Cisco Remote-PHY Solution Overview

Introduction

Driven by market evolution towards triple-play services, cable operators in emerging markets are seeking standardized and digital fiber-based solutions for economical and future proof access technologies. Much of the demand is driven by the need to provide higher bandwidth packet transport for Internet connectivity, video and voice services.

Data Over Cable Systems Interface Standard (DOCSIS®) is a standardized technology for services over cable and thus has strong interoperability between system providers. It also provides robust Quality of Service (QoS) methods, ensuring packet delivery during periods of network congestion. Traditionally, DOCSIS runs on linear fiber (or HFC) to provide service and is not naturally applicable for digital fiber. Cisco has bridged the gap by introducing a new access technology called the Remote-PHY.

Existing Architecture

In the emerging markets, most triple-play consumers live in multi-tenant buildings (referred to as Multi Dwelling Units or MDU) with the number of residents usually being less than 500 residents per building or cluster. These buildings are typically served by fiber with one of several “final 100 meter” technologies installed in the buildings. These technologies include fiber, twisted pair, Ethernet, and coaxial. Cable operators have access to the cable in the building and use this cable for their services. Several technologies exist for enabling two-way services over cable. These include a number of proprietary and vendor-specific methods. However, a standards-based approach to using cable is typically preferred by operators, since this ensures vendor interoperability.

Need for the Cisco Remote-PHY Solution

DOCSIS and EuroDOCSIS are standards that define two-way operation over a cable network. DOCSIS provides the necessary Quality of Service (QoS) tools for ensuring voice call connectivity during periods of network congestion that are anticipated in triple-play networks. DOCSIS is a robust and mature technology for voice, video, and IP video services.

The Cisco Remote-PHY solution leverages existing IP technologies and deploys DOCSIS in remote field over digital fiber to enable two-way services over cable.

Benefits

The Cisco Remote-PHY solution provides a cost-effective digital fiber-based DOCSIS solution that uses Metro Ethernet (MetroE) as the transmission network between the Cisco CMTS and the cable modem.

- Reduced investment cost including capital and operational expenditure.
- Low-cost yet highly stable Cisco GS7000 node (includes only the PHY layer).
- Reduced CMTS hardware complexity.
- No restriction on Converged Interconnect Network (CIN) network.
- Futureproof architecture. Easy to migrate as the hardware and control functions are on separate layers.
- End-to-end QoS assurance provided by DOCSIS.
- Support for all DOCSIS services.
- Support for existing DOCSIS network provisioning system.
- High access bandwidth.
- With deep fiber, the optical noise contribution to SNR is eliminated. As a result, the remote QAM modulator runs at higher orders of modulation as compared to a centralized QAM modulator.

Architecture Overview

Modular Headend Architecture version 2 (MHAv2) is a set of specifications for the Cisco Remote-PHY solution. It uses digital fiber compatible baseband networking technology to drive the fiber portion of the HFC plant. The coaxial portion of the plant remains the same. The upstream and downstream PHY are located on the remote side and acts as the remote PHY system. The Cisco GS7000 node with the Cisco DOCSIS R-PHY node acts as the remote PHY system. It connects the digital fiber and the coaxial portions of the plant together. The remote PHY system resides near or in buildings and has both RFI and Gigabit Ethernet interfaces. It provides layer 1 PHY (downstream and upstream PHY) functionality, layer 2 MAC functionality, and layer 3 tunneling and forwarding support. The CMTS remains unchanged with the exception of the upstream and downstream PHY being moved to the remote PHY system. The Cisco RF line card installed in the Cisco CMTS does not have the RFI interfaces for downstream and upstream, instead, it has Gigabit Ethernet interfaces for both downstream and upstream.

Protocols that form this architecture include:

- Downstream External PHY Interface Decapsulation—Downstream External PHY Interface (DEPI) is a L2TPv3-based protocol defined for downstream DOCSIS MAC management and data packets decapsulation. It is unidirectional, that is, from CMTS to remote PHY system.

DEPI supports:

- IP/User Datagram Protocol (UDP)
- DOCSIS MPT Mode (D-MPT)/Packet Streaming Protocol (PSP)

- Upstream External PHY Interface Encapsulation—Upstream External PHY Interface (UEPI) is a L2TPv3-based protocol defined for upstream DOCSIS MAC management and data packets encapsulation. It is unidirectional, that is, from remote PHY system to CMTS.

  UEPI:

  - Does not support UDP
  - Supports PSP mode only
  - Supports multiple pseudowires for RNG/BW-REQ/SPECTRUM-MGMT/MAP

- GCP—Generic Control Protocol, sets up a control plane tunnel over a generic transport protocol such as TCP or UDP. GCP is used to program the remote PHY system upstream and downstream parameters from the CMTS. It is also used to control the remote PHY system.

  GCP supports:

  - TCP/UDP
  - DS/US PHY configuration and CMC provisioning/configuration
  - Register mode and type, length, value (TLV) mode
  - Notification

Cisco Cable Modem Termination System

The Cisco cBR converged broadband router acts as the Cable Modem Termination System (CMTS) core for the Cisco Remote-PHY architecture.

Following are its functions:

- Assigns downstream and upstream channels of the Cisco RF line card to the Cisco DOCSIS R-PHY GS7000 node.
- Performs MAC classification, forwarding, and management functions.
- Handles the Cisco DOCSIS R-PHY GS7000 node configuration and management.

For more information on the Cisco CMTS, go to Cisco cBR Series Converged Broadband Routers page.

Cisco 1.2 GHz Super High Output (SHO) GS7000 Node

The Cisco 1.2 GHz Super High Output (SHO) GS7000 Node (Cisco GS7000 node) acts as the edge QAM in the Cisco Remote-PHY architecture. It is located between the Cisco CMTS and the cable modem, and controlled by the Cisco CMTS. The Cisco GS7000 node has network interfaces on one side connecting to the fiber (digital and linear) portion of the Hybrid Fiber Coaxial (HFC) plant, and RF interfaces on the other side

connecting to the coaxial portion of the HFC plant. The Cisco GS7000 node can be mounted either on a wall or strand (aerial installation). The RF output of the Cisco GS7000 node can be combined with other services, such as, analog or digital video services. The Cisco GS7000 node uses the linux operating system. Most of the Cisco GS7000 node configurations are performed on the Cisco CMTS.

The Cisco GS7000 node originates the DOCSIS protocol using the DOCSIS MAC and PHY layer technology used in the Cisco CMTS. The Cisco GS7000 node has built-in downstream PHY and upstream PHY, and a small FPGA for DEPI decapsulation and UEPI encapsulation.

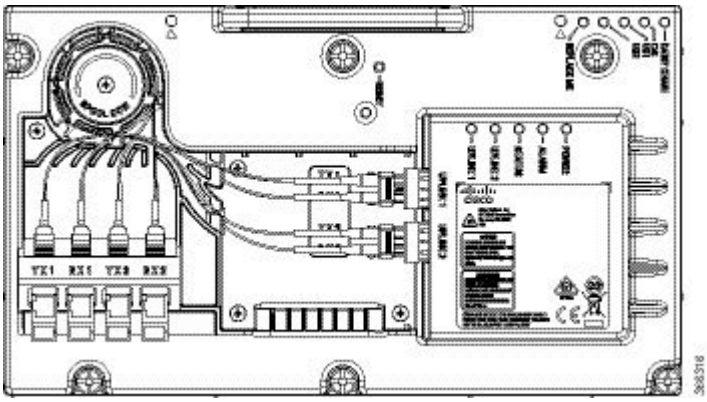
For more information, see the Cisco GS7000 1218-MHz 4-Port Fiber Deep Node Data Sheet and Cisco 1.2 GHz Super High Output (SHO) GS7000 Node Installation and Operation Guide.

Cisco Remote-PHY Device

The Cisco Remote-PHY Device (RPD) resides inside the Cisco GS7000 node. Below are some of its features:

- Full spectrum DOCSIS 3.0 support
- Full spectrum DOCSIS 3.1 support
- Converged broadcast, narrowcast, and VOD video support
- Out of Band (OOB) signaling support
- Dual 10GBE SFP+ backhaul connectivity
- Support of Daisy Chain architecture topology
- CCAP support
- Support of optical overlay architectures

Figure 1: Cisco RPD



Cisco CCAP RF Line Card for R-PHY

The Cisco CCAP RF line card for remote PHY architecture is available in two flavours:

- CBR-LC-8D31-16U30—This RF line card with the downstream and upstream PHY modules can be connected with the Cisco GS7000 node by configuring it using the **card cBR-CCAP-LC-40G r-phy** command.
- CBR-CCAP-LC-40G-R—This RF line card with no downstream and upstream PHY modules can be connected with the Cisco GS7000 node.

Cisco Digital Physical Interface Card

The Cisco Digital Physical Interface Card (DPIC) transmits and receives RF signals between the subscriber and headend over the hybrid fiber-coaxial (HFC) system and is DOCSIS-compliant. This interface card is designed specifically for the Cisco cBR router and conforms to the Integrated CMTS (I-CMTS) architecture. The PID is cBR-DPIC-8X10G.

The DPIC is installed in the CMTS and connected to the Cisco GS7000 node via the Metro Ethernet. It supports both downstream and upstream traffic. Both the downstream and upstream traffic share the same ports.

Table 1: Physical Specifications of the DPIC

Unit	Dimensions
Width	10.96 in (27.8cm)
Height	1.43 in (3.6cm)
Depth	7.32 in (18.6cm) with handle
Weight	2.943lb (1.335kg)

The DPIC supports:

- Eight ten gigabit ethernet SFP+ interfaces
- 80 gigabit non-blocking switching architecture with 40+40 protection scheme
- 40 gigabit DOCSIS traffic bandwidth when connected with the Cisco CBR-CCAP-LC-40G-R line card
- Cisco SFP-10G-SR-S/Cisco SFP-10G-LR-S/Cisco SFP-10G-ZR-S/Cisco SFP-10G-ER-S optic modules
- MACSec and 1588 TC

The faceplate of the Cisco DPIC has the following:

- Optic Cable Clip—Helps route and manage the optic cables.
- 8 x SFP+ ports—Used as 8 x 10GE lanes for DOCSIS traffic to the Cisco RPDs.
- 10GE Link Status LED—Indicates the status of the 10GE link.
- Status LED—Indicates the status of the Cisco DPIC.
- Replace LED—Indicates the Cisco DPIC must be replaced.

Onboard Failure Logging

The Onboard Failure Logging (OBFL) feature enables the storage and collection of critical failure information in the nonvolatile memory of a Field Replaceable Unit (FRU), like a route processor (RP) or line card. The data stored through OBFL assists in understanding and debugging the field failures upon Return Material Authorization (RMA) of a RP or line card at repair and failure analysis sites. OBFL records operating temperatures, voltages, hardware uptime, and any other important events that assist board diagnosis in case of hardware failures.

For more information about the feature, see Onboard Failure Logging.

Note The sample output provided in the Onboard Failure Logging guide may vary slightly for the Cisco CMTS routers.