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SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Interactive systems for digital television distribution

Cabinet DOCSIS (C-DOCSIS) system specification

Recommendation ITU-T J.223.2

International Telecommunication Union

Recommendation ITU-T J.223.2

Cabinet DOCSIS (C-DOCSIS) system specification

Summary

Recommendation ITU-T J.223.2 defines the system architecture, functional modules within the cabinet data over cable service interface specification (C-DOCSIS) system, three C-DOCSIS systems utilizing the functional modules and the data and control interfaces between these modules for each system. It also defines general device requirements for the three C-DOCSIS systems. With a C-DOCSIS system, the modules that perform the physical layer and data link layer functions can be deployed in the optical nodes of the hybrid fibre and coaxial (HFC) cable network. This Recommendation is technically identical to the ETSI ES 203 312 standard.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T J.223.2	2016-10-14	9	11.1002/1000/13051

Keywords

C-DOCSIS, DOCSIS.

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Cabinet DOCSIS (C-DOCSIS) system specification

1 Scope

This Recommendation describes a method for distributed deployment and centralized control of a DOCSIS cable broadband access system, referred to as cabinet data over cable service interface specification (C-DOCSIS). C-DOCSIS has been developed to meet the operability and manageability requirements for cable networks that offer a variety of high-bandwidth services and provide quality of service (QoS) guarantees for these services in a distributed architecture. C-DOCSIS applies to the architecture and operations, administration and management (OAM) of cable broadband access networks.

This Recommendation defines the functional modules within the C-DOCSIS system, three C-DOCSIS system architectures utilizing the functional modules and the data and control interfaces between these modules for each architecture. It also defines general device requirements for the different C-DOCSIS architectures. This Recommendation is technically identical to [ETSI ES 203 312].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T J.210] Recommendation ITU-T J.210 (2006), *Downstream RF interface for cable modem termination systems.*

[ITU-T J.222.1] Recommendation ITU-T J.222.1 (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems: Physical layer specification*.

[ITU-T J.222.2] Recommendation ITU-T J.222.2 (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems: MAC and Upper Layer protocols.*

[ITU-T J.222.3] Recommendation ITU-T J.222.3 (2007), *Third-generation transmission systems for interactive cable television services – IP cable modems: Security services.*

[ETSI ES 203 312] ETSI ES 203 312 V1.1.1 (2015), *Integrated broadband cable telecommunication networks (CABLE); Cabinet DOCSIS (C-DOCSIS) System Specification.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 C-DOCSIS system [b-ITU-T J.223.1]: The C-DOCSIS system consists of the CMC controller, CMC, and C-DOCSIS CM. It implements broadband data access and forwarding, service configuration, as well as management and maintenance of coaxial cable networks.

3.1.2 CMC [b-ITU-T J.223.1]: The cable media converter (CMC) converts data from a coaxial cable network to a packet digital optical network (such as PON or Ethernet). The CMC connects to a cable modem (CM) through the coaxial cable network in the downstream direction and to the CMC controller through the packet digital optical network in the upstream direction.

3.1.3 CMC controller [b-ITU-T J.223.1]: The CMC controller forwards upstream and downstream service data and manages the configuration of the CMC.

3.1.4 service flow [b-ITU-T J.112 Annex B]: A MAC-layer transport service which: – provides unidirectional transport of packets from the upper layer service entity to the RF; – shapes, polices, and prioritizes traffic according to QoS traffic parameters defined for the Flow.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 C-DOCSIS management messages (CDMM): The C-DOCSIS management messages (CDMMs) are used for exchanging configurations, status, and management information between the system control module and the radio frequency interface (RFI) module.

3.2.2 C-DOCSIS CM: A cable modem (CM) that complies with the CM requirements of DOCSIS 3.0.

3.2.3 C-DOCSIS CMTS: A cable modem termination system (CMTS) that complies with the CMTS requirements of DOCSIS 3.0. In the context of this specification, it consists of a coax media converter (CMC) controller and a CMC or multiple CMCs operating together.

3.2.4 C-DOCSIS data tag (CDT): As defined in the C-DOCSIS system, C-DOCSIS data tags (CDTs) are used to identify a service flow to which each data packet belongs.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

C-DOCSIS	Cabinet DOCSIS
CCI	Control and Classifier Interface
CDMM	C-DOCSIS Management Message
CDT	C-DOCSIS Data Tag
CLI	Command Line Interface
CM	Cable Modem
CMC	Coax Media Converter
CMTS	Cable Modem Termination System
CoS	Class of Service
CPE	Customer Premises Equipment
DHCP	Dynamic Host Configuration Protocol

DOCSIS	Data Over Cable Service Interface Specification
EPON	Ethernet Passive Optical Network
FTTx	Fibre To The "x", where "x" indicates the final location on the user side of any one of a variety of optical fibre architectures, e.g., fibre to the building (FTTB), fibre to the curb (FTTC), fibre to the premises (FTTP)
GE	Gigabit Ethernet
GPON	Gigabit-capable Passive Optical Network
HFC	Hybrid Fibre and Coaxial
IP	Internet Protocol
LLC	Logical Link Control
MAC	Media Access Control
MAN	Metropolitan Area Network
MPI	Main Path Interface
NMS	Network Management System
NSI	Network Side Interface
OAM	Operations, Administration and Maintenance
OLT	Optical Line Terminal
OMI	Operation and Management Interface
ONU	Optical Network Unit
PHY	Physical Layer
PON	Passive Optical Network
QoS	Quality of Service
RF	Radio Frequency
RFI	Radio Frequency Interface
SNMP	Simple Network Management Protocol
SNR	Signal-to-Noise Ratio
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VLAN	Virtual Local Area Network

5 Conventions

The keywords "**is/are required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

6 Overview

Cabinet data over cable service interface specification (C-DOCSIS) is based on proven DOCSIS 3.0 technology and with objectives of carrying high-bandwidth services and enabling cost effective system operation. C-DOCSIS presents a logical architecture of distributed deployment and centralized management for the cable broadband access system. It defines the logical functional modules of the system as well as related interfaces and protocols that support the architecture, through

different combinations of the logical functional modules; C-DOCSIS specifies three different system implementations and the corresponding systems devices.

As the key to implementing the architecture of distributed deployment and centralized management, C-DOCSIS defines the C-DOCSIS cable modem termination system (CMTS) with a coax media converter (CMC) and the CMC controller to achieve the DOCSIS CMTS functionality, as shown in Figure 1. The CMC controller implements the metropolitan area network (MAN) interfaces and the CMC implements the radio frequency (RF) interfaces specified in [ITU-T J.222.1], [ITU-T J.222.2], [ITU-T J.222.3] and [ITU-T J.210], which are a part of C-DOCSIS. The CMC controller and CMC can be interconnected via a layer-2 or layer-3 network, such as digital optical packet network.

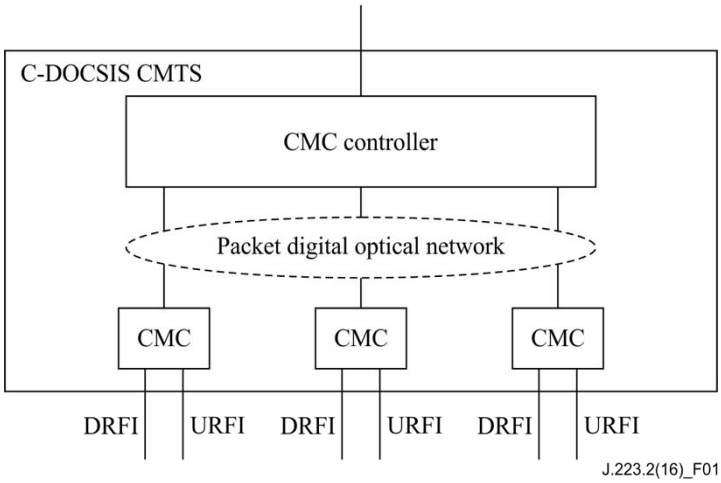

Figure 1 – C-DOCSIS CMTS network diagram

The CMC controller is deployed in the central office or headend to realize the centralized system management, configuration and scheduling, thus enabling the C-DOCSIS CMTS to inherit the advantages of a centralized DOCSIS CMTS system. The CMC itself is distributed; it is deployed in the optical node, enabling the C-DOCSIS CMTS to introduce the space-division multiplexing on top of the time-division multiplexing and frequency-division multiplexing utilized by the DOCSIS CMTS to achieve higher access bandwidth per user, which is highly desirable for the applications with large upstream bandwidth consumption. With the distributed deployment of CMC and coupled with the technical advantages of the digital optical packet network, a C-DOCSIS system can fully utilize the resources of the hybrid fibre and coaxial (HFC) network and existing cable modems (CMs) to realize a cost-effective system deployment and operation, it reduces the return noise and enhances the CMTS downlink channel signal-to-noise ratio (SNR), and is thus able to implement a higher order modulation scheme to obtain higher bandwidth.

C-DOCSIS specifies three types of CMC controllers and CMCs to implement the C-DOCSIS CMTS.

1) Type I CMC implements all the DOCSIS CMTS functions, and type I CMC controller implements high-level and partial-system management and configuration functions;
2) Type II CMC implements the data forwarding and CM access functions, and Type II CMC controller implements the system management, configuration, and scheduling functions;
3) Type III CMC only implements the C-DOCSIS CMTS physical layer (PHY) function, and the CMC controller implements the rest of the functions of the C-DOCSIS CMTS.

C-DOCSIS system architecture is an open architecture, which nicely aligns the DOCSIS system with the HFC migration toward the fibre to the "x" (FTTx) network. The implementation of the C-DOCSIS system is flexible. The CMC controller and CMC can be realized as stand-alone devices in accordance with the provisions of the specification, or they can be integrated with other existing devices to meet the needs of future development, such as the combination of CMC controller with optical line terminal

(OLT), router and switches, and the combination of CMC with optical network unit (ONU), light stations, and Internet protocol quadrature amplitude modulation (IPQAM)s.

7 C-DOCSIS system and characteristics

7.1 System definition and description

The C-DOCSIS system defined in this Recommendation consists of C-DOCSIS CMTSs and C-DOCSIS CMs. C-DOCSIS CMTSs consist of CMC controllers and CMCs as shown in Figure 2. This Recommendation defines the functional modules, interface, and requirements of C-DOCSIS CMTSs in detail, which are implemented by the CMC controllers and CMCs.

A C-DOCSIS CMTS is required to comply with [ITU-T J.222.1], [ITU-T J.222.2], [ITU-T J.222.3] and [ITU-T J.210]. C-DOCSIS CMs are compliant with the requirements in [ITU-T J.222.1], [ITU-T J.222.2], [ITU-T J.222.3] and [ITU-T J.210]. In a C-DOCSIS system, the CMC controller manages the configuration of the CMC and/or forwards upstream and downstream service data. The CMC converts and forwards the upstream and downstream service data and the management and configuration data of the CMs. The CM terminates the upstream and downstream service data, as well as receiving and responding to management and configuration data. The CMC controller connects to the CMC through a digital optical packet network. The CMC connects to the CMs through a coax RF network.

The configuration system configures services and devices on the C-DOCSIS system. It generates and issues configuration files and upgrades the software of the CMs. The configuration system consists of the dynamic host configuration protocol (DHCP) server, configuration file server, software downloading server and time protocol server. The network management system (NMS) consists of the simple network management protocol (SNMP) management system and the syslog server.

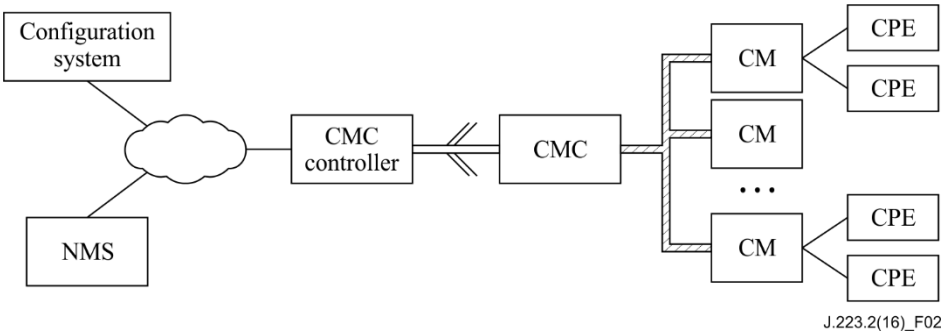

Figure 2 – C-DOCSIS system

7.2 Characteristics

C-DOCSIS introduces several features based on a traditional DOCSIS system, as listed below:

– Distributed architecture for deep-fibre network: C-DOCSIS introduces a three-level distributed architecture including the CMC controller, the CMC, and the C-DOCSIS CM. In its typical deployment, a CMC controller bridges the digital optical distribution network and the convergence network, a CMC bridges the digital optical network and the coax network, C-DOCSIS CM bridges the terminal and customer premises equipment (CPE) devices.

– Centralized network administration: C-DOCSIS introduces a centralized network administration approach, defines the corresponding interfaces and protocols, and supports the end-to-end administration, provisioning, and monitoring of equipment and services.

– Modular equipment and system: C-DOCSIS defines a series of new system modules. It supports different equipment modules, systems equipment, service requirements and features.

– CDT data plane interfaces: C-DOCSIS defines a C-DOCSIS data tag (CDT) interface for service flow tagging among different modules and provides a QoS guarantee for the system.
– CDMM interface: C-DOCSIS defines a C-DOCSIS management message (CDMM) interface to support centralized administration requirement.
– Service flow convergence mapping: C-DOCSIS defines a mapping protocol between DOCSIS service flows and virtual local area network (VLAN) tags to support QoS requirements and seamless connection with different type of networks.
– C-DOCSIS applies to the networks featuring high-density residents, large number of users, various service types, and high QoS requirements.

7.3 Relationship to ETSI ES 203 312

The text of [ETSI ES 203 312] is applied with the modifications as given below.

Un-numbered clauses "Intellectual Property Rights" and "Foreword"

The introductory clauses labelled "Intellectual Property Rights" and 'Foreword' do not apply in the context of this Recommendation.

Appendix I

Functional modules and system devices of Cabinet DOCSIS (C-DOCSIS) System

(This appendix does not form an integral part of this Recommendation.)

I.1 Introduction

This appendix derives from the C-DOCSIS specification. The C-DOCSIS specification has been published as [b-GY/T 266] in China, as "CM-SP-CDOCSIS" by CableLabs and as [ETSI ES 203 312] by the European Telecommunications Standards Institute (ETSI).

The C-DOCSIS specification describes a method for distributed deployment and centralized control of a DOCSIS cable broadband access system, referred to as C-DOCSIS. The C-DOCSIS specification defines the system architecture, the functional modules within the C-DOCSIS system, three different C-DOCSIS systems utilizing the functional modules, and the data and control interfaces between these modules for each of those systems. It also defines general device requirements for the different C-DOCSIS systems. With C-DOCSIS system, the modules that perform the physical layer and data link layer function can be deployed in the optical nodes of the HFC cable network.

I.2 Functional modules and interfaces

I.2.1 Functional modules

Figure I.1 shows the functional modules of the C-DOCSIS system.

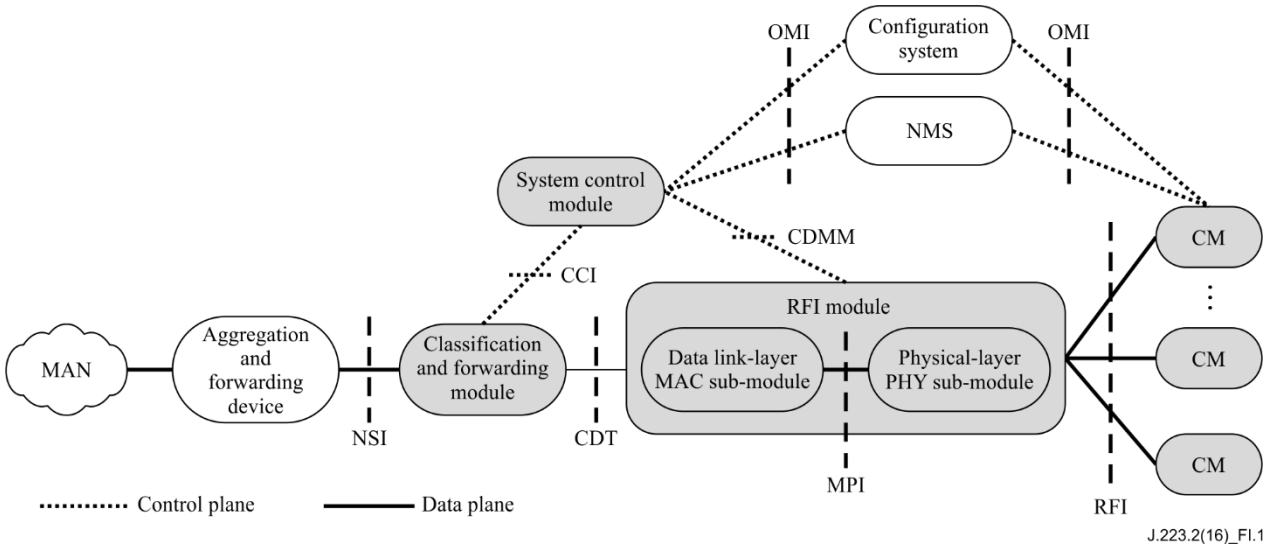

Figure I.1 – Functional module of the C-DOCSIS system

The C-DOCSIS system consists of a C-DOCSIS CMTS and C-DOCSIS CMs. While the C-DOCSIS CMTS consists of two physical devices – the CMC and CMC controller – it can contain several logical modules. These C-DOCSIS system logical modules are: the system control module; the classification and forwarding module; and the RFI module (including the data link-layer media access control (MAC) sub-module and the physical-layer PHY sub-module).

The C-DOCSIS system logical modules are defined as follows:

– System control module: This module is responsible for configuration and management of the RFI module and the classification and forwarding module. In addition, this module works with the NMS and the configuration system for service configuration and management.

– Classification and forwarding module: For downstream data flows, this module matches data packets based on fields, such as those in the transmission control protocol (TCP), user datagram protocol (UDP), Internet protocol (IP), as well as logical link control (LLC) headers and inserts into the data packet header the CDT of the service flow to which the data packet belongs. For upstream data flows, this module inserts service identifiers of the aggregation network based on C-DOCSIS service mapping rules and forwards data to the network side.

– RFI module: This module implements the functions of the data link-layer MAC sub-module and the physical-layer PHY sub-module. In the downstream direction, the RFI module implements service flow-based scheduling, queuing, and shaping, creates C-DOCSIS MAC frames, as well as modulates and transmits RF signals. In the upstream direction, the radio frequency interface (RFI) module receives RF signals, processes the C-DOCSIS MAC frame header, implements queuing and scheduling, and processes C-DOCSIS MAC management messages.

The configuration system and the NMS are the support systems of the C-DOCSIS system. The configuration system configures services and devices in the C-DOCSIS system. It generates and issues configuration files and upgrades the software of the CMs. The configuration system consists of the DHCP server, configuration file server, software downloading server, and time protocol server. The NMS consists of the SNMP management system and the Syslog server. The SNMP management system configures and monitors CMC controllers, CMCs, and CMs through SNMP. The Syslog server collects device operation messages.

The C-DOCSIS system connects to a MAN through an aggregation and forwarding device, which can be an OLT), an Ethernet switch, or a router.

I.2.2 Interfaces on C-DOCSIS functional modules

The interfaces on C-DOCSIS functional modules are as follows:

1) Radio frequency interface

The RFI defines the interface specification at the data link and physical layers between the C-DOCSIS RFI module and the CMs, including:

– modulation modes and parameters for upstream and downstream channels;

– MAC layer characteristics;

– electrical characteristics.

2) Network side interface

The network side interface (NSI) defines the physical interface and service flow mapping logic between the C-DOCSIS system and the aggregation network. The physical interface is not defined in this specification and can be a Gigabit Ethernet (GE) interface, a 10GE interface, an Ethernet passive optical network (EPON) interface, a Gigabit-capable passive optical network (GPON) interface, or a 10G passive optical network (PON) interface. The service flow mapping logic defines the mapping from C-DOCSIS service flows to Ethernet VLANs.

3) Operation and management interface

The operation and management interface (OMI) is used between the system control module and the NMS as well as the configuration system. It is also used between the C-DOCSIS CM and the NMS as well as the configuration system.

The NMS uses SNMP to configure, maintain, and monitor C-DOCSIS devices through the OMI and command line interface (CLI).

4) C-DOCSIS data tag

The CDT interface defines the identifier format on the data plane between the classification and forwarding module and the RFI module inside the C-DOCSIS system. The CDT interface uses the

format of the IEEE 802.1p/q VLAN tag. The VLAN ID identifies the CM to which a data packet belongs, and the class of service (CoS) field identifies the service flow to which a data packet belongs.

5) C-DOCSIS management message

The CDMM interface defines the control messaging between the system control module and the RFI module as well as the message format. CDMMs are used to exchange configurations, status, and management information between the system control module and the RFI module.

6) Control and classifier interface

The control and classifier interface (CCI) is the control interface between the system control module and the classification and forwarding module.

7) Main path interface

The main path interface (MPI) is the data communication and management interface between the data link-layer MAC sub-module and the physical-layer PHY sub-module of the RFI module. When the data link-layer MAC sub-module and the physical-layer PHY sub-module are implemented separately, use the MPI protocol for their communications.

I.3 System devices

I.3.1 C-DOCSIS I system and devices

The C-DOCSIS I system consists of the CMC controller I device, CMC I devices and CMs, as shown in Figure I.2. The CMC controller I device works with the CMC I devices to implement C-DOCSIS CMTS functions.

The CMC I device contains the classification and forwarding module, the RFI module, which includes the data link-layer MAC sub-module and the physical layer PHY sub-module, and the system control module. The CMC I device classifies and forwards service data, implements data-link layer MAC framing, as well as data modulation and demodulation on the physical layer. The device is deployed close to the user side on the network. CMs implement the functions of the CM module. In the C-DOCSIS I system, the system control module of the CMC I device controls protocols, configurations, and managements of services. The CMC controller I device implements service aggregation and routing.

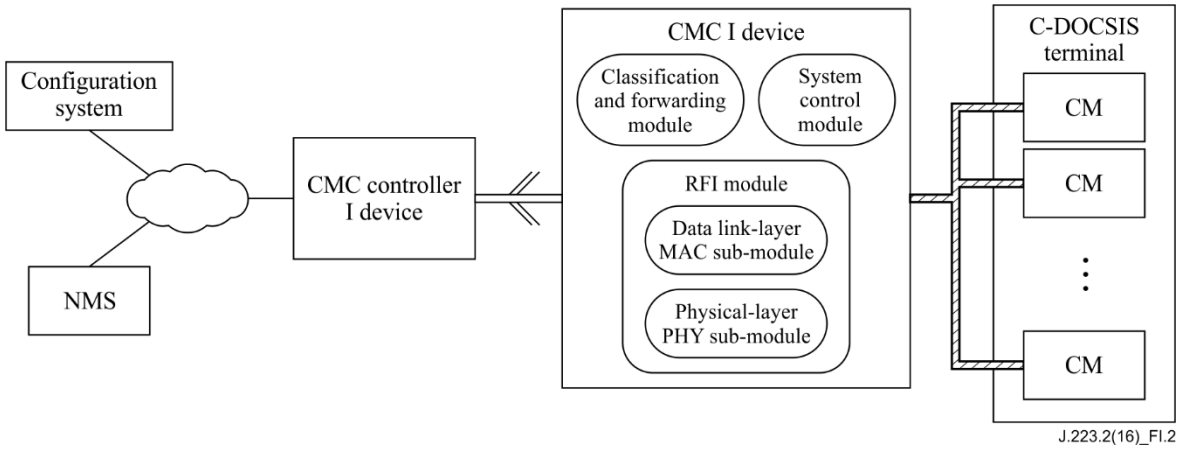

Figure I.2 – C-DOCSIS I system

In a system implementation, the CMC controller I device can be either a separate device or a component embedded in an aggregation and switching device, such as a router, a switch or an OLT.

In a networking solution, C-DOCSIS I system can be applied in HFC network as traditional DOCSIS or in the "FTTx+Coax" network architecture. The CMC converts data from a coaxial cable network

to a packet digital optical network (such as PON or Ethernet). The CMC connects to a CM through the coaxial cable network in the downstream direction and to the CMC controller through the packet digital optical network in the upstream direction. According to the implementation of the CMC controller I device, the CMC I device can connect to layer-3 OLT, switch/router and layer-2 OLT, or switch/router.

I.3.2 C-DOCSIS II system and devices

The C-DOCSIS II system consists of the CMC controller II device, CMC II devices and CMs, as shown in Figure I.3. The CMC controller II device works with the CMC II devices to implement C-DOCSIS CMTS functions.

The CMC controller II device contains the classification and forwarding module and the system control module to implement the following functions: service flow classification and forwarding, configuration and management of CMC II devices, and configuration and control of services. The CMC controller II device is deployed on the hub side. The CMC II device contains the RFI module, including the data link-layer MAC sub-module and the physical-layer PHY sub-module, to implement the data link-layer MAC framing as well as data modulation and demodulation on the physical layer. The device is deployed close to the user side on the network. CMs implement the functions of the CM module.

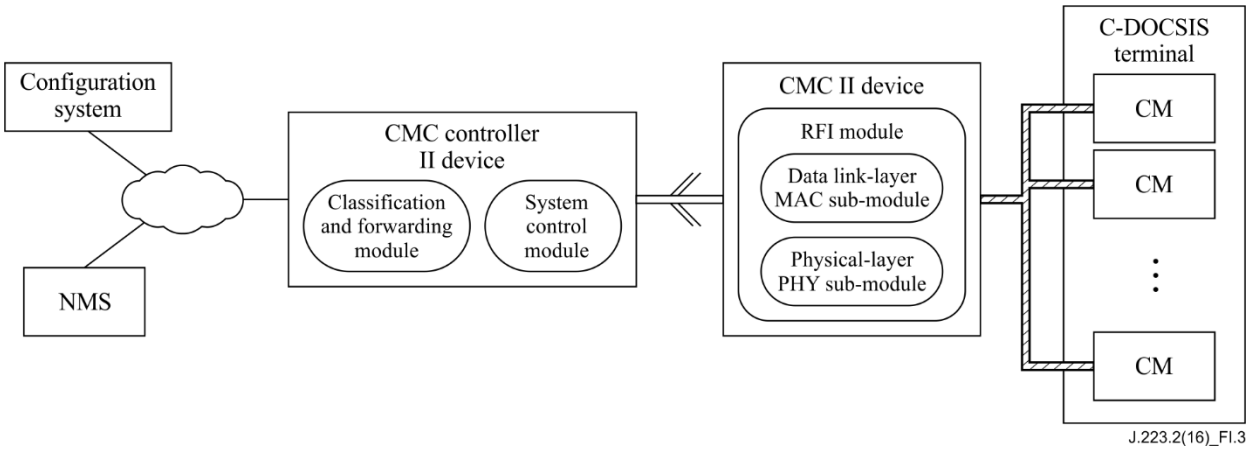

Figure I.3 – C-DOCSIS II system

In a system implementation, the CMC controller II device can be either a separate device or a component integrated in an aggregation and switching device, such as a router, a switch or an OLT.

In a networking solution, C-DOCSIS II system is applied in the "FTTx+Coax" network architecture. The CMC converts data from a coaxial cable network to a packet digital optical network (such as PON or Ethernet). The CMC connects to a CM through the coaxial cable network in the downstream direction and to the CMC controller through the packet digital optical network in the upstream direction. According to the implementation of the CMC controller II device, the CMC II device can connect to layer-3 OLT, switch/router and layer-2 OLT, or switch/router.

I.3.3 C-DOCSIS III system and devices

The C-DOCSIS III system consists of the CMC controller III device, CMC III devices and CMs, as shown in Figure I.4. The CMC Controller III device works with the CMC III devices to implement C-DOCSIS CMTS functions.

The CMC controller III device contains the classification and forwarding module, the data link-layer MAC sub-module, and the system control module to implement the following functions: classify and forward service data, implement data link-layer MAC framing, control system protocols, configure and manage services, and manage the system and devices. The CMC controller III device is deployed

on the hub side. The CMC III device contains the physical-layer PHY sub-module to modulate data and change frequencies at the physical layer for service data. The device is deployed close to the user side on the network.

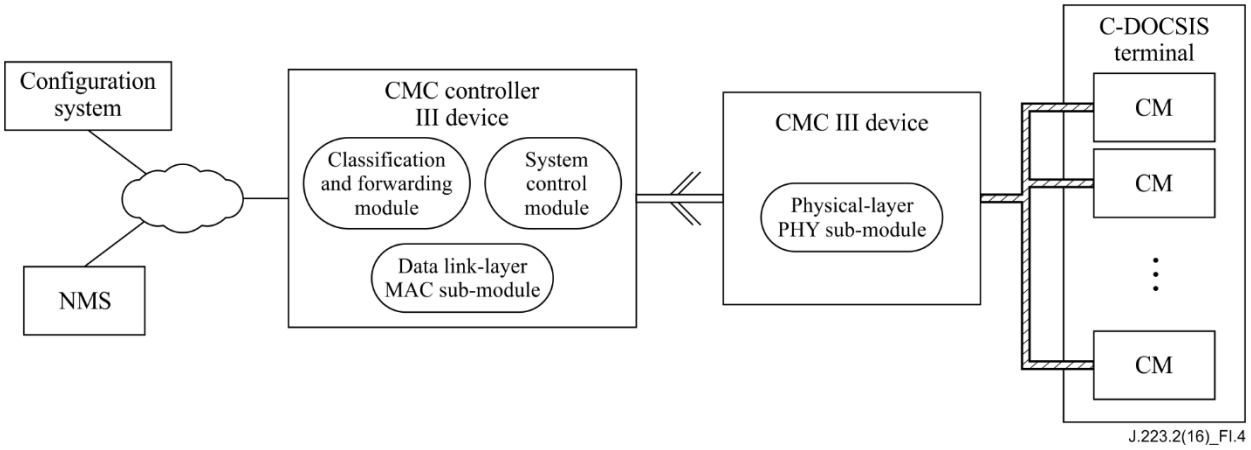

Figure I.4 – C-DOCSIS III system

In this system, the CMC controller III device can be either a separate device or a device supporting core CMTS functions, such as a CMTS, router or switch.

In a networking solution, C-DOCSIS III system is applied in the HFC or "FTTx+Coax" network architecture. The CMC converts data from a coaxial cable network to a packet digital optical network (such as PON or Ethernet). The CMC connects to a CM through the coaxial cable network in the downstream direction and to the CMC controller through the packet digital optical network in the upstream direction. According to the implementation of the CMC controller III device, the CMC III device can connect to CMTS or switch/router supporting core CMTS functions.

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[b-GY/T 266] China standard, *GY/T 266-2012 NGB broadband access system—Technical specification of C-DOCSIS.*

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