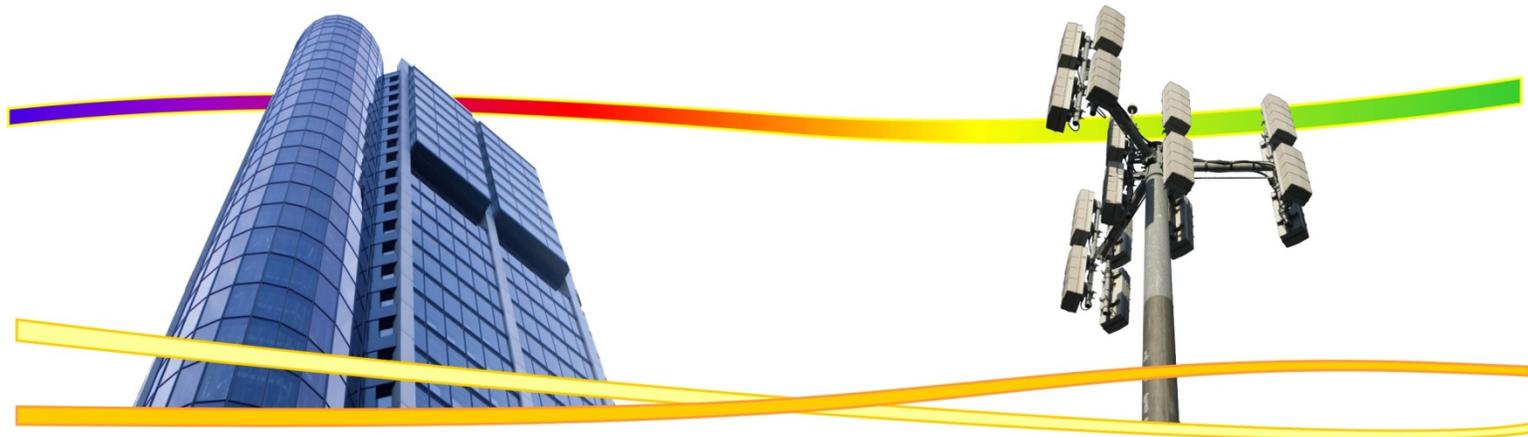


CENTRALIZED RAN FRONTHAUL



Deploying CPRI Fronthaul with CWDM

Migrating to Centralized RAN Fronthaul

Escalating bandwidth demand in the mobile network due to the proliferation of smart devices is driving upgrades to the Radio Access Network (RAN). The cost to build, operate and upgrade the RAN is increasing, while the revenue is not growing at the same rate.

Power and equipment space are expensive resources at cell sites, so Mobile Network Operators (MNOs) are looking to reduce these ongoing expenditures and maximize Return on Investment by enabling more dynamic use of network resources. To reduce infrastructure costs, MNOs are migrating from expensive, high-power base stations to the Heterogeneous Network (HetNet) that includes Femto cells, Pico cells, Metro cells, Distributed Antenna Systems (DAS) and Centralized Radio Access Networks.

The traditional cellular network architecture is illustrated in Figure 1. Base Station Controllers (BSC), or Radio Network Controllers (RNC) are located on a RAN fiber ring. The access links connect to Base Station Transceivers (BTS)/nodeB at the cell tower via fiber, microwave or bonded copper. The BTS is connected to the antenna with coax cabling.

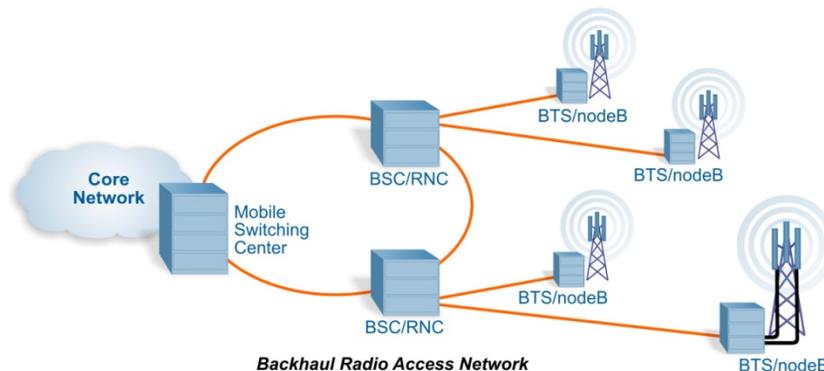


Figure 1: Traditional Mobile Backhaul RAN Architecture

In the Centralized RAN architecture shown in Figure 2, Base Band Processing Units (BBU) are deployed at a consolidated location like a Central Office or BBU hotel. The BBUs are connected to the Remote Radio Head (RRH) at the cell towers with fiber, and this link is commonly referred to as fronthaul. The fronthaul from the BBU Hotel to the RRH uses a Digital Radio over Fiber (D-RoF) protocol such as Common Public Radio Interface (CPRI) or Open Base Station Architecture Initiative (OBSAI). The RRH is collocated with the antenna at the top of the cell tower.

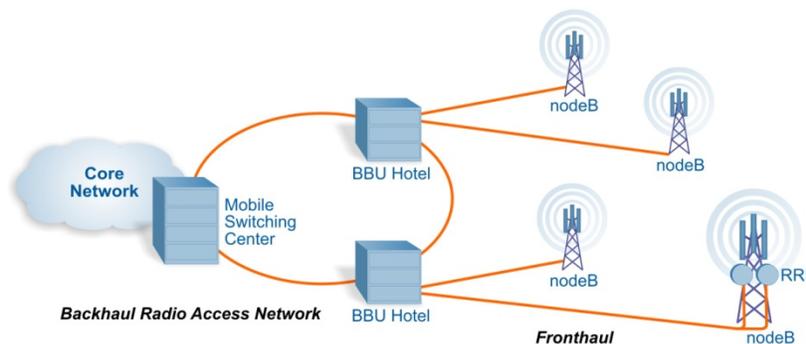


Figure 2: Centralized RAN Architecture with Fronthaul

Consolidating equipment at a BBU Hotel or Central Office lowers deployment costs and operational expenses by reducing the power requirements and the space constraints at the cell site. The collocated BBUs also simplify the X2 interface and improve the performance with no transmission delay among the BBUs.

Expanding CPRI Fronthaul Fiber Capacity with CWDM

Migrating to a Centralized RAN architecture enables operational efficiencies and reduces costs. The challenge for Mobile Network Operators is transporting multiple CPRI or OBSAI channels for different wireless carriers and services (3G and 4G/LTE) to multiple cell towers over the fronthaul fiber links. The RAN and the fronthaul networks may be owned by a Mobile Network Operator, but they typically lease fiber or purchase services from an Access Operator for fronthaul access to cell towers.

The application in Figure 3 illustrates how to transport 3G and LTE services over CPRI channels to two different cell towers using Coarse Wavelength Division Multiplexing (CWDM). Omnitron's iConverter CWDM/X Multiplexers and xFF Transponders enable four CWDM data channels over a fiber fronthaul link from a BBU to four RRH to antennae located at two different cell towers.

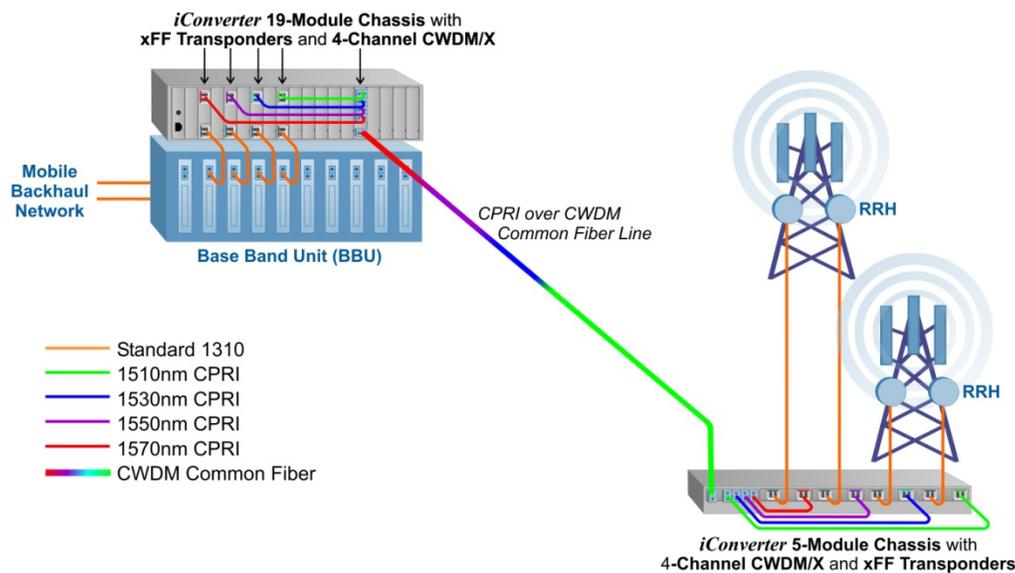


Figure 3: CPRI Fronthaul with Multiple Services to Cell Towers

At the top of the diagram, the BBU is located at a BBU hotel or at a Central Office location. The fiber ports on line cards in the BBU support standard 1310 wavelengths. At the BBU Hotel and RRH demarcation points the standard wavelengths, or gray optics, from the Mobile Network Operator's equipment is connected to the Access Operator's CWDM equipment with transponders.

Fiber patch cables connect the BBU line cards to iConverter xFF transponders installed in a high-density 19-Module Chassis with redundant power supplies. The four xFF transponders convert the standard wavelengths to CWDM wavelengths (channels) with SFP transceivers. Standard wavelength SFPs and CWDM wavelength SFPs are installed in each of the xFF transponders. The CWDM SFPs support specific wavelengths to enable connectivity to the matching channel ports on the iConverter CWDM/X four-channel multiplexer with fiber patch cables (shown in different colors to represent the CWDM wavelengths). Omnitron's CWDM transceivers have color-coded latch handles for easy identification.

The CWDM/X multiplexes the wavelengths that transport the four CPRI channels over the CWDM Common Fiber Line (fronthaul). Note that up to 16 CWDM wavelengths can be transported over the Common Fiber Line using two iConverter 8 Channel Muxes and a Band Splitter, deployed with 16 transponders in just 1½ RU of rack space.

At the other end of the Common Fiber Line, another iConverter CWDM/X four-channel multiplexer and four xFF Transponders are installed in a 5-Module Chassis with redundant power supplies. Four fiber patch cables connect the channel ports on the iConverter CWDM/X multiplexer to iConverter xFF Transponders that convert the fiber with CWDM wavelengths back to standard 1310 wavelengths. The standard wavelength fiber connects to the Remote Radio Heads on the two cell towers.

The application in Figure 4 illustrates how to daisy chain four CPRI channels over fiber fronthaul links to two different cell towers using CWDM. Omnitron's iConverter CWDM/X Multiplexers, CWDM/AD Add+Drop Multiplexers and xFF Transponders enable CWDM connectivity between a BBU and Remote Radio Head (RRH) antennae located at two cell towers in a serial bus network topology.

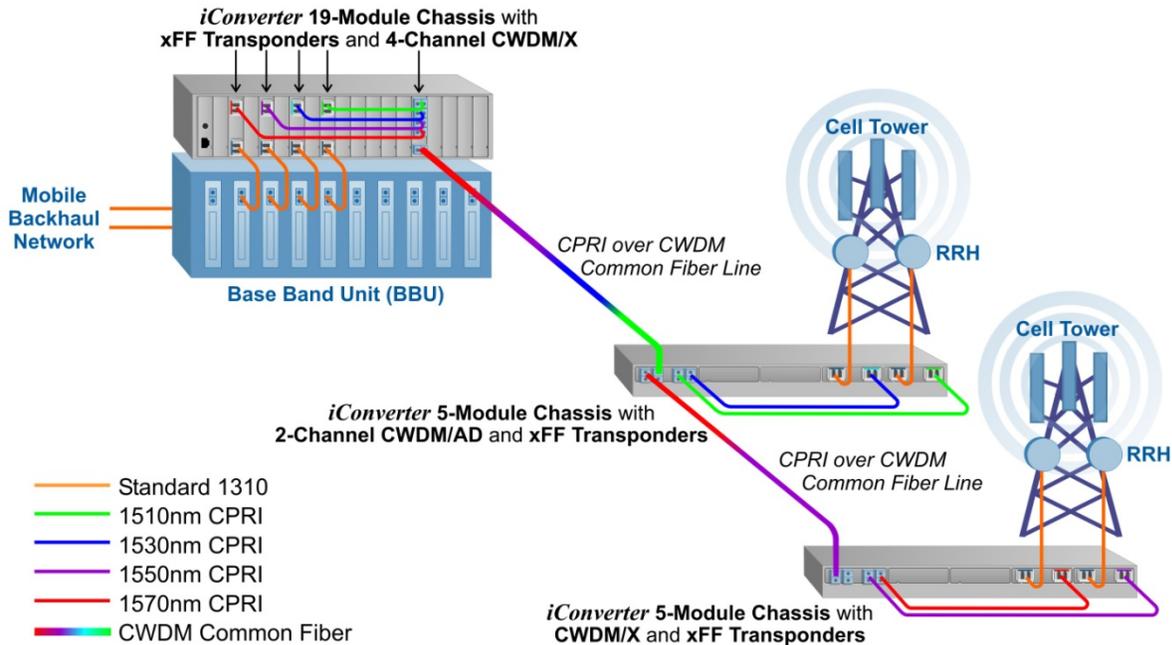


Figure 4: CPRI Fronthaul Daisy-Chain with Multiple Services to Cell Towers

Connectivity between the BBU and the Fronthaul CWDM Common Fiber Line is achieved with CWDM/X Multiplexers and xFF Transponders in the same fashion as described in Figure 3.

At the first cell tower, a 5-Module Chassis with a two-channel CWDM/AD Add+Drop Multiplexer and xFF Transponders is deployed. The CWDM/AD Add+Drop Multiplexer filters out the 1510nm and the 1530nm CWDM channels to connect the CPRI data to the Remote Radio Heads in the cell tower. Fiber patch cables (shown in light blue and green to represent the CWDM wavelengths) connect the channel ports on the iConverter CWDM/AD multiplexer to iConverter xFF Transponders that convert the fiber with CWDM wavelengths back to standard 1310 wavelengths. The standard wavelength fiber connects to the two Remote Radio Heads on the cell tower.

The 1550nm and 1570nm CWDM channels pass through the Add+Drop MUX and travel over the CWDM Common Line to the second cell tower.

At the second cell tower, another 5-Module Chassis with a two-channel CWDM/AD Add+Drop Multiplexer and xFF Transponders is deployed. The CWDM/AD Add+Drop Multiplexer filters out the 1550nm and the 1570nm CWDM channels to connect the CPRI data to the Remote Radio Heads in the cell tower.

The application in Figure 5 illustrates how to daisy chain cell towers deployed in a rural area, or Green Field, where covering a wide area is more important than adding capacity at the cell tower, so one channel is dropped off at each tower.

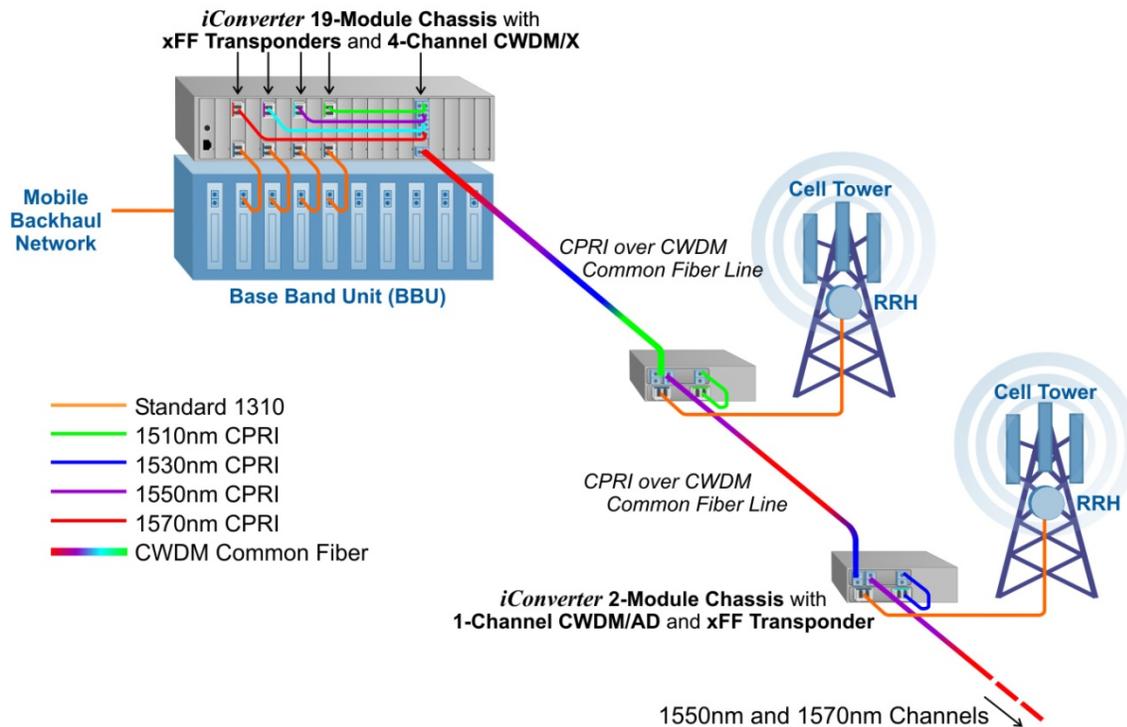


Figure 5: CPRI Fronthaul Daisy-Chain with a Single Service to Multiple Cell Towers

Connectivity between the BBU and the Fronthaul CWDM Common Fiber Line is achieved with CWDM/X Multiplexers and xFF Transponders in the same fashion as described in Figure 3.

At the first tower, a two-module chassis is deployed with a 1 Channel CWDM/Add+Drop MUX and an xFF Transponder. The Add+Drop Multiplexer filters out the 1510 wavelength, and the xFF Transponder converts it to standard 1310 for connectivity to the RRH. The other wavelengths pass through the CWDM Add+Drop Multiplexer and pass on to the other towers where similar equipment is deployed. In this example, four wavelengths are dropped off at four different towers.

Summary

Mobile Network Operators are migrating to Centralized RAN architecture and consolidating equipment at the BBU Hotel or Central Office to lower deployment costs and operational expenses, but are facing challenges with fiber fronthaul capacity.

iConverter CWDM Multiplexers and Add+Drop Multiplexers provide a simple, reliable and cost effective method to expand the fiber capacity of existing fiber fronthaul links. iConverter xFF Transponders enable connectivity between BBU equipment with standard wavelength fiber ports and CWDM Multiplexer channel ports. These modular products can be installed in a variety of iConverter chassis for flexible and scalable CPRI fronthaul deployments.

Related Products

iConverter[®] Multi-Service Platform

The modular *iConverter* Multi-Service Platform of [Network Interface Devices](#), [media converters](#), [transponders](#), [CWDM multiplexers](#) and [T1 multiplexers](#) can be combined in a variety of chassis configurations.

The Multi-Service Platform provides a managed, flexible and scalable architecture for today's evolving fiber networks.

Network managers can leverage investments in existing infrastructure and deliver new services, protocols and data rates over fiber, and multiplex different services over a CWDM common fiber link.



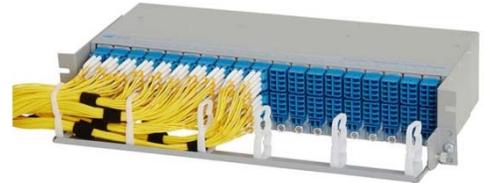
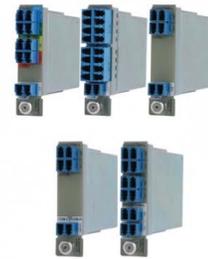
iConverter CWDM Multiplexers

iConverter [CWDM/X multiplexer](#) modules are available in 4 and 8-Channel (wavelength) models, supporting a variety of wavelength combinations and port configurations.

iConverter [CWDM/AD multiplexer](#) modules add (multiplex) and drop (demultiplex) selected channels in one or both directions of a CWDM fiber route.

iConverter CWDM/X and CWDM/AD multiplexers are available for dual and [single fiber](#).

The *iConverter* [CWDM Compact Chassis](#) provides high-density fiber distribution with up to 304 CWDM ports in 2U of rack space.



iConverter xFF Transponders

The *iConverter* [xFF Transponder](#) is a protocol-transparent media converter that provides reliable and cost-effective conversion between different wavelengths, multimode and single-mode, and dual and single-fiber.

The *iConverter* xFF operates as a protocol and rate-transparent device, supporting Small Form Pluggable (SFP) transceivers with data rates from 1Mbps to 8.50Gbps. The xFF supports a variety of network protocols, including Ethernet, CPRI, SONET and Fibre Channel.

