it can support an unlimited number of simultaneous MAC addresses, because MAC address learning of an Ethernet bridge is not required. On a bench testing using IXIA testing tool, the WiSP was very pleased to witness PTP 820C handling 150,000MAC addresses over a six (6)second period (controlled by the testing tool).

4x4 MIMO with Cisco LACP
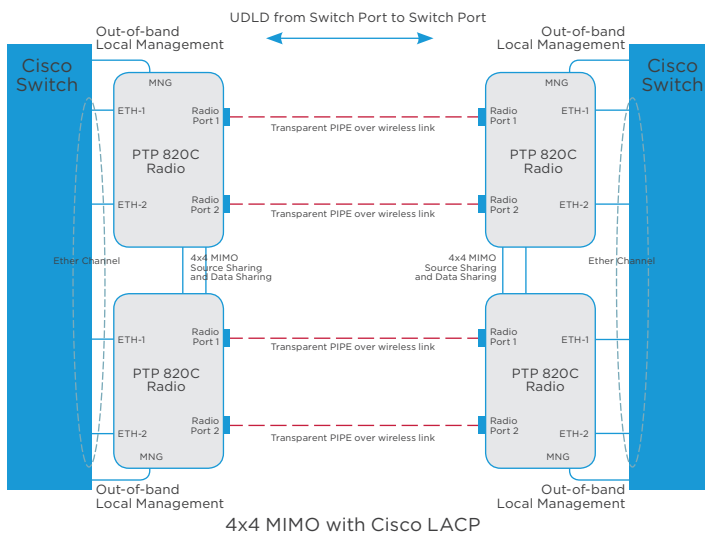
Network Robustness. The WiSP chose to use Cisco LACP protocol to aggregate the link capacity over the PTP 820 link. By using UDLD protocol on the Cisco switch, by fine tuning the UDLD message interval, radio link failure will be detected promptly to trigger Cisco switch port blocking and prevent LACP load sharing traffic to the impaired link and also prevent Cisco disabling the whole Ether channel and triggering Spanning Tree re-convergence. This solution allows the 4x4MIMO and 2+0 XPIC link to continue to transport traffic even when partial of the link setup fails. For example, in a 4x4MIMO scenario, half of the link failed, e.g. connectivity between one of the two pairs of the 4x4MIMO radios is lost due to sharp fading or hardware failure, the 4x4MIMO link can continue to provide up to 50% of the designed capacity, rather than completely stops passing traffic.

In addition to the robustness in networking solution, the link was put on bench test for the WiSP with full capacity load for over 24 hours load testing. No packet loss were found during the test and this further prove the reliability of the product.

Easy of radio configuration PTP 820 supports command line (CLI) configuration for most of the parameters. This allows the operator to write scripts to configure the radios in batch command lines. The CLI feature is highly desired especially b large service providers when

the needs to commission a big number of the links. By creating a configuration template script, the WiSP can modify a few parameters for each particular link. This makes commissioning the links very efficient and also reduce human error.

Summary

In summary, the PTP 820C, with its high capacity, spectral efficiency and flexibility, provides an ideal solution for WiSPs in need of expand their backhaul capacity economically.

About Cambium Networks

Cambium Networks provides world-class wireless broadband access and microwave solutions for Service Providers, enterprise customers, military, government, and municipal networks around the world.

It currently has more than 4 million modules deployed in thousands of networks in over 150 countries.

Our innovative technologies provide reliable, secure, cost-effective connectivity that's easy to deploy and proven to deliver outstanding metrics. Cambium's ecosystem of partners, development engineers, and support teams work together to design and deliver innovative, forward-looking solutions that provide data, voice and video connectivity when and where it's needed.

Glossary

LACP	Link Aggregation Control Protocol
UDLD	Unidirectional Link Detection
MIMO	Multi-in-Multi-out
XPIC	Cross-Polarization Interference Cancellation
CDP	Cisco Discovery Protocol
VTP	VLAN Transport Protocol
WiSP	Wireless Internet Service Provider
STP	Spanning Tree Protocol
POP	Point of Presence
LLDP	Link Layer Discovery Protocol

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