CHAPTER 1

Solution Overview

Note The information provided in this document for Cisco DOCSIS 3.0 Downstream Solution is specific to Cisco IOS Releases 12.2(33)SCB and 12.3(23)BC. For information that is specific to Cisco IOS Releases 12.3(21)BC and12.3(21a)BC3, refer to the *Cisco Cable Wideband Solution Design and Implementation Guide* for these releases.

This chapter provides an overview of the Cisco DOCSIS 3.0 Downstream Solution, and contains the following major topics:

In this document, the terms *wideband channel, bonded channel,* and *bonding group* have the same meaning: a logical grouping of one or more physical radio frequency (RF) channels over which MPEG-TS packets are carried.

Solution Description and Scope

Cisco IOS Release 12.3(23)BC introduces the DOCSIS 3.0 Downstream Solution. In the Cisco Modular CMTS (M-CMTS) implementation, the downstream channels over the Downstream External PHY Interface (DEPI) are processed and encapsulated by the Cisco shared port adapter (SPA) and therefore they are also referred to as SPA downstream (DS) channels. The SPA DS channels can be used either as primary-capable channels (narrowband channels), or as part of bonded channels (wideband channels), or both. The solution provides narrowband data services to support DOCSIS 1.x/2.0 modems and wideband data services to support DOCSIS 3.0 modems over existing hybrid fiber coaxial (HFC) networks and allows DOCSIS 1.x/2.0 and DOCSIS 3.0 modems to share the same SPA DS channel. With wideband data services, multiple SPA DS channels are aggregated into a single logical wideband channel (bonding group) that delivers higher bandwidth to the wideband cable modem than was previously possible with DOCSIS 2.0 technology. This aggregation of the SPA DS channels is referred to as *channel bonding*.

The maximum bandwidth supported depends on the number of SPA DS channels that can be aggregated into a wideband channel.

- The Scientific Atlanta DPC2505 wideband cable modem supports downstream throughput of over 100 Mbps (with a wideband channel consisting of three RF channels at 6 MHz and 256 QAM).

The Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, can be deployed in parallel with DOCSIS 1.X/2.0 technology. The CMTS supports DOCSIS 1.X/ 2.0 modems on Cisco uBR10-MC5X20 line card channels as well as on the primary-capable SPA downstream channels, and it supports wideband cable modems via bonded SPA DS channels, delivering significantly higher throughput.

The solution provides the following capabilities:

- Primary-capable downstream channels from the SPA

  Primary-capable channels are SPA DS channels (also known as SPA RF channels) associated with the upstream channels from the Cisco uBR10-MC5X20 line card. These downstream channels carry SYNC messages as well as Upstream Channel Descriptors (UCD) and Mini-slot Allocation Packet (MAP) messages for at least one upstream channel. They may also carry primary MAC Domain Descriptor (MDD) messages for DOCSIS 3.0 modems.

  This capability:

  - Increases legacy downstream port density
  - Allows legacy and bonded modems to share the same SPA DS channels
  - Supports 3-channel bonding for 3-channel modems and 8-channel bonding for Linksys modems on the SPA DS channels

- Extensible MAC domain
  - Provides support for multiple primary-capable channels per MAC domain
  - Allows flexible upstream and downstream associations within a MAC domain
  - Allows association of bonded channel to MAC domains
- Primary-capable downstream channel selection

  Provides primary-capable downstream channel selection to facilitate channel bonding and reliability of voice-enabled modems.

- High availability

  Provides high availability support for modems on SPA DS channels.

- DOCSIS 1.x/2.0 and legacy feature support on SPA DS channels
- DOCSIS 3.0 support on SPA DS channels

Architecture and Scope

The Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, includes these major components:

- Wideband cable modem termination system (WCMTS)—Cisco uBR10012 router

  The WCMTS is the component located at the cable television system headend or distribution hub and exchanges digital signals with cable modems in a cable network to enable data connectivity to a wide-area network.

- Cisco Wideband shared port adapter (SPA) and Cisco Wideband SPA interface processor (SIP)

  The Cisco Wideband SIP for the 1-Gbps wideband SPA is a carrier card that inserts into a router like a line card and enables cable operators to offer high-speed broadband connectivity. The SIP provides no network connectivity on its own. The Wideband SPA that inserts into the bay of the SIP provides ports for network connectivity.

- DOCSIS Timing and Control Card (DTCC)

The DTCC supplies centralized DOCSIS clock and time-stamp distribution to the cable line cards within the WCMTS. This card allows synchronization of the DOCSIS clock and time stamp to an external DTI server.

- DOCSIS Timing Interface (DTI) server

  The DTI server provides DOCSIS clock generation in an M-CMTS architecture. It ensures that the DOCSIS time stamp and frequency between the modular CMTS core, edge QAM device and upstream are synchronized to nanosecond levels.

- Edge QAM (EQAM) device

  The edge QAM device is a network element that is separate from the CMTS. It allows operators to leverage the same network resources to support multiple types of services, such as data, voice, and video.

- Wideband cable modem (WCM)

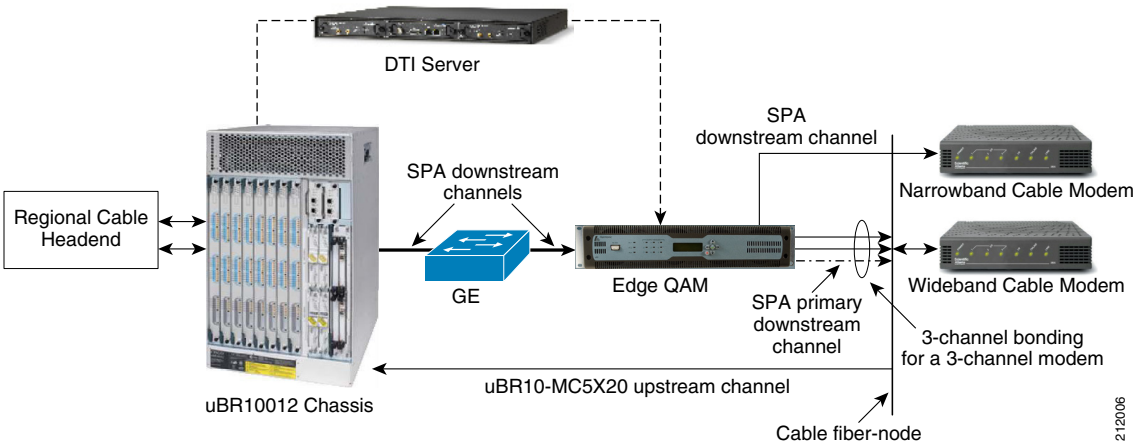
  WCMs are modems that are DOCSIS 3.0-compliant and support downstream channel bonding.

- Narrowband cable modem (NCM)

  NCMs are modems that are DOCSIS 1.x/2.0-compliant and support data from a single RF channel.

Figure 1-1 presents a simplified view of the Cisco DOCSIS 3.0 Downstream Solution. In Figure 1-1, three SPA RF channels are bonded into a wideband channel (bonding group).

Figure 1-1 Cisco DOCSIS 3.0 Downstream Solution



In Cisco IOS Release 12.2(33)SCB, the following components have been added to the scope of the DOCSIS 3.0 Downstream Solution:

- Cisco 10000 SIP-600 SPA Interface Processor

  The Cisco SIP-600 is a high-performance, feature-rich SPA interface processor (SIP) that functions as a carrier card for shared port adapters (SPAs) on the Cisco uBR10012 router. The SIP is compatible with one or more platform-independent SPAs.

- Gigabit Ethernet Shared Port Adapters (SPAs)

  In addition to the Cisco Wideband SPA, the Cisco SIP-600 also supports the following Gigabit Ethernet SPAs:

  - 5-Port Gigabit Ethernet SPA
  - 1-Port 10-Gigabit Ethernet SPA (supported on PRE4 only)

In Scope

The scope of the Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, comprises fully tested and supported Cisco and Scientific Atlanta components, as well as selected third-party components tested for interoperability by Cisco.

The following aspects of the solution are in scope:

- DOCSIS 3.0 Downstream software
- Wideband CMTS (Cisco uBR10012 router)
- Cable interface and network uplink line cards
- Cisco Wideband SIP and Cisco Wideband SPA
- DOCSIS Timing and Control Card (DTCC)
- DTI server
- Edge QAM device
- Narrowband cable modem
- Wideband cable modem
- DOCSIS 1.x/2.0 cable modem configuration file parameters
- DOCSIS 3.0 cable modem configuration file parameters
- Cisco IOS command set for wideband-channel configuration, provisioning, and maintenance
- Cisco IOS command set for wideband hardware monitoring, troubleshooting, and debugging
- MIBs for the wideband CMTS, wideband cable modem, and wideband channel and service statistics

Device configuration that is in scope for this document is limited to the Wideband SIP and Wideband SPA. Comprehensive documentation for other CMTS components is provided in the existing Cisco uBR10012 documentation set, which is accessible at www.cisco.com.

For information on edge QAM device installation and software configuration, refer to the vendor's edge QAM device documentation.

Out of Scope

The Cisco DOCSIS 3.0 Downstream Solution-related information in this document pertains to the components listed in "In Scope" section above. Not included in the scope of the Cisco DOCSIS 3.0 Downstream Solution are the hardware and software components that make up the remainder of the cable data network.

For the Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, cable network management tools and operations support system (OSS) facilities for wideband cable are outside the scope of the solution.

Solution Key Features

In the Cisco IOS Release 12.3(23)BC, DOCSIS 3.0 Downstream Solution, provides the following key features:

- Cisco DOCSIS 3.0 Downstream Solution that includes support for the following functionality:
  - Primary-capable SPA DS channels
  - Modular-cable interfaces

Represents the narrowband capability of a SPA DS channel.

– DOCSIS 1.x/2.0 modem support on primary-capable SPA DS channels

  Primary-capable channels provide narrowband data services to support DOCSIS 1.x/2.0 modems.

– Increased port density

  Provides up to 48 SPA DS channels plus 40 built-in DS channels in addition to the downstream channels on Cisco uBR10-MC5X20 line cards for DOCSIS 1.x/2.0 traffic.

– SPA DS channel sharing

  Provides narrowband data services to support DOCSIS 1.x/2.0 modems and wideband data services to support DOCSIS 3.0 modems over existing hybrid fiber coaxial (HFC) networks and allows DOCSIS 1.x/2.0 and DOCSIS 3.0 modems to share the same SPA RF channel.

- Enhancements to SPA DS Channels

– Annex and modulation configurable for individual SPA RF channels

– Layer 2 Transport Protocol (L2TP) encapsulation support on Downstream External PHY Interface (DEPI)

– Each Cisco Wideband SPA can support up to 24 downstream RF channels.

– Each Cisco Wideband SPA can support up to 32 logical wideband channels (bonding groups).

- Extensible MAC domain construction using Channel Grouping Domain (CGD)

– Flexible association of primary-capable SPA DS channels with upstream channels within the same MAC domain

- DOCSIS 1.x/2.0 and legacy feature support on primary-capable SPA DS channels

– Load balancing

– Virtual interface bundling

– Full DOCSIS Quality of Service (QoS)

– Committed Information Rate (CIR) Admission Control

– Bonded multicast

– Non-bonded multicast

– DOCSIS Set-top Gateway (DSG)

– Subscriber Accounting and Management Interface Specification (SAMIS)

– Multiprotocol Label Switching (MPLS)/Virtual Private Network (VPN)

– Baseline Privacy Interface (BPI)/Baseline Privacy Interface Plus (BPI+)

– Payload Header Suppression (PHS)

– Packet Cable and PacketCable™ Multimedia (PCMM)

– Cable modem flaplist

– Source Verify (with Dynamic Host Configuration Protocol (DHCP) option)

– Computer Assisted Law Enforcement Act (CALEA)/Service Independent Intercept (SII)/Packet Intercept

– Cable modem remote query

– DOCSIS Packet filters

– Cable Address Resolution Protocol (ARP)

    - Channel bonding of downstream channels from the SPA for DOCSIS 3.0 modem support
    - Downstream channel selection
    - Provides support for voice-enabled cable modems
- Existing Cisco uBR10012 router (CMTS) can be upgraded to wideband CMTS with add-on components.
- Cisco DOCSIS 3.0 Downstream Solution supports timing synchronization to the DTI server using DTCC.
- The SPA supports external Gigabit Ethernet interface to connect to the EQAM device directly or through the network.
- Cisco uBR10012 router (CMTS) supports up to two Wideband SPAs in a Wideband SIP.
- Cisco Wideband CMTS and line cards have built-in redundancy and resiliency features.
- Harmonic NSG 9000 edge QAM device is tested for interoperability.
- The Symmetricom TimeCreator 1000 DTI server is tested for interoperability.
- Linksys WCM300-NA, WCM300-EURO (for EuroDOCSIS), and WCM300-JP (for J-DOCSIS) wideband cable modems support the receiving of up to eight RF channels, which can be bonded into wideband channels. One traditional DOCSIS downstream channel is used for MAC management and signaling messages.
- Linksys WCM300-NA, WCM300-EURO, and WCM300-J wideband cable modems support one primary bonded (wideband) channel for unicast and multicast traffic and up to two secondary bonded channels for multicast traffic.
- Scientific Atlanta DPC2505 and EPC2505 wideband cable modems support one bonded downstream channel consisting of three RF channels, of which one RF channel is a primary downstream channel that is used for modem registration.

In Cisco IOS Release 12.2(33)SCB, the following additional features are supported on the DOCSIS 3.0 Downstream Solution:

- DOCSIS WFQ Scheduler

  The DOCSIS WFQ Scheduler is an output packet scheduler that provides output scheduling services on both WAN uplink interfaces and DOCSIS downstream interfaces.

- CMTS Dynamic Bandwidth Sharing

  The Cable Modem Termination Service (CMTS) new feature enables dynamic bandwidth sharing (DBS) on modular cable and wideband cable interfaces.

- Voice support on wideband modems

  CMTS supports voice services on voice-enabled wideband (WB) cable modems.

- Wideband Modem Resiliency

  The Wideband Modem Resiliency feature provides the best possible service in the event of non-primary radio frequency (RF) channel disruptions to ensure that a cable modem (CM) remains operational. With the implementation of this feature, the Cable Modem Termination System (CMTS) does not force a cable modem to perform a MAC reset if the CM loses connectivity to the CMTS on one or all of its non-primary RF channels.

- DOCSIS 3.0 Downstream Bonding for Bronze Certification

  The DOCSIS 3.0 Downstream Bonding for Bronze Certification feature helps cable operators offer new, more bandwidth-intensive services by adding one or more additional downstream quadrature amplitude modulation (QAM) channels to the standard broadband DOCSIS system.

Solution Components

Cisco DOCSIS 3.0 Downstream, Release 2.0, consists of Cisco and Scientific Atlanta components that are tested, documented, and fully supported by Cisco or Scientific Atlanta. Also, third-party equipment, although not fully supported by Cisco, has been selected and tested for interoperability with the solution components.

Cisco and Scientific Atlanta Equipment

For the Cisco DOCSIS 3.0 Downstream, Release 2.0, the following Cisco and Scientific Atlanta equipment has been tested in the context of the solution.

- Cisco uBR10012 universal broadband router with PRE2 processor modules and these components:
  - Cisco SPA interface processor (SIP) for the 1-Gbps Wideband SPA—Referred to in this document as the Cisco Wideband SIP or Wideband SIP
  - Cisco 1-Gbps Wideband shared port adapter (SPA)—Referred to in this document as the Cisco Wideband SPA or Wideband SPA
  - Cisco uBR10-MC5X20S/U/H and Cisco uBR10-MC5X20U-D cable interface line cards
- Wideband cable modem
  - Linksys WCM300-NA, WCM300-EURO, and WCM300-JP wideband cable modems Scientific Atlanta DPC2505 and EPC2505 wideband cable modems

Third-Party Equipment

For the Cisco DOCSIS 3.0 Downstream Solution, Release 2.0, Table 1-1 lists the third-party component, vendor, and the basic functionality each component provides.

Table 1-1 Component Partners and Basic Functionality

Component and Vendor	Basic Functionality
Symmetricom TimeCreator 1000 www.symmetricom.com	DOCSIS Timing Interface (DTI) Server
Harmonic NSG 9000 www.harmonicinc.com	Edge QAM device