

Cable Data Services

DOCSIS® Provisioning of EPON Specifications

DPoE™ IP Network Element Requirements

DPoE-SP-IPNEv1.0-I06-130808

ISSUED

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- Work in Progress** An incomplete document, designed to guide discussion and generate feedback that may include several alternative requirements for consideration.
- Draft** A document in specification format considered largely complete, but lacking review by Members and vendors. Drafts are susceptible to substantial change during the review process.
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CONTENTS

1	INTRODUCTION	1
1.1	DPoE Technology Introduction	1
1.2	Scope	2
1.3	Goals.....	2
1.4	Requirements	3
1.5	Organization of Specifications.....	3
1.6	DPoE Specifications	4
1.7	Reference Architecture	5
1.8	DPoE Interfaces and Reference Points	6
2	REFERENCES	8
2.1	Normative References.....	8
2.2	Informative References.....	9
2.3	Reference Acquisition.....	10
3	TERMS AND DEFINITIONS	11
3.1	DPoE Network Elements	11
4	ABBREVIATIONS AND ACRONYMS.....	12
5	IP NE FUNCTIONS (INFORMATIVE)	15
6	DPOE SYSTEM IP NE REQUIREMENTS.....	16
6.1	Network Element Access Methods and Operations.....	16
6.1.1	<i>Command Line Interface</i>	16
6.1.2	<i>Terminal Access</i>	16
6.1.3	<i>Lights Out Management</i>	17
6.1.4	<i>Secure Login</i>	17
6.1.5	<i>Client Applications</i>	17
6.1.6	<i>Command Logging</i>	18
6.1.7	<i>XML Management</i>	18
6.1.8	<i>SNMP</i>	18
6.2	Messages.....	19
6.3	System Configuration File	19
6.4	DPoE System Executable Software (Images).....	20
6.4.1	<i>System Image Storage and Control</i>	20
6.5	File Transfer	20
6.6	File Storage and Control	20
6.6.1	<i>Integrated</i>	21
6.6.2	<i>Pluggable Storage</i>	21
6.6.3	<i>Local Log</i>	21
6.7	Logs	21
6.8	Syslog Configuration	21
6.9	Network Element Addressing.....	22
6.9.1	<i>Loopback IP Address</i>	22
6.9.2	<i>I-BEB</i>	22
6.9.3	<i>IPv4 Addressing</i>	22
6.9.4	<i>IPv6 Addressing</i>	23
6.10	Management Addresses	23
6.11	Documentation Requirements.....	24
6.12	IP Services	25
6.12.1	<i>Other Daemons</i>	26
6.12.2	<i>DHCP Relay Configuration</i>	26
6.12.3	<i>Physical Product Requirements</i>	26

6.12.4	General Requirements	26
6.12.5	Power Requirements	26
6.12.6	Rack Mount Requirements	26
6.12.7	Cabling	26
6.12.8	Grounding.....	27
6.12.9	Environmental Requirements.....	27
6.13	Message of the Day	27
6.14	Broadband Intercept (public IP only)	27
6.15	Diagnostics	27
6.15.1	System Diagnostics	27
6.15.2	IP Diagnostics	27
6.15.3	Ethernet Diagnostics.....	28
6.16	Certificate Entry.....	28
7	EPON SPECIFIC IP NE REQUIREMENTS	29
7.1	EPON Configuration	29
7.2	EPON Interface Requirements.....	29
7.3	10G-EPON and 1G-EPON Compatibility Settings.....	29
7.4	Show Cable Modem	29
7.5	EPON Diagnostics	30
7.6	Multi-Source Agreement Transceivers	30
7.7	DPoE ONU Logging.....	30
8	DPOE PROTOCOL SPECIFIC SUPPORT	31
8.1	MULPI Parameters	31
8.1.1	Bundling.....	31
8.1.2	IP Serving Group (IP-SG)	31
8.2	MEF Parameters	33
8.2.1	Encapsulation and Tagging	33
8.2.2	TPID Translation.....	33
8.2.3	I-BEB	33
8.3	OSSI Parameters.....	34
9	COMBINED IP(HSD) AND MEF NNI FORWARDING REQUIREMENTS	35
9.1	Ethernet Interface Requirements.....	35
9.1.1	Link Aggregation (LAG).....	35
9.1.2	D and MN Interface Data Rates	35
9.1.3	NNI Link Aggregation.....	35
9.2	IP Forwarding Requirements	36
9.2.1	IP Interfaces.....	36
9.2.2	Multi-Protocol	37
9.2.3	Label Forwarding.....	37
9.2.4	SF QoS Assignment.....	37
9.3	IP Routing.....	38
9.3.1	Route Distribution	38
9.3.2	Bi-Directional Forwarding Detection	38
9.3.3	Equal Cost Multi-Path.....	38
9.3.4	Policy Routing	38
9.3.5	Static Routes	38
9.3.6	Default Route	38
9.3.7	Interior Gateway Protocols (IGPs)	38
9.3.8	Autonomous System Routing.....	39
9.3.9	BGP Routing.....	40
9.3.10	MPLS	40
9.4	IP Routing Debug	40
9.5	Host Routing.....	40

9.6	CMCI Routing	40
9.7	IP Traffic Engineering	41
APPENDIX I CMTS EXAMPLE CONFIGURATION FILE A		42
APPENDIX II CMTS EXAMPLE CONFIGURATION B.....		51
II.1	CMTS Example Configuration B File with Explanations	51
II.2	CMTS Example Configuration File B	62
APPENDIX III EXAMPLE OF IS-IS CONFIGURATION		80
APPENDIX IV DPOE EXAMPLE CONFIGURATION FILE		81
APPENDIX V ACKNOWLEDGEMENTS		91
APPENDIX VI REVISION HISTORY		92
VI.1	Engineering Change for DPoE-SP-IPNEv1.0-I02-120607	92
VI.2	Engineering Change for DPoE-SP-IPNEv1.0-I03-120830	92
VI.3	Engineering Change for DPoE-SP-IPNEv1.0-I04-121115	92
VI.4	Engineering Change for DPoE-SP-IPNEv1.0-I05-130328	92
VI.5	Engineering Change for DPoE-SP-IPNEv1.0-I06-130808	92

Figures

Figure 1 - DPoE Reference Architecture	5
Figure 2 - DPoE Interfaces and Reference Points.....	6
Figure 3 - DPoE Network Elements	11

Tables

Table 1 - DPoE Specifications.....	4
Table 2 - DPoE Interface and Reference Point Descriptions.....	7

1 INTRODUCTION

Comcast Corporation, Time Warner Cable, and Bright House Networks collaborated to develop the interoperability requirements to support business services products using Ethernet Passive Optical Network (EPON) as an access technology.

DOCSIS Provisioning of EPON (DPoE) is a joint effort of operators, vendors, and suppliers to support EPON technology using existing DOCSIS-based back office systems and processes.

Ethernet PON or EPON is an [802.3] standard for a passive optical network (PON). A PON is a specific type of multi-access optical network. A multi-access optical network is an optical fiber based network technology that permits more than two network elements to transmit and receive on the same fiber. Appendix I in [DPoE-SP-ARCHv1.0] has a more detailed explanation of multi-access optical networks.

This version of the DPoE specifications is focused on DOCSIS-based provisioning and operations of Internet Protocol (IP) using DOCSIS High Speed Data (HSD), or IP(HSD) for short, and Metro Ethernet Forum (MEF) services. DPoE Networks offer IP(HSD) services functionally equivalent to DOCSIS networks, where the DPoE System acts like a DOCSIS CMTS and the DPoE System and DPoE Optical Network Unit (ONU) to appear to act like a DOCSIS CM.

1.1 DPoE Technology Introduction

DPoE technology was established with the following common requirements already developed by operators. Each of the participant operators had previously selected 1G-EPON and 10G-EPON as the appropriate technology for one or more applications. EPON is a widely-deployed technology with a sufficient and large supply of vendors offering a variety of products for each component of the access network. 10G-EPON technology is now becoming available and is backwards compatible with 1G-EPON. A 1G-EPON network can be incrementally upgraded to 10G-EPON, adding or replacing ONUs one at a time if required. 1G-EPON and 10G-EPON are compatible with [SCTE 174], Radio Frequency over Glass (RFoG).

The EPON protocol [802.3ah] and the amendment for 10G-EPON [802.3av] support a centralized Optical Line Termination (OLT) architecture with low cost Layer 2 access devices (ONU). The basic service mapping architecture in EPON is to map Ethernet (or IP) frame header information (such as addresses, IP DiffServ Code Points, Ethernet Q tag, S-VLAN/C-VLAN ID, I-SID, bridge address, or other marking) to a logical circuit called a Logical Link Identifier (LLID) in [802.3ah]. The service function is similar to that used in DOCSIS networks in many ways because it is based on a centralized scheduler and uses an LLID which functions like an SID, supports both unicast and broadcast, and has other similarities.

Existing [802.3ah] EPON systems do interoperate within the strict definitions of 1G-EPON. Experience with lab testing, field trials, and deployments has shown operators that 1G-EPON OLT and ONU systems typically only interoperate with a single port ONU. This is because [802.3ah] specifies the interfaces on the PON (the DPoE TU interface) but does not specify any of the other system interfaces. For example, an OLT from vendor A will register an ONU from vendor B, but it is not possible to construct a VLAN from the DPoE MN interface to an S interface. This is a well-recognized limitation of [802.3ah]. The challenge is that neither 1G-EPON nor 10G-EPON specify Operations Administration Maintenance and Provisioning (OAMP) to forward traffic between Network to Network Interface (NNI) ports and the PON, or User Network Interface (UNI) ports and the PON. This is not different from other Ethernet standards. For example, if two Ethernet switches from two different vendors are connected, each switch must typically be configured independently. The challenge for EPON is that the remote device (the ONU) cannot be reached, and therefore cannot be configured. A solution to this problem must then be based on developing a common (standard) method of reaching the controller for the ONU, identifying the ONU capabilities, and providing that information to the OLT so that it can configure a working end to forwarding service (in both directions).

Even if EPON had solved that provisioning challenge, there are no standard management interfaces for the ongoing operations and maintenance of the network, including fault management, performance management, security, etc. Operators already have fully working and scaled-out systems that solve these challenges for DOCSIS networks. One of the primary goals for DPoE specifications is to use the existing DOCSIS back office infrastructure to scale up EPON-based business services.

1.2 Scope

This document identifies requirements for the IP network element operation, administration, maintenance, provisioning, forwarding, and signaling for DPoE System NNI interfaces. The scope is limited to the interfaces required for the DPoE System element and excludes those interfaces already specified elsewhere in [DOCSIS], DPoE specifications, Packet Cable, or Packet Cable Multimedia. This version of the specification does not include requirements for IPv6 or multicast.

The forwarding and signaling requirements are a subset of the D and MN interfaces requirements. In addition to this specification, D and MN requirements are specified in [DPoE-SP-MULPIv1.0] and [DPoE-SP-OSSIV1.0].

Requirements for some interfaces may use the same protocols as those protocols used in the other DPoE specifications, but do not overlap. For example, this document specifies additional SNMP requirements that are not specified in [DPoE-SP-OSSIV1.0] for IP routing and other functions not addressed by [DOCSIS] which [DPoE-SP-OSSIV1.0] loosely mirrors.

IP NE requirements include IEEE Ethernet protocol, IETF protocol, and non-standard Command Line Interface (CLI) or other functional requirements.

Most of the NE requirements are independent of specific services. The common requirement for all of the NNIs is [802.1Qaz]. In particular these interfaces require most Ethernet link layer and Media Access Control (MAC) layer services. The interfaces are not exclusive of each other. Although MEF and Ethernet services will be delivered over a Layer 2 NNI, IP services and IP OAMP operate over a converged IP router function across one or more address spaces. Therefore, the scope of the IP Network Element requirements includes IP routing functions identical to those in CMTS systems deployed by operators today. The IP requirements can be converged with the Layer 2 requirements either by the use of separate interfaces or of by combining the D and MN interfaces as sub-interfaces on a trunked Ethernet physical link or a trunked Ethernet logical link formed by link aggregation across multiple physical Ethernet interfaces.

1.3 Goals

Collectively, the operators started the DPoE specification development to accomplish the following objectives:

- Identify and document the common requirements for triple play services for business customers over EPON.
- Adapt DOCSIS-based back office provisioning and operations models to EPON. This is the core objective of DPoE specifications.
- Develop consensus on additional requirements above and beyond DOCSIS specifications to take advantage of the capabilities of EPON. These are focused in the area of Ethernet services and MEF integration.
- Continue to leverage the supply chain and economic benefits of a large base of suppliers and high-volume supply chain in optics, subsystems, and network systems based on a commodity EPON technology. Doing so requires adapting operator processes and networks to the EPON system rather than making any changes to the EPON systems.
- Position DPoE specifications to continue to leverage those same benefits for 10G-EPON.
- Work with the established EPON vendor community to assure that these strategies can be effective to mutually develop DPoE Networks, and to create a marketplace for success for multiple vendors to provide solutions for the variety of needs within the operator environment.

1.4 Requirements

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

1.5 Organization of Specifications

The DPoE specifications are organized around existing DOCSIS specifications. The purpose of matching DPoE specification documents to existing CableLabs DOCSIS, IEEE, IETF, and MEF requirements is to facilitate the mapping of services from existing DOCSIS infrastructure to DPoE infrastructure, and to provide an organization that will be easy to maintain as related (referenced) standards, recommendations, or specifications undergo independent changes.

There are two types of documents in the DPoE specifications. The first includes informative and requirements documents called specifications that detail the specific requirements for products claiming compliance with the specifications. The DPoE specifications also include a new kind of document that does not fit into any of the above categories. The IP Network Elements (IP NE) Requirements are a set of common requirements for the management of IP network elements that operators have developed, which are above and beyond the requirements in DOCSIS specifications, but are nonetheless required in DOCSIS CMTS products today. These are not specifications because no new protocols or algorithms are provided. Most of the requirements in IP NE are existing requirements based on IEEE, IETF, or other network management standards.

The DPoE documents are detailed in Section 1.6 of this document and duplicated, for reference, in each of the DPoE specifications.

1.6 DPoE Specifications

This document is one in a series of nine (9) documents comprising the DPoE specifications. Collectively these documents represent the operators' requirements for EPON-based commercial services.

Table 1 - DPoE Specifications

Document	Document Title	Description
DPoE-SP-ARCHv1.0	DPoE Architecture Specification	DOCSIS Provisioning of EPON introduction, architecture, and narrative. Specifies fundamental architectural requirements (those that apply to more than one specification). Explains the purpose of each document below.
DPoE-SP-OAMv1.0	DPoE OAM Extensions Specification	Extensions beyond [802.3ah] and [802.3av] requirements.
DPoE-SP-PHYv1.0	DPoE Physical Layer Specification	Using the EPON PHY, the DPoE PHY specification makes mandatory some options within EPON and adds some additional requirements.
DPoE-SP-SECv1.0	DPoE Security and Certificate Specification	Specifications for support for DOCSIS network and system interfaces to provide transparent support of DOCSIS device authentication, code verification, and additional security for a DPoE implementation.
DPoE-SP-IPNEv1.0	DPoE IP Network Element Requirements	Best practices and operator requirements for IP network element management and operations. This document includes CMTS-like IP router requirements. This document recommends practices not currently covered by any existing DOCSIS specifications.
DPoE-SP-MULPIv1.0	DPoE MAC and Upper Layer Protocols Requirements	Specifications for support of a subset of DOCSIS 3.0 MULPI functionality with additional EPON requirements.
DPoE-SP-MEFv1.0	DPoE Metro Ethernet Forum Specification	Specifications for Metro Ethernet services added to DOCSIS static configuration provisioning model.
DPoE-SP-OSSIv1.0	DPoE Operations and Support System Interface Specification	Specifications for support of a subset of DOCSIS 3.0 OSSI functionality with additional EPON requirements.
DPoE-SP-DEMARCv1.0	DPoE Demarcation Device Specification	Specifications to support the DEMARC Auto-Configuration process to discover and provision a demarcation device connected to a DPoE ONU.

1.7 Reference Architecture

The DPoE reference architecture identifies the elements that a DPoE Network minimally requires to illustrate and communicate the physical hardware and logical software interfaces between the functional subsystems of the DPoE architecture. The principal elements in the architecture are the DPoE System that resides in the operator network, and the DPoE ONU which may be an off the shelf EPON ONU, EPON SFP-ONU, or an EPON ONU with additional subsystems. The remaining elements in the architecture are existing servers and systems in the operator's network. All of the server elements have connectivity through an IP (TCP/IP) network. Transport of bearer traffic, and (in some cases) Layer 2 OAM signaling is available through either IP or Layer 2 Ethernet-based Network Interfaces.

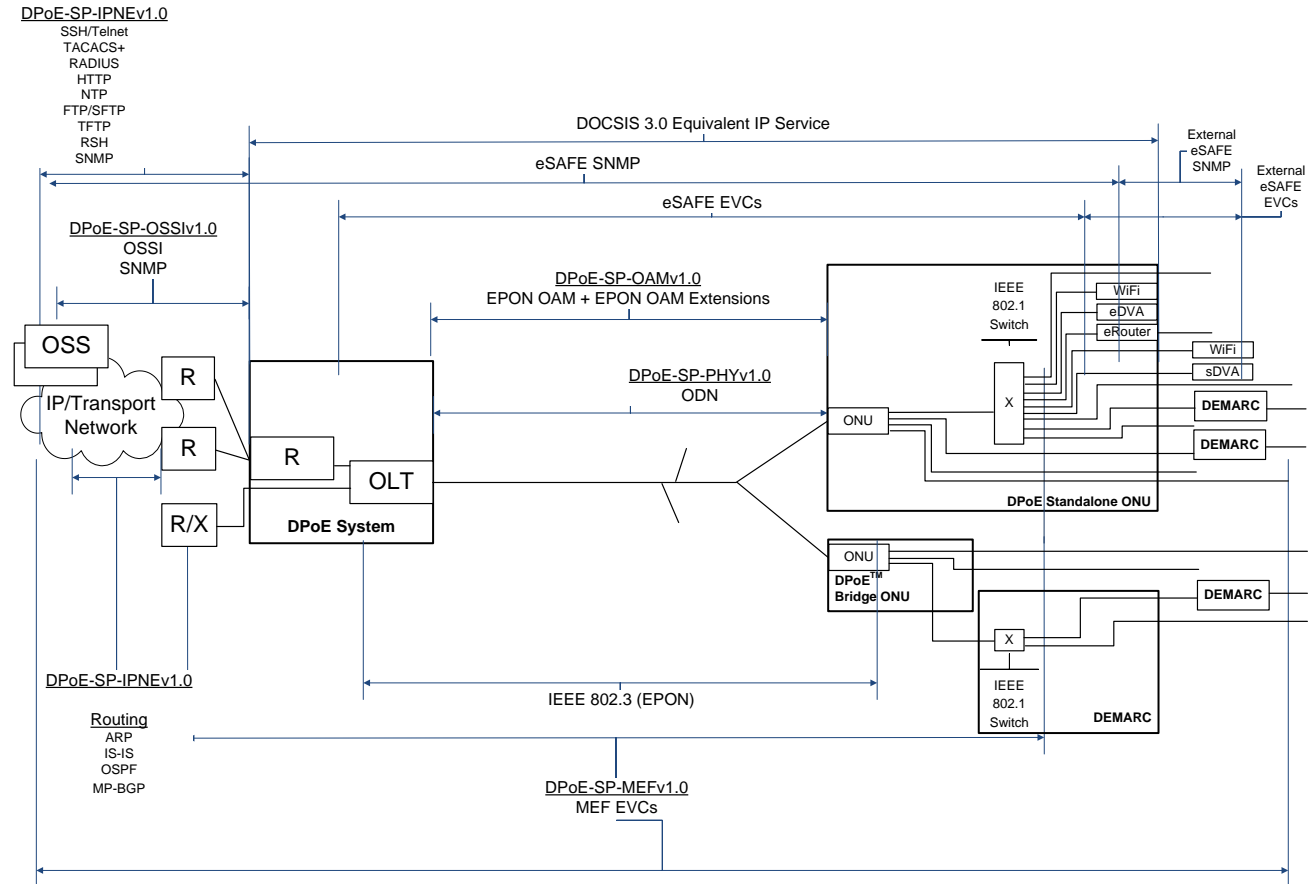


Figure 1 - DPoE Reference Architecture

Table 2 - DPoE Interface and Reference Point Descriptions

Interface or Reference Point		Interface or Reference Point Description
MN		The MN interface is an [802.3] interface for Ethernet (or MEF or [L2VPN] emulated) services only. It serves the role of a MEF INNI or L2VPN NSI. It is an NNI for Metro Ethernet services only.
D		The D interface is the DOCSIS IP NNI interface. It is an operator network facing interface, sometimes called a Network to Network Interface (NNI) or Network Systems Interface (NSI) in DOCSIS specifications. The D interface allows a DPoE System to communicate with an IP network. The D interface carries all IP management traffic including OSSl and IP NE traffic. The D interface carries all DOCSIS IP service traffic.
TU		The TU interface is a short form of expressing the interface between the DPoE System and the DPoE ONU.
C		The C reference point is used for explanation of traffic ingress to a DPoE classifier.
	C _O	The C _O reference point is used for explanation of traffic ingress to a DPoE ONU upstream classifier.
	C _S	The C _S reference point is used for explanation of traffic ingress to a DPoE System downstream classifier.
S		The S interface is an IEEE 802 interface. The S interface may be an internal interface (such as [802.3] across a GMII SERDES or XGMII interface in an SFP-ONU, SFP+ONU, or XFP-ONU) or it may be an external Ethernet interface. S ₁ is an interface for a DPoE Standalone ONU. S ₂ is a reference point used for explanation of services with the DPoE Bridge ONU.
	S ₁	The S ₁ interfaces are the general case of all interfaces on a DPoE Standalone ONU. S ₁ interfaces may be CMCI, LCI, MI, or MU interfaces.
	S ₂	The S ₂ reference point is used for explanation of traffic ingress to and egress from interfaces on a DEMARC device in a DPoE System. Although there are no specifications or requirements for the S ₂ reference point, informative text refers to the S ₂ reference point to provide the full context for the use of a DPoE Bridge ONU in a DEMARC device providing Metro Ethernet services.
LCI		The Logical CPE Interface (LCI) interface is an eDOCSIS interface as defined in [eDOCSIS]. The eDOCSIS architecture is [802.1d] MAC-based according to the DOCSIS 3.0 specifications; however, DOCSIS L2VPN clearly supports [802.1q] switching. In practice, therefore, the eDOCSIS interface consists of a DOCSIS classifier and [802.1] switch as illustrated. The function of a DOCSIS classifier is in part replaced by forwarding (tagging and encapsulation) in MEF and in part covered by classifiers in [DPoE-SP-MULPIv1.0].
CMCI		CMCI is the DPoE interface equivalent of the DOCSIS Cable Modem CPE Interface as defined in [CMCIv3.0]. This is the service interface for DOCSIS-based IP services.
MI		MI is usually an S interface (or S reference point) that operates as a MEF INNI. A DPoE ONU that provides a MEF INNI has an MI interface. A DPoE ONU can have MU as an interface and an MI reference point on different S interfaces in a single DPoE ONU. The MI interface or reference point is an [802.3] interface (or reference point) between a DPoE ONU and a DEMARC device.
MU		MU is usually an S interface (or S reference point) that operates as a MEF UNI. A DPoE ONU that directly provides a MEF UNI (MU) interface has MU as an interface. A DPoE ONU can have MU as an interface and an MI reference point on different S interfaces in a single DPoE ONU. The MU interface or reference point is an [802.3] interface (or reference point) between a DPoE ONU or a DEMARC device and a customer's equipment.

2 REFERENCES

2.1 Normative References

In order to claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references. At the time of publication, the editions indicated were valid. All references are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below. References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific. For a non-specific reference, the latest version applies.

- [802.1ah] IEEE Std. 802.1ah-2008, IEEE Standard for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks – Amendment 6: Provider Backbone Bridges, January 2008.
- [802.1d] IEEE Std. 802.1d™-2004, IEEE Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges, June 2004.
- [802.1q] IEEE Std. 802.1q-2009, IEEE Standard for Local and Metropolitan Area Networks-Virtual Bridged Local Area Networks, January 2010.
- [802.1] Refers to entire suite of IEEE 802.1 standards unless otherwise specified.
- [802.3] IEEE 802.3-2008, Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and Physical Layer specifications, January 2008.
- [802.3ah] IEEE 802.3ah™-2004: Amendment to IEEE 802.3™-2005: Media Access Control Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks, now part of [802.3].
- [802.3av] IEEE 802.3AV-2009, IEEE Standard for Information technology-Telecommunications and information systems-Local and metropolitan area networks-Specific requirements, Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment 1: Physical Layer Specifications and Management Parameters for 10Gb/s Passive Optical Networks.
- [CANN-DHCP-Reg] CableLabs' DHCP Options Registry, CL-SP-CANN-DHCP-Reg, Cable Television Laboratories, Inc.
- [CBI2.0] Data-Over-Cable Service Interface Specifications, Cable Broadband Intercept Specification, CM-SP-CBI2.0, Cable Television Laboratories, Inc.
- [CMCIv3.0] Data-Over-Cable Service Interface Specifications, Cable Modem to Customer Premise Equipment Interface Specification, CM-SP-CMCIv3.0, Cable Television Laboratories, Inc.
- [DPoE-SP-ARCHv1.0] DPoE-SP-ARCHv1.0, DOCSIS Provisioning of EPON, DPoE Architecture Specification, Cable Television Laboratories, Inc.
- [DPoE-SP-DEMARCv1.0] DPoE-SP-DEMARCv1.0, DOCSIS Provisioning of EPON, DPoE Demarcation Device Specification, Cable Television Laboratories, Inc.
- [DPoE-SP-MULPIv1.0] DPoE-SP-MULPIv1.0, DOCSIS Provisioning of EPON, MAC and Upper Layer Protocols Requirements, Cable Television Laboratories, Inc.
- [eDOCSIS] Data-Over-Cable Service Interface Specifications, eDOCSIS Specification, CM-SP-eDOCSIS, Cable Television Laboratories, Inc.
- [RFC 2355] IETF RFC 2355, TN3270 Enhancements, June 2006.
- [RFC 2575] IETF RFC 2575, View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP), B. Wijnen, R. Presuhn, K. McCloghrie, April 1999.
- [RFC 2863] IETF RFC 2863, The Interfaces Group MIB, K. McCloghrie, F. Kastenholz, June 2000.
- [RFC 4022] IETF RFC 4022, Management Information Base for the Transmission Control Protocol (TCP), February 2004.
- [RFC 4113] IETF RFC 4113, Management Information Base for the User Datagram Protocol (UDP), October 2004.
- [RFC 4293] IETF RFC 4293, Management Information Base for the Internet Protocol (IP), S. Routhier, April 2006.

[RFC 4750] IETF RFC 4750, OSPF Version 2 Management Information Base, December 2006.

2.2 Informative References

This specification uses the following informative references.

- [802.1ad] IEEE Std. 802.1ad-2005™, IEEE Standard for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks Amendment 4: Provider Bridges, May 2006.
- [802.1ag] IEEE Std. 802.1ag™-2007, IEEE Standard for Local and metropolitan Area Networks – Virtual Bridged Local Area Networks Amendment 5: Connectivity Fault Management, December 2007.
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2.3 Reference Acquisition

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- Internet Engineering Task Force (IETF) Secretariat, 48377 Fremont Blvd., Suite 117, Fremont, California 94538, USA, Phone: +1-510-492-4080, Fax: +1-510-492-4001, <http://www.ietf.org>
- Institute of Electrical and Electronics Engineers (IEEE), +1 800 422 4633 (USA and Canada); <http://www.ieee.org>
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- SCTE, Society of Cable Telecommunications Engineers Inc., 140 Philips Road, Exton, PA 19341 Phone: +1-800-542-5040, Fax: +1-610-363-5898, Internet: <http://www.scte.org/>

3 TERMS AND DEFINITIONS

3.1 DPoE Network Elements

DPoE Network	This term means the entire network described in Figure 3 from the D or MN interface to the LCI, S, MI, or MU interface (see Figure 2 for interface and reference points), depending on the service being described. In no case does the term DPoE Network ever include a DEMARC device.
DPoE System	This term means all of the collected elements that provide the DPoE function within the operator's network facilities. This includes the EPON OLT function, DOCSIS service functions required for the D interface, Metro Ethernet service functions required for the MN interface, and IP NE element management, routing and forwarding functions specified in this specification. The DPoE System is depicted in Figure 3.
DPoE ONU	This term means a DPoE-capable ONU that complies with all of the DPoE specifications. There are two types of DPoE ONUs. These are the DPoE Standalone ONU and the DPoE Bridge ONU.
DPoE Standalone ONU	This term means a DPoE ONU that is a standalone ONU capable of providing IP or Ethernet services directly to customer premise equipment or transport of traffic to an external DEMARC device.
DPoE Bridge ONU	This term means a DPoE ONU that is capable of [802.1] forwarding but cannot do all of the encapsulation functions required to be a DPoE Standalone ONU. Examples include an SFP-ONU and some simple EPON chipset-only based ONUs.
DEMARC	Short form of "Demarcation Device." This term means the device, owned and operated by the operator that provides the demarcation (sometimes called the UNI interface) to the customer. Some architecture describes this device as the CPE (as in DOCSIS, DSL, or Broadband Forum Models) or the NID (as in the MEF model).

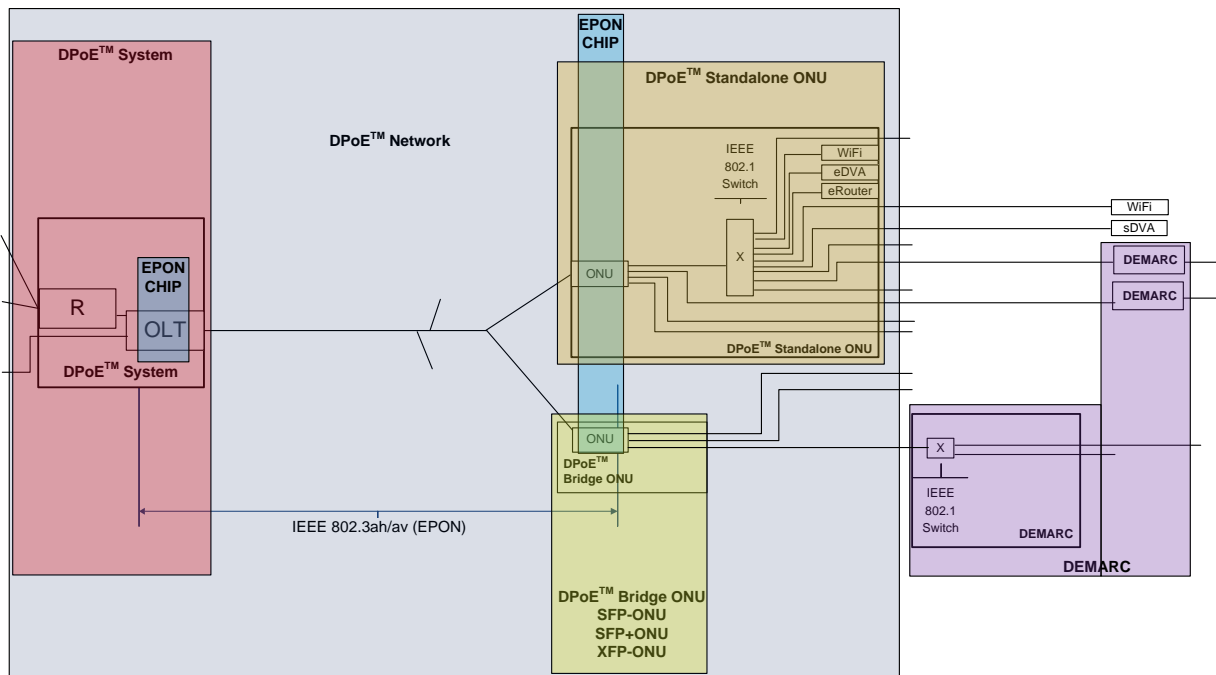


Figure 3 - DPoE Network Elements

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations:

1G-EPON	EPON as defined in [802.3ah]
10G-EPON	EPON as defined in [802.3ah] and amended in [802.3av]
ACL	Access Control Lists
ARP	Address Resolution Protocol
BFD	Bi-directional Forwarding Detection
CFM	Connectivity Fault Management
CLI	Command Line Interface
CM	Cable Modem
CMCI	Cable Modem CPE Interface
CMTS	Cable Modem Termination System
CPE	Customer Premise Equipment
CoS	Class of Service
DSCP	Diff-Serv Code Point
DPoE	DOCSIS Provisioning of EPON
DR	Default Router
EACL	Extended Access Control Lists
eCM	embedded Cable Modem
ECMP	Equal Cost Multi-path
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
EPON	Ethernet Passive Optical Network
eSAFE	embedded Service/Application Functional Entity
FTP	File Transfer Protocol
HSD	High Speed Data
Gbps	Gigabits per second (as used in the industry)
IGP	Interior Gateway Protocols
IP(HSD)	High Speed Data (Broadband Internet Access using DOCSIS)
INNI	Internal Network to Network Interface
IP	Internet Protocol
IP-SG	IP Serving Group
I-SID	[802.1ah] I-Component Service Identifier
LCI	Logical CPE Interface
LDP	Label Distribution Protocol
LLID	Logical Link Identifier
LOM	Lights Out Management
LSA	Link State Advertisement
MAC	Media Access Control
MEF	Metro Ethernet Forum
MEN	Metro Ethernet Network

MI	MEF INNI Interface at a customer premise
MLS	Multi-Layer Switching
MN	MEF INNI Interface to operators MEN
MOTD	Message Of The Day
MPLS	Multi-protocol Label Switching
MSA	Multi-source Agreement
MU	MEF UNI Interface
NE	Network Elements
NEBS	Network Equipment Building Standard
NID	Network Interface Device
NNI	Network to Network Interface
OAM	EPON Operations Administration and Maintenance
OAMP	Operations Administration Maintenance and Provisioning
ODN	Optical Distribution Network
OLT	Optical Line Termination
ONU	Optical Network Unit
OSC	Optical Splitter Combiner
PB	Provider Bridging [802.1ad]
PBB	Provider Backbone Bridging [802.1ah]
PHY	Physical Layer
PON	Passive Optical Network
PPP	Point to Point Protocol
QoS	Quality of Service
R	IP Router
RADIUS	Remote Authentication Dial In User Service
RFoG	Radio Frequency over Glass
RIP	Routing Information Protocol
sDVA	Standalone Digital Voice Adapter
SFP	Small Form-factor Pluggable
SFP+	Small Form-factor Pluggable Plus (+)
SLARP	Serial Line Address Resolution Protocol
SLIP	Serial Line Internet Protocol
TOS	Terms of Service
TACACS+	Terminal Access Controller Access-Control System Plus
TPID	Tag Protocol Identifier
ULL	Underwriter Laboratory Listing
UNI	User Network Interface
UTC	Coordinated Universal Time
vCM	Virtual Cable Modem
VLAN	Virtual Local Area Network
VLSM	Variable Length Subnet Masking
X	IEEE Ethernet Switch (Generic)

XFP

X Form-factor Pluggable

5 IP NE FUNCTIONS (INFORMATIVE)

Existing [DOCSIS] based CMTS have a number of functions that are necessary which are not specified or explained in the [DOCSIS] or DPoE Specifications. This section provides the rationale and description of the functions required by CMTS and DPoE Systems.

The [DOCSIS] specifications provide a standard set of methods for the interoperability of Cable Modems (CM) and Cable Modem Termination Systems (CMTS). These methods require standard interfaces and capabilities for the DOCSIS RF interfaces and the operations, administration, maintenance, and provisioning of CMs to that any operator's systems and any CMTS can operate any CM. DOCSIS has proven to be very effective for multi-vendor CM interoperability across multiple operators and multiple CMTS vendors.

The [DOCSIS] specifications do contain requirements for some aspects of CMTS OAMP. These are focused primarily on the interoperability described above. However, [DOCSIS] requirements are silent on the forwarding and signaling architecture for both Ethernet and IP NNI interface that connects the CMTS to the operator's Ethernet and IP networks. [DOCSIS] also provides some minimal requirements for the management of the CMTS entity, but is again silent on entity requirements such as the IP address of the element itself, security, and access to the element itself, etc.

In lieu of specifications for the CMTS, operators have, over their years of experience, developed product requirements for their CMTS vendors. This document collects the requirements from the participating operators and provides a single document as a baseline for the requirements for CMTS that will apply to DPoE Systems.

Although the operators do have requirements for IPv6 for CMTS, this document does not identify IPv6 requirements for DPoE Systems because they are not included in the scope of this version of the DPoE specifications.

6 DPOE SYSTEM IP NE REQUIREMENTS

Despite the extensive detail for the configuration of Cable Modems, DOCSIS specifications do not describe the configuration of the CMTS. Like DOCSIS, the other DPoE specifications are focused on the Operations, Administration, Maintenance, and Provisioning of DPoE ONUs. DOCSIS and the other DPoE specifications identify requirements for the CMTS and DPoE System (respectively) but do not specify methods of provisioning the CMTS and DPoE System. This document specifies only those (missing) requirements not otherwise specified.

6.1 Network Element Access Methods and Operations

6.1.1 Command Line Interface¹

The DPoE System **MUST** have a Command Line Interface (CLI). The DPoE System **MUST** have a serial port terminal for the management and operation of the complete DPoE System. The DPoE System **MUST** make the CLI accessible from a serial port terminal and from configurable IP loopback addresses using the SSH2 protocol. The DPoE System CLI is expected to be identical CLI whether accessed via terminal / serial interface or IP via SSH2 or telnet. The DPoE System **MUST** have the capability to support Access Control Lists (ACLs) and Extended Access Control Lists (EACLs) to limit the connection of clients to the SSH2 daemon by source IP address.

The DPoE System CLI is expected to provide a structured command syntax format for input and output in order to support scripting.

The DPoE System CLI **MUST** provide context sensitive help. The DPoE System **SHOULD** provide command interactive command completion using the ASCII TAB character when the existing portion of an entered command is unique and can be completed without further information typed, sent or read into the CLI parser.

The DPoE System CLI **MUST** support a configurable idle-timer to automatically log off clients connected via serial ports locally or remotely over IP after the configured period of time.

The DPoE System CLI **MUST** provide a capability to list all clients connected to the CLI (by any means available). The DPoE System CLI **MUST** provide a method to disconnect selected clients connected to the CLI from the CLI.

The DPoE System CLI prompt **MUST** be operator configurable from the CLI and from the configuration file.

The DPoE System **MUST** support CLI access from any means for at least four (4) sessions simultaneously. The DPoE System **MUST** support simultaneous access for users with different privileges. The DPoE System **MUST** allow at least four (4) simultaneous CLI users to enter an active configuration mode simultaneously and enter real-time configuration changes or make changes to a configuration file. The DPoE System **MUST** inform each connected CLI user that another user has connected to the CLI or been disconnected from the CLI. The DPoE System **MUST** inform each connected CLI user that another user has entered a configuration mode when in the CLI.

6.1.2 Terminal Access²

The DPoE System **MUST** support VT100 terminal access via serial port with RJ-45 or RS-232 connectors to the CLI. The DPoE System terminal access **MUST NOT** require the use of IP addresses, Serial Line Internet Protocol (SLIP), or Point to Point Protocol (PPP).

The DPoE System terminal access **MUST** provide access to the entire DPoE System. The DPoE System **MAY** have more than one port for terminal access. If the DPoE System has more than one port for terminal access, all terminal access ports are expected to provide identical functionality.

¹ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

² Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

6.1.3 Lights Out Management

The DPoE System MAY provide Ethernet-based Lights Out Management (LOM) interface which may use Serial Line Address Resolution Protocol (SLARP), SLIP, PPP, or other means of automatic IP address and IP network configuration to provide console or terminal access.

The DPoE System Lights Out Management (LOM) access MUST provide access to all of the hardware in the DPoE System. The DPoE System MAY have more than one port for LOM. If the DPoE System has more than one LOM port, all LOM ports MUST provide identical functionality.

6.1.4 Secure Login³

The DPoE System MUST support non-encrypted password access via Telnet if configured.

The DPoE System MUST support MD5 encrypted storage of passwords for CLI access (by any means) if configured.

The DPoE System MUST support encrypted password access via SSH2 if configured.

The DPoE System MUST support Remote Authentication Dial In User Service (RADIUS) for password authentication if configured.

The DPoE System MUST support Terminal Access Controller Access-Control System Plus (TACACS+) for password authentication if configured.

The DPoE System MUST support at least two operating RADIUS or two operating TACACS+ servers.. At any time, only one of operating authentication servers is expected to be active. The DPoE System is expected to be able to forward authentication requests to the currently active authentication server. The details of how DPoE System tracks authentication server status and selects the authentication server to send authentication requests to are outside the scope of this specification.

The DPoE System MUST provide a local method for password recovery for passwords stored on the DPoE System. The DPoE System LOM or serial port MUST allow access to the password recovery method. The DPoE System MUST NOT allow access to the password recovery method over the D, MN, or TU interfaces.

The DPoE System SHOULD provide a method to configure (from the CLI and in the configuration file) the DPoE System to limit access to each and every CLI command and each and every configuration command based on the type of secure login (SSH2, RADIUS, TACACS+, Telnet, or local), the operator name (username), and the time of day.

6.1.5 Client Applications

The DPoE System MUST support Telnet and SSH2 as a client. The DPoE System MUST allow the use of either target IP addresses or DNS names when acting as a client. The purpose of this functionality is to allow operators logged into a DPoE System to login to another system (DPoE System, CMTS, server, router, etc.) without logging out of the DPoE System.

The DPoE System MUST act as a DNS client. DNS client support is required for TCP/IP applications. For example, an operator might use ftp and want to designate the hostname using DNS rather than having to know the IP address. The DPoE System MUST be configurable to support at least two DNS servers configured by IP address in the configuration file.

The DPoE System MUST act as an NTP client. The DPoE System MUST be configurable to support at least two NTP servers configured by IP address in the configuration file.

³ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 and IPNEv1.0-N-12.0045-1 on 10/25/12 by JB.

6.1.6 Command Logging⁴

The DPoE System MUST log (if enabled) commands entered from any active CLI connection to a log file. Each DPoE System command log file entry MUST contain the exact command as entered, a time and date stamp, and the login identification used by the operator that entered the command.

The DPoE System MUST provide a means (in the configuration file and at the command line) to enable and disable command logging. The DPoE System MUST provide a means to limit the capability enable and disable command logging to specifically authorized operators based on the login identification.

The DPoE System MUST log (if enabled) commands entered from any active CLI connection to configured TACACS+ server. Each DPoE System TACACS+ command log entry MUST contain the exact command as entered, a time and date stamp, and the login identification used by the operator that entered the command.

The DPoE System SHOULD be capable of displaying entries from the command log, as described above; sorted by any combination of: login identification (name), date, and time.

The DPoE System MAY be capable of displaying entries from the command log, as described above; sorted or filtered by classes or categories of command as defined by the DPoE System vendor.

6.1.7 XML Management

The DPoE System MAY support XML-based management. The DPoE System MAY support XML-based management using:

- XML Configuration Files
- XML/SOAP over HTTP
- XML/SOAP over RSH
- XML with other access methods

If a DPoE System supports XML-based management, it SHOULD have a publicly published XML API using a well-known object architecture such as [NETCONF], custom SOAP objects, etc. A DPoE System that supports XML management and has an XML API SHOULD publish the API in the DPoE System documentation and have that same documentation available from the CLI.

6.1.8 SNMP⁵

The DPoE System MUST provide a unique text (string) description for the DPoE System in the object: system.sysDescr.0.

The DPoE System MUST provide a chassis serial number for each DPoE System chassis. The DPoE System serial number MUST NOT be operator configurable. The DPoE System MUST provide access to the chassis serial number for each chassis in the DPoE System by a MIB.

The DPoE System MUST support SNMPv2 MIBs specified in this document.

The DPoE System SHOULD support SNMPv3 MIBs specified in this document.

The DPoE System MUST support [RFC 2863] MIB II.

The DPoE System MUST support [RFC 4293] IP MIB for all IP interfaces (D and TU interfaces).

The DPoE System MUST support [RFC 4022] UDP MIB for all IP interfaces (D and TU interfaces).

The DPoE System MUST support [RFC 4113] TCP MIB for all IP interfaces (D and TU interfaces).

The DPoE System MUST support [RFC 2355] BGP4 MIB for DPoE System and D interface.

⁴ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

⁵ Revised per IPNEv1.0-N-12.0029-1 on 5/22/12 and per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

The DPoE System MUST support [RFC 4750] OSPF traps for the DPoE System and D interface.

The DPoE System MUST support [802.3] Ethernet MIBs for D interfaces.

The DPoE System MUST provide an industry standard or vendor-specific MIB to provide the following information:

- memory utilization
- CPU utilization
- hardware version for all DPoE System components that are modular (chassis, blades, servers, line cards, shelves, power supplies, etc.)
- firmware version for all DPoE System components that are modular (chassis, blades, servers, line cards, shelves, power supplies, etc.)
- software version for all DPoE System components that are modular (chassis, blades, servers, line cards, shelves, power supplies, etc.)
- fail over notifications for all redundant elements (processors, switches, fabrics, line cards, servers, ports, interfaces, power supplies, etc.)

The DPoE System MUST support at least two community strings for read-only (RO). The DPoE System MUST support at least two community strings for read-write (RW) that are distinct from the RO community strings.

The DPoE System SHOULD provide a method to separately limit or block each of both read and write access to MIB objects by OID based on the received community string for each SNMP message otherwise known as the view-based access control model for SNMP [RFC 2575].

The DPoE System MUST support at least two SNMP trap destination (servers or IP addresses).

The DPoE System SHOULD provide a method to individually enable and disable each possible trap required by this specification. The DPoE System SHOULD provide a method to assign a severity level for each possible trap.

6.2 Messages⁶

The DPoE System uses messages to all active login sessions to provide a method of notification to all active sessions. The DPoE System MUST provide a message to all active login sessions and create a matching local log entry for each of the following events: Configuration change is committed or saved.

- An interface is administratively configured up or down.
- A new session is started (logged in) or ended (logged out).
- An attempt to login fails.

The DPoE System SHOULD support the capability to configure the DPoE System to provide messages to all active login sessions and a matching local log entry for all configuration changes and state changes. The DPoE System MAY offer the capability to turn on or turn off specific verbose messaging and logging capabilities in addition to the all on or all off capability.

The DPoE System MUST provide a warning message to an active login session when that session enters an interactive configuration mode where changes entered can affect the configuration currently in use.

6.3 System Configuration File⁷

The DPoE System MUST provide a method for the transfer, storage, use, editing, and manipulation of a human-readable configuration file for the entire DPoE System as a single contiguous configuration file.

⁶ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

⁷ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

The DPoE System MAY use an XML format configuration file such as that described in [NETCONF]. The DPoE System SHOULD provide a method to designate a configuration file as the next active configuration file. The DPoE System SHOULD provide a separate method to activate the currently designated configuration file to load and run the system..

The DPoE System SHOULD provide a method for storage of a previous configuration (for roll-back or back-out) when configuration changes are made interactively or by file transfer.

The DPoE System SHOULD provide a complete revision control system for making, accepting, and providing comments on revision of configuration files such as RCS, SCCS, CVS, or similar tools.

The DPoE System SHOULD provide a method to compare the current (active) configuration and the immediate (previous) configuration, displaying the differences between the two files.

The DPoE System SHOULD provide a method to compare any two stored or saved configuration files, displaying the differences between the two files.

The DPoE System MUST provide a method to edit configuration files at the terminal of the device and over the SSH2 interface that is operable with a text based terminal or terminal window.

6.4 DPoE System Executable Software (Images)⁸

The DPoE System MUST operate as a single IP NE such that a single binary software image can be transferred to the system to provide the executable (binary) software image for the entire DPoE System.

The DPoE System image MUST be a monolithic system image for the entire DPoE System. The DPoE System executable (binary) software image MAY consist of various modules or other segments of code that the DPoE System can parse and use to manage the software of sub-systems within the DPoE System.

6.4.1 System Image Storage and Control

The storage capacity on the DPoE System is expected to be sufficient to store the active DPoE System executable software (image) currently running and at least two other versions of the software. This functionality is useful to allow the operator to roll-back or back-out the software to a previous version and download newer versions for software upgrades.

The DPoE System MUST have the capability for the operator to designate which of the available software images to load on the next reboot from among the available software images.

As part of the software release program, each published version of the DPoE System executable software (image) needs to include a separate file containing the corresponding MD5 hash computed against the executable image. The DPoE System MUST provide a command to read and compute an MD5 hash from the executable software (image) stored on the DPoE System and compare it to the corresponding MD5 key. The DPoE System MAY run this same executable software (image) file validation against an executable software (image) immediately before loading or running the image.

6.5 File Transfer

The DPoE System MUST support FTP and SFTP for the transfer of the binary software (as defined above) files, configuration files, and local log files (as defined above) to and from the DPoE System.

6.6 File Storage and Control⁹

The DPoE System SHOULD store configuration files in an ASCII formatted file.

⁸ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

⁹ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

6.6.1 Integrated¹⁰

The DPoE System **MUST** have integrated (or built-in) storage for configuration files, executable software (images) files, and local log files.

The DPoE System **MUST** have sufficient storage capacity to store the active DPoE System configuration file currently running and at least three other configurations for the DPoE System. This functionality is required in order to allow the operator to back-out the configuration to a previous configuration and download, edit, or create new configurations.

The DPoE System **SHOULD** have sufficient storage capacity to store the system configuration files as described above, all local logs, and any crash files, core dumps, or other diagnostic data. As described below, the size of the log files can be adjusted by operators to limit the space required for the potentially unbounded resource demands of logs.

The DPoE System **MUST** have the capability for the operator to designate which of the available configurations to run on the next reboot from among the available configurations.

6.6.2 Pluggable Storage

The DPoE System **SHOULD** support a pluggable storage medium capable of the same file storage and control as the integrated file storage and control described above. USB, PCMCIA Flash, Compact Flash, or other non-volatile memory could be used for such storage.

6.6.3 Local Log¹¹

The DPoE System uses local log as specified in [DPoE-SP-OSSv1.0]. The DPoE System **SHOULD** save the local log or a copy of the local log as an ASCII file.

6.7 Logs¹²

On the DPoE System there are requirements for log space to store vCM log events and requirements for log space to store DPoE System log events – hardware, software, and network interface failures – referred to as “platform logs”. The DPoE System **MUST** log all platform logs in a local log. The DPoE System **MUST** provide an option to store all platform logs in non-volatile memory in order to preserve log entries across system failures, administrative, or manual reboot or reloads.

The DPoE System **MUST** be configurable to log all debug messages into the “local log” for debugging functions that are configured or enabled (turned on).

The DPoE System **SHOULD** be configurable to set thresholds or threshold limits on performance management statistics to create local log, SNMP trap, and syslog events for all statistics.

The DPoE System **MUST** be configurable to set the size of the local log file in kilobytes, megabytes, or gigabytes.

6.8 Syslog Configuration¹³

The DPoE System **MUST** support syslog with support for facilities local0 through local7 (facilities 16 through 23). The DPoE System **SHOULD** offer a method (in the configuration file, at the CLI, and/or with XML) to map specific alarm, fault, error, and informational notifications to each facilities (local0 through local7) which is customizable by the operator.

¹⁰ Revised per IPNEv1.0-N-13.0096-1 on 7/16/13 by JB.

¹¹ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

¹² Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

¹³ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

The DPoE System MUST support logging to at least two syslog servers. The DPoE System SHOULD be configurable to filter the syslog events for each syslog server by at least syslog facility, but MAY also offer the capability to configure by additional criteria.

6.9 Network Element Addressing¹⁴

6.9.1 Loopback IP Address

DPoE System MUST support the configuration and operation of at least one (1) loopback interface. The DPoE System MUST support the configuration and operation of at least one (1) IPv4 host address per loopback interface. The DPoE System SHOULD support the configuration and operation of at least four (4) loopback interfaces. Loopback IP addresses are configured as host addresses and have an all 1's mask as shown in the example below.

Example loopback address configuration:

```
! Loopback for SNMP
interface loopback0
description SNMP address
ip address 10.1.1.1 255.255.255.255
!
! Loopback for Routing
interface loopback1
description D interface forwarding
ip address 1.1.1.1 255.255.255.255
```

6.9.2 I-BEB

The DPoE System is required to act as an I-BEB as specified in [DPoE-SP-MULPIv1.0]. The DPoE System MUST provide the capability to configure a single I-BEB address for the DPoE System. The DPoE System MUST provide the capability to configure the I-BEB from the CLI and in the configuration file. The DPoE System MAY provide the capability to configure the I-BEB with XML.

Example format of a CLI or configuration file command:

```
ibeb <hhhh>.<hhhh>.<hhhh>.<hhhh>
```

Where <hhhh>.<hhhh>.<hhhh>.<hhhh> is the assigned MAC address.

Here is an example with a MAC address:

```
ibeb 0000.0010.FF3C.ABCD
```

The I-BEB address on the DPoE System is the B-SA that DPoE ONUs using [802.1ah] will use when encapsulating ingress traffic to a DPoE ONU S interface. The I-BEB address on the DPoE System is the B-DA of ingress from at the MN interface that are coming from other DPoE ONUs (through DPoE Systems) that have used [802.1ah] encapsulation and configured the B-DA via the DHCP relay process described in [DPoE-SP-MULPIv1.0].

DPoE Systems use a single I-BEB address whether there is one or more than one MN interface. If an operator uses more than one MN interface the same I component Backbone Edge Bridge (I-BEB) could be reachable across more than one interface.

6.9.3 IPv4 Addressing

The DPoE System MUST support IPv4 network and netmask entry at the CLI and in configurations using either of the following two formats shown by example:

Universal Address	1.1.1.0 255.255.255.0
VLSM Short-Form	1.1.1.0/24

¹⁴ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

6.9.4 IPv6 Addressing

This section intentionally left blank.

6.10 Management Addresses¹⁵

The DPoE System SHOULD provide the capability to designate the following IP service proxies, ALGs, and IP signaling and forwarding to each loopback with the CLI, in the configuration file, and via XML (if XML is supported):

- IP forwarding (IP routing)
- SSH2
- FTP/SFTP
- TFTP
- SCP (RCP + SSH2)
- HTTP
- NTP
- TELNET
- DNS (CLIENT)
- SNMPv2/SNMPv3

For example, an operator may choose to allow SSH2 access only to a particular (loopback) IP address on the DPoE System to enhance IPNE security. In another example, an operator may choose to allow FTP on a particular (loopback) IP address in order to limit access to file transfers.

The DPoE System MUST support IPv4 Type of Service (TOS) marking of all IP traffic on the D interface by configuration based on these parameters:

- Source IP address
- Including Management (Loopback) IP Address
- D interface IP addresses
- Source IP Port
 - IP port for the corresponding IP service, proxy, ALG, or daemon

The DPoE System MUST support IPv4 Diff-Serv Code Point (DSCP) (IETF RFC 2474) marking of all IP traffic on the D interface by configuration based on these parameters:

- Source IP address
 - Including Management (Loopback) IP Address
- D interface IP addresses
- Source IP Port
- IP port for the corresponding IP service, proxy, ALG, or daemon

The DPoE System MUST support Access Control Lists (ACLs) to limit or block access to management based on:

- Source IP address
- Source IP Port

¹⁵ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

- Destination IP Address (Management Loopback IP Address if used)
- Destination IP Port

6.11 Documentation Requirements¹⁶

The DPoE System documentation is expected to describe at least the following:

- Physical Dimensions
 - Length, width, depth, and weight of each chassis or shelf
 - Length, width, depth, and weight of all sub-systems, cards, modules, etc.

The noted physical dimensions are expected to indicate clearance required for connectors including network interfaces, power, and safety (grounding) connectors.

- The noted physical dimensions are expected to clearly indicate whether the dimensions for weight, size, and clearance include pluggable optical modules or not in the product documentation.
- The noted physical dimensions are expected to be documented in both text and 2D (two-dimensional) drawings.
- The noted physical dimensions are expected to include an estimated gross weight calculation for a fully-loaded system including the heaviest possible (including optional) line cards and modules and clearly state the assumptions of such a system configuration used to provide such an estimate.
 - Redundant power configuration
 - Power supply load sharing
 - Power supply source voltage, frequency, and current draw for AC and DC. Power factor (for AC supplies).
 - Module or card insertion, removal, and hot-swap procedures
 - Failover process for redundant modules or cards
 - Release notes (bug lists, resolved, and un-resolved)
 - User reference
 - Installation (Software/Image)
 - Cabling
 - Rack mount
 - Interface reference
 - Troubleshooting
 - Technical support contact information
 - Software upgrade (Method of Operation)
 - Environmental requirements for safe and warranted operation include at least:
 - Operating temperature range
 - Operating humidity range
 - Operating altitude
 - Air quality requirements (if applicable)
 - Storage temperature range
 - Storage humidity range

¹⁶ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

- Regulatory compliance as required but at least including:
 - FCC Class and other markings for lasers
 - FCC markings for RF emissions if applicable
 - Underwriters Laboratory Listing (ULL)

The DPoE System documentation must be available online (but may require secure access). The DPoE System documentation must be available for download via FTP or SFTP (but may require secure access). The DPoE System documentation is expected to be available in Portable Document Format (PDF). The DPoE System documentation is expected to be available in a packaged document format that can be viewed online, on a computer, or printed.

6.12 IP Services¹⁷

The DPoE System **MUST** support the following IP service daemons, helpers, proxies, or ALGs:

- SSH2
- FTP/SFTP
- SCP (RCP + SSH2)
- TFTP
- HTTP
- NTP/SNTP
- TELNET
- DNS Proxy (Server)
- SNMPv2/SNMPv3
- BOOTP Relay
- DHCP Relay [RFC 2131]

These are so called “small servers” and are distinct from the client requirements in section 4.1.5. Each of these provides a service where the DPoE System acts like a server (or host) providing that service to other clients. Those clients may be other hosts, other DPoE Systems, CMTS, routers, switches, or any other host or network element.

The DPoE System **MAY** support the following IP service daemons, helpers, or ALGs:

- PCMM
- DSG Proxy
- Basic Mode
- Advanced Mode

The DPoE System **MUST** support an NTP daemon which includes the peer function with at least two NTP servers. The DPoE System **MUST** support an NTP daemon which includes the gain time function from at least 2 NTP servers. The DPoE System **MUST** support UTC Time Zone setting for NTP and for DPoE System display, logs, and file system time and date stamping.

The DPoE System **MUST** support BOOTP and DHCP Relays (helpers or proxies) that filter all other broadcast other than the broadcast discovery packets.

The DPoE System **MUST** support at least four (4) helper IP addresses for each DHCP, BOOTP, DNS, and other helpers.

¹⁷ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

The DPoE System MUST operate as a DNS proxy, forwarding all DNS queries to DNS servers configured. The DPoE System MUST be configurable to support at least eight (8) DNS servers that may be different from the DNS servers configured for the DNS client (in section 4.1.5) or may be the same.

6.12.1 Other Daemons

The DPoE System MUST support the capability to enable and disable each and every IP service or protocol daemon (as listed above) at the CLI or in the system configuration file.

6.12.2 DHCP Relay Configuration¹⁸

The DPoE System MUST implement a DHCP relay (helper) to implement DHCP as specified in [DPoE-SP-MULPIv1.0].

The DPoE System MUST use the I-BEB configured from section 4.6.1 to populate the DHCP relay-agent for the system capabilities option specified in [eDOCSIS], for the "DHCPv4 PBB service option" defined in [CANN-DHCP-Reg], section 4.2.1.1.3.

6.12.3 Physical Product Requirements

The following requirements are for the physical aspects of the DPoE System.

6.12.4 General Requirements

The DPoE System MUST have hot-swappable line cards for all line cards used within a single chassis.

Centralized components or sub-systems within the DPoE System (such as power supplies, fabrics, switches, and processor cards) SHOULD be redundant and field replaceable.

Redundant options SHOULD be implemented to distribute, move, or fail-over all services and functions in one (1) second or less. Any option that takes longer than one (1) second SHOULD not be identified as redundant.

DPoE System functions that are redundant SHOULD offer a method to manually force a fail-over or otherwise switch service for any redundant capability.

The DPoE System SHOULD be Network Equipment Building Standard (NEBS) Level 3 Compliant.

6.12.5 Power Requirements

The DPoE System SHOULD have redundant power supplies.

The DPoE System SHOULD draw power (load share) across all power supplies rather than operating with a primary and backup or switching implementation. Load sharing is helpful to distribute and manage overall power system reliability in facilities.

6.12.6 Rack Mount Requirements

The DPoE System MUST be rack mountable in an EIA/ECA-310 rack or cabinet.

6.12.7 Cabling

The DPoE System MAY have fiber and twisted-pair Ethernet cable management integrated. The DPoE System MUST NOT require external lashing for interfaces or power connectors.

The DPoE System SHOULD support SC/UPC and LC/UPC connectors for any integrated (not modular) interfaces for MN or D.

¹⁸ Revised per IPNEv1.0-N-13.0064-1 on 2/14/13 by JB.

6.12.8 Grounding

The DPoE System **MUST** have a terminal connector for electrical safety grounding. The DPoE System **MUST** have a wire terminal for electrical (safety) ground bonding.

6.12.9 Environmental Requirements

The DPoE System **MUST** be capable of operating in the temperature range of 0 to 40 degrees Celsius continuously. The DPoE System **SHOULD** be capable of operating in temperatures up to 50 degrees Celsius for up to 24 hours.

The DPoE System **SHOULD** be capable of operating from 5% to 95% humidity.

The DPoE System **MUST** be capable of operating at altitudes from -200 feet (below sea level) to 10,000 feet (above sea level).

6.13 Message of the Day

The DPoE System **MUST** provide a method to configure a Message Of The Day (MOTD) in the configuration file. The DPoE System **MUST** display the MOTD each and every time a secure connection (login) is authenticated to the CLI, regardless of the protocol used for the connection.

6.14 Broadband Intercept (public IP only)

The DPoE System **SHOULD** support broadband intercept using one or more of the following methods:

- [IPFIX]
- Port Mirroring
- ACL Based IP Port Mirroring
- [CBI2.0]

6.15 Diagnostics

Diagnostic functions assist the operator in the operations, administration, and maintenance of the DPoE System. Diagnostic functions are used both interactively and scripted.

6.15.1 System Diagnostics

The DPoE System **MUST** provide a CLI command that dumps all necessary system information (such as configuration, logs, settings, states, etc. to the CLI for debugging, troubleshooting, and reporting).

6.15.2 IP Diagnostics

The DPoE System **MUST** track and support the following statistics per direction for the D and TU interfaces:

- Bits Per Second (BPS) (per interface)
- Packets Per Second (PPS)
- IP Subnets in Use (count)
- ACL Filters in use (count and list of ACL numbers)

The DPoE System **MUST** provide a method to display and reset these statistics from a CLI. The DPoE System **MAY** provide a method to obtain and reset these statistics via an XML (API).

6.15.3 Ethernet Diagnostics

The DPoE System SHOULD support [802.1ag] Connectivity Fault Management (CFM) diagnostics for the D and MN interfaces. The DPoE System MUST support [802.3ah] Link diagnostics on DPoE ONUs by providing a method to operate DPoE ONU S interface diagnostics as specified in [DPoE-SP-OAMv1.0] sections 9.7.8 and 9.7.9.

6.16 Certificate Entry

This section intentionally left blank.

7 EPON SPECIFIC IP NE REQUIREMENTS

In addition to the common requirements, there are some additional DPoE specific requirements for the DPoE System element management, included in the following subsections.

7.1 EPON Configuration

The DPoE System SHOULD provide a CLI command for any DPoE System capabilities to enable and disable TU interfaces or control other EPON settings that the DPoE System may offer.

7.2 EPON Interface Requirements

The DPoE System SHOULD provide a CLI command to enable and disable DPoE ONU Remote Loopback as specified in [DPoE-SP-OSSiv1.0] and [802.3], Clause 57.

7.3 10G-EPON and 1G-EPON Compatibility Settings

The DPoE System MUST provide CLI commands to indicate whether a TU interface is operating as 10G-EPON, 10/1G-EPON, or 1G-EPON. The DPoE System MUST provide CLI commands to show which DPoE ONUs on a TU interface are operating 10G-EPON, 10/1G-EPON, or 1G-EPON.

7.4 Show Cable Modem

The DPoE System MUST provide a CLI ‘show’ command to show the registration status, authentication status, operating interfaces, and the data rate (10G-EPON, 10/1G-EPON, or 1G-EPON) for a DPoE ONU based on a provided DPoE ONU MAC address. The DPoE System MUST support a ‘show’ command that shows interfaces configured on each DPoE ONU. The DPoE System MUST support a ‘show’ command that shows received optical power for each DPoE ONU. The DPoE System MUST support a ‘show’ command that shows the CPE or eSAFE address for each active CMCI and LCI on each DPoE ONU. The DPoE System MUST support a ‘show’ command that shows the CE or DEMARC MAC address for each active MU and MI on each DPoE ONU. The DPoE System MUST support a ‘show’ command that shows the S-VLAN ID and C-VLAN ID for each active S1 interface on each DPoE ONU.

Example Show Cable Modem:

```
CLI# show cable modem
Interface      SID      State Rec   Interface      CPE or eSAFE address      S/C      MAC
address
Power
tu0            10      <#>    0.25   online CMCI    10.1.1.25                  1/1
0000.0000.0001
tu0            11      <#>    0.25   online LCI     10.30.2.1                  1/2
0000.0000.0001
tu0            12      <#>    0.28   online MI      0000.FFFF.0001
0000.0000.0002
tu0            13      <#>    0.30   online MU      0000.FFFF.0002
0000.0000.0003
```

In this example, <#> is a coded number to indicate an EPON or DPoE registration state. S/C is the S-VLAN ID and the C-VLAN ID for S1 interface, as is required for IP(HSD) forwarding.

Example Show Cable Modem <MAC>:

```
CLI# show cable modem 0000.0000.0001
Interface      SID      State Rec   Interface      CPE or eSAFE address      S/C      MAC
address
Power
tu0            10      <#>    0.25   online CMCI    10.1.1.25
0000.0000.0001
```

```
tu0      11      <#>    0.25   online LCI    10.30.2.1
        0000.0000.0001
```

7.5 EPON Diagnostics

The DPoE System SHOULD support basic EPON debug capabilities such as EPON ONU registration logging, optical power receive, and EPON OAM PDU received message logging. Such EPON debugging SHOULD be operator configurable to be enabled and disabled on per TU interface or per ONU MAC address, or for the entire DPoE System.

7.6 Multi-Source Agreement Transceivers

The DPoE System TU interface SHOULD support one of the Small Form Factor Committee Multi-Source Agreement (MSA) standards for pluggable transceivers such as SFP, SFP+, or XFP. Modular transceiver interfaces provide operators with the flexibility to select, install, or change the proper optical transceiver for current needs on the TU interface.

7.7 DPoE ONU Logging

The DPoE System MUST support logging (local log and syslog) for severe error ONU logging as follows:

- Report DPoE ONUs that register, de-register, and re-register more than N times in T time, where N and T are operator configurable.
- Report the last registration state before a registration failure on every failed DPoE ONU registration.
- Report the optical power and signal parameters available for a failed DPoE ONU registration.

8 DPOE PROTOCOL SPECIFIC SUPPORT¹⁹

8.1 MULPI Parameters

8.1.1 Bundling

Virtual bundles are a logical construct used in DOCSIS for a set of configurations that are applied to one or more cable interfaces. While widely used in DOCSIS, there is no standard for this practice in DOCSIS.

Bundling is the mechanism by which multiple TU interfaces can be associated to one (or more) IP serving groups. Alternatively, a DPoE System could be configured to have some set of TUs associated with one bundle and some other non-overlapping set of TUs associated with another bundle.

Below is an example of the configuration to instantiate a bundle on a DPoE System:

```
interface bundle 1
  Description TU0-1
!
interface tu0
  bundle 1
!
interface tu1
  bundle 1
!
interface bundle 2
  Description TU2-3
!
interface tu2
  bundle 2
!
interface tu3
  bundle 2
```

A DPoE System MUST support the configuration of all TUs on the DPoE System to the same bundle.

A DPoE System MUST support the configuration of a bundle for each TU.

8.1.2 IP Serving Group (IP-SG)

IP Serving Group (IP-SG) configurations are largely an organizational function that allows an operator to group a set of similar services to a common IP interface on the router within the DPoE System. Such functionality is achieved today in shipping DOCSIS CMTS products using vendor-specific mechanisms. However, detailed requirements for such mechanisms are not part of DOCSIS specifications. The mechanism described within this text is currently implemented on CMTS platforms to accomplish the goal of being able to define to which IP interface a specific service flow should be bound for first hop routing and forwarding. This relationship to what is done in DOCSIS is important because operators want to use the same method of directing service flows to IP interfaces as they utilize on their DOCSIS CMTS or CCAP platforms.

In DPoE specifications, an IP-SG is required to be associated with an S-VID pool. The primary reason for the definition of the S-VID pool is to ensure that operators can avoid classification collisions by defining a pool of S-VIDs that do not conflict with S-VIDs used for forwarding MEF services. There are other ways of accomplishing the same objective, though they are outside the scope of this specification.

A DPoE System uses [802.1q] S-VLAN and C-VLAN to forward Ethernet frames carrying IP(HSD) services as defined in [DPoE-SP-MULPIv1.0] and [DPoE-SP-ARCHv1.0]; and DEMARC auto-configuration traffic as defined in [DPoE-SP-DEMARCv1.0]. This section describes the configuration capabilities required for the IP-SG.

¹⁹ Sections revised per IPNEv1.0-N-13.0085-1 on 6/18/13 by JB.

A sample configuration for a serving group configuration is below:

```
interface tu0
  bundle 1
  !
interface tu3
  bundle 1
  !
interface bundle 1.1
  Description "Example bundle configuration for default IP-HSD"
  s-vlan 1001
  docsis attribute-mask 80000001
  [ip configuration parameters]
  !
interface bundle 1.2
  Description "Example bundle configuration for default MTA"
  s-vlan 1002
  docsis attribute-mask 80000002
  [ip configuration parameters]
  !
interface bundle 1.3
  Description "Example bundle configuration for DEMARC Auto Config (DAC)"
  s-vlan 1003
  bundle-type dac
  [ip configuration parameters]
```

Note in the example above the definition of the "s-vlan" object which defines the S-VID pool. This S-VID pool is for use in dynamic allocation of a unique S-VID and C-VID combination for purposes of connection-oriented Ethernet forwarding. This mechanism is described in detail in [DPoE-SP-MULPIv1.0].

Example format of CLI commands for the S-VID pool creation and association with the serving group:

```
interface bundle 1.2
s-vlan N
```

Where N is one or more S-VIDs between 2 and 4094.

The DPoE System MUST be able to associate multiple IP-SGs to the same bundle. An example of this capability is above where the single bundle ("bundle 1") has multiple IP-SG definitions by creating a subinterface on the bundle such as interface bundle 1.1 or interface bundle 1.2.

The DPoE System MUST support the reservation of at least one S-VID that creates a reserved IP-SG S-VID pool.

The DPoE System MUST allow the association of the IP-SG S-VID pool to a selected serving group.

The DPoE System MUST provide CLI configuration commands to configure the IP-SG S-VID pool.

The DPoE System MUST provide CLI configuration command to configure a serving group

Also note in the example above the definition of the "docsis attribute-mask" object. In [MULPIv3.0], this object is the SF Required Attribute Mask (TLV24/25.31.) This object might be present in the CM configuration file or it could be referenced via a Service Class object in the CM configuration file.

The DPoE System SHOULD support the configuration of the SF Required Attribute Mask (TLV24/25.31) on a serving group.

The DPoE System SHOULD use the configured SF Required Attribute Mask (TLV24/25.31) to associate provisioned IP(HSD) service flows with an serving group.

The DPoE System MAY support the configuration of other methods for the sole purpose of associating a service flow to a serving group.

Finally, in the example above note the definition of the "bundle type" object. This object in the configuration example is the configuration of the serving group to associate dynamically configured DAC service-flows to the DAC serving group.

The DPoE System MUST support a serving group that is configured as the IP interface for all dynamically created DAC SFs. Similar to the serving group configured for traditional IP(HSD) services, the dynamically created DAC SFs would use the S-VID pool associated with the serving group to dynamically generate the S-VID and C-VID used for purposes of encapsulating Ethernet frames from the DEMARC management entity to the router within the

DPoE System. The example above shows the bundle-type DAC object as the configuration object to identify the serving group as the DAC IP interface.

The DPoE System MUST have a type attribute to specify whether the bundle uses the DAC mechanism for steering service flows to a service group or whether the bundle uses the IP(HSD) methods (the SF Required Attribute Mask) for steering service flows to a service group.

8.2 MEF Parameters

8.2.1 Encapsulation and Tagging

The DPoE System MUST provide ‘show’ commands to show the type of encapsulation in use for each S interface configured and active on DPoE ONUs. The DPoE System MUST provide a ‘show’ command to show all interfaces operating with [802.1ah] encapsulation in a summary.

This example would show PBB [802.1ah] forwarding active, by port, on TU number 0:

```
show interface tu0 pbb
```

This example would show PBB [802.1ah] forwarding active, by port, all TU interfaces:

```
show interface pbb
```

The DPoE System MUST provide a ‘show’ command to show all [802.1ad] tagging, including S-VLANs assigned for use by IP-HSD, in a summary.

This example would show PB [802.1ad] forwarding active, by port for all TU interfaces:

```
show interface pb
```

The DPoE System MUST provide a ‘show’ command to show all MU and MI interfaces operating with [802.1ad] tagging in a summary. This could be accomplished by a variation of the above show command with an option to hide the S-VLANs in use for IP(HSD).

This example would show PB [802.1ad] forwarding active, by port, on TU number 0, excluding IP(HSD). The “-ip” hides the PB tagged IP(HSD) S-VLANs:

```
show interface tu0 pb -ip
```

This example would show PB [802.1ad] forwarding active, by port, all TU interfaces, excluding IP(HSD):

```
show interface pb -ip
```

8.2.2 TPID Translation

The DPoE System MUST provide a ‘show’ command to show all TPID translation in use on the system or by interface.

This example would show TPID translation by port on TU number 0:

```
show interface tu0 xtpid
```

This example would show TPID translation by port on all TU interfaces:

```
show interface xtpid
```

8.2.3 I-BEB

The DPoE System MUST provide a ‘show’ command to show the I-BEB configured for the DPoE System.

This example would show the I-BEB configured for the DPoE System:

```
show ibeb
```

8.3 OSSI Parameters

DPoE Systems MUST provide a method of limiting the rate of DHCP lease renewals by providing a configurable limit of the number of lease renewals permitted on the DPoE System, for each individual helper (relay) for a moving window for which the period (in seconds) is configured.

9 COMBINED IP(HSD) AND MEF NNI FORWARDING REQUIREMENTS

Both the D and MN interfaces on DPoE Systems share Ethernet interface and forwarding requirements identified in this section.

9.1 Ethernet Interface Requirements²⁰

The DPoE System MUST be capable of forwarding Ethernet frames on the D and MN interfaces using [802.1d], [802.1q], [802.1ad], and [802.1ah].

9.1.1 Link Aggregation (LAG)

The DPoE System MUST support [802.1ax] Link Aggregation on the D and MN or combined D and MN interfaces for all network to network traffic. The DPoE System MUST support LAG for the smaller of either eight (8) ports or the maximum number of D and MN ports on the DPoE System. The latter would, for example, apply to a DPoE System that might have only 7 or less ports.

The DPoE MUST support [802.1ax] LAG for all [802.3z] ports or all [802.3ae] ports. The DPoE System MUST NOT support [802.1ax] across both [802.3z] and [802.3ae] ports.

9.1.2 D and MN Interface Data Rates

DPoE Systems with 1G-EPON only MUST support 1GigE for the D and MN interfaces. DPoE Systems with 10G-EPON (10/1G-EPON or 10/10G-EPON) MUST support 10GigE for the D and MN interfaces. DPoE Systems with 10/1G-EPON or 10G-EPON MAY support 1GigE.

DPoE Systems SHOULD support modular MSA-compliant Ethernet interfaces for the MN and D interfaces.

9.1.3 NNI Link Aggregation

The DPoE System MUST allow the D and MN interfaces to operate over a combined (trunked) Ethernet interface, using [802.1q] VLAN tags to separate the two logical interfaces.

9.1.3.1 NNI Link Aggregation Egress Tagging

If a DPoE System is configured to combine D and MN using [802.1q], that tag MUST be applied as an outer (trunking) tag in addition to existing [802.1q], [802.1ad], or [802.1ah] tags. A DPoE System multiplexing the logical D and MN interfaces into a single Ethernet interface MUST NOT remove or re-write any existing tags upon egress from MN or D.

DPoE ONUs can accept frames that are tagged by the customer. In addition to accepting customer tagged frames, DPoE ONUs can be configured to add up to two additional [802.1ad] tags. With the addition of an optional outer tag (described herein) for NNI link aggregation, egress frames may contain up to four (4) [802.1ad] tags or a combination of up to four (4) [802.1q] and [802.1ad] tags if TPID translation is used for the service.

DPoE ONUs can accept frames that are tagged by the customer. In addition to accepting customer tagged frames, DPoE ONUs can be configured to add [802.1ah] encapsulation (tagging). With the addition of an optional outer tag (described herein) for NNI link aggregation, egress frames may contain a combination of up to three (3) [802.1ad] tags and a [802.1ah] encapsulation or a combination of up to three (3) [802.1q] and [802.1ad] tags and single [802.1ah] encapsulation, if TPID translation is used for the service.

9.1.3.2 NNI Link Aggregation Ingress Tagging

If a DPoE System is configured to combine D and MN using [802.1q] that (trunking) outer tag MUST be removed before passing the frame to the logical D or MN interface.

²⁰ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

9.2 IP Forwarding Requirements²¹

IP forwarding requirements apply to the D interface, TU interface, or S1 interfaces as described below. TU interfaces used for IP(HSD) can also be concurrently used for Metro Ethernet services. When TU interfaces are configured for IP(HSD) service, the IP forwarding requirements only apply to IP(HSD) services and therefore only to S1 interfaces configured as CMCI or LCI interfaces.

9.2.1 IP Interfaces

The DPoE System **MUST** support Variable Length Subnet Masking (VLSM) on all IP interfaces. The DPoE System **MUST** support IP subnet masks of any length on the D interface. (For example, an operator may use this option to configure /31 or 255.255.255.254 subnet mask length of subnet mask for point to point networks in order to conserve IP address space).

9.2.1.1 Multinet

The DPoE System is expected to support the capability to configure and operate multiple IP addresses per physical or logical (sub-interface) interface. The DPoE System **MUST** support at least four (4) IP subnetworks for each SG interface. The DPoE System **MUST** support at least four (4) IP subnetworks for each D interface.

9.2.1.2 TU Forwarding Rates

The DPoE System **MUST** support IP-SG commands to associated service address verification, ACLs, sub-interfaces, and Address Resolution Protocol (ARP) filters with an IP-SG

A DPoE System is expected to be capable of forwarding at least 900Mbps downstream and 900Mbps upstream on a 1G-EPON TU with sixty-four (64) DPoE ONUs registered.

A DPoE System is expected to be capable of forwarding at least 9Gbps downstream and 9Gbps upstream on a 10G-EPON TU with sixty-four (64) DPoE ONUs registered.

9.2.1.2.1 Access Control Lists

The DPoE System **MUST** support ACLs and EACLs on the D interface to limit and control access to any IP address and port combination based on source IP address, source port, destination IP address, and destination port for all IP addresses configured on the DPoE System including loopback addresses (if configured), interface addresses, vCM addresses, and embedded Cable Modem (eCM) addresses (if present) and CPE addresses assigned for any active CMCI interfaces.

The DPoE System **SHOULD** be configurable to apply such ACLs or EACLs to all or only to specific D interfaces. This will allow operators to use different ACLs on different interfaces if desired.

The DPoE System **MAY** support EACL for traffic on the D interface based on TCP State.

The DPoE System **MUST** support Layer 2 ACLs on the D and MN interfaces. The DPoE System **MUST** support the following parameters for Layer 2 ACLs:

- MAC
- Source Address
- Destination Address
- MAC Address Ranges
 - Source Address
 - Destination Address
- [802.1ad]
- S-VLAN ID
- C-VLAN

²¹ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 and per IPNEv1.0-N-13.0085-1 on 6/18/13 by JB.

- [802.1q] VLAN ID
- [802.1] TPID
- [802.1ah] I-SID

The DPoE System MAY support the following parameters for Layer 2 ACLs:

- [802.1ah] B-Tag

The DPoE System MUST support logging ACL matches. The DPoE System MUST support enabling and disabling of logging of ACL matches.

9.2.2 Multi-Protocol

This version of the DPoE specifications supports only IPv4 forwarding and does not require IP routing protocol support for Layer 2 (Ethernet), IPv6, IP-VPN, or other address family route distribution.

9.2.3 Label Forwarding

DPoE Systems MAY support Multiprotocol Label Switching (MPLS) using Label Distribution Protocol (LDP) for the D interface.

9.2.4 SF QoS Assignment²²

The DOCSIS Service Class is referenced within the CM configuration file and points to a configured Service Class on the DPoE System,

The DOCSIS Service Class is defined in [MULPIv3.0].

The DPoE System MUST support the configuration of a DOCSIS Service Class, which includes (at a minimum) the following configurable elements::

- Service Class Identifier
- Direction
- Service Class Name
- ToS Overwrite
- Priority
 - Service Flow Scheduling Type to include RTPS and Best Effort
 - Nominal Polling Interval
 - Maximum Sustained Traffic Rate
 - Maximum Traffic Burst

The DPoE System SHOULD support the configuration of a DOCSIS Service Class, which includes the following configuration element:

- SF Required Attribute Mask (TLV24/25.31)

The DPoE System MAY include more configuration elements within the service class beyond those enumerated here.

²² Section added per IPNEv1.0-N-13.0085-1 on 6/18/13 by JB.

9.3 IP Routing²³

9.3.1 Route Distribution

DPoE Systems MUST support IP route re-distribution from every active IP routing protocol to every other IP routing protocol. DPoE Systems SHOULD support the re-distribution of at least 8,000 routes from any IP routing protocol into every other IP routing protocol.

9.3.2 Bi-Directional Forwarding Detection

DPoE Systems MUST support Bi-Directional Forwarding Detection (BFD) as specified in [RFC 5880], [RFC 5881], and [RFC 5882] on the D interface. DPoE Systems MUST provide configurable timers for BFD. DPoE Systems SHOULD support timers as low as 1 second. BFD is described in [RFC 5880], [RFC 5881], [RFC 5882], and [RFC 5883].

9.3.3 Equal Cost Multi-Path

DPoE Systems MUST support Equal Cost Multi-Path (ECMP) for IP forwarding based on all IP routing protocols and static routes (including default route and default network).

DPoE Systems SHOULD be able to forward across at least 16 MAX-PATHS for ECMP.

9.3.4 Policy Routing

DPoE Systems MUST support source policy based routing. That is routing decisions based on the source IP address rather than destination IP address based lookup only.

9.3.5 Static Routes

DPoE Systems MUST support static IP routes configured by the configuration file or at the CLI. DPoE Systems MUST provide the capability to remove static routes from the active forwarding routes (but keep the configuration file the same) when BFD detects a next hop failure.

9.3.6 Default Route

The DPoE System MUST support the configuration and forwarding of a static route to which all traffic not otherwise reachable by other routing protocols or static routes, should be forwarded by default. DPoE Systems MUST support at least four (4) default routes. DPoE Systems MUST support BFD for default routes just as for static routes. DPoE Systems MUST provide the capability to remove default routes from the active forwarding routes (but keep the configuration file the same) when BFD detects a next hop failure.

9.3.7 Interior Gateway Protocols (IGPs)

DPoE Systems MUST support both IS-IS and OSPFv2 ([RFC 2328] and [RFC 3623]) for IGP routing. DPoE Systems MUST support re-distribution of routes between IGPs and between IGPs and other routing protocols if implemented. The DPoE System MUST support route maps for configuration of IP route distribution between routing protocols.

DPoE Systems MUST support the capability to run both IS-IS and OSPFv2 simultaneously.

DPoE Systems MUST provide the capability to remove OSPF or IS-IS adjacencies from the link state database (but keep the adjacency configured) when BFD detects an adjacency failure. The DPoE System MUST keep running BFD and upon recovery from the link failure, should re-establish the adjacency and admit the route to the link state database.

²³ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

9.3.7.1 OSPF

DPoE Systems MUST support OSPF “not so stubby” areas. DPoE Systems MUST support the ability to set tag values per IP subnet in type 7 Link State Advertisements (LSAs). DPoE Systems MUST support point to point links without a default router (DR). DPoE Systems MUST label routes redistributed into OSPF as type 5/7 LSAs. DPoE Systems MUST support Graceful OSPF Restart [RFC 3623].

9.3.7.2 IS-IS

DPoE Systems MUST support multiple-topology IS-IS (M-ISIS) as specified in [RFC 5120]. DPoE Systems MUST support MT extensions for LSP in order to support multiple-topology as specified in [RFC 5311].

9.3.8 Autonomous System Routing

The DPoE System MUST support BGP [RFC 4271] for the distribution of route throughout an Autonomous System. The DPoE System MUST support iBGP. The DPoE System MUST support route reflector client as specified in [RFC 4456]. The DPoE System MUST support iBGP peering with at least two neighbors total. DPoE Systems MUST support Graceful Restart for all BGP (iBGP) peers. DPoE Systems MUST support BGP confederations [RFC 5065]. DPoE Systems MUST support the MD5 signature option [RFC 2385].

The DPoE System MUST support community tagging for announced and received IP routes with iBGP [RFC 1997]. The DPoE System MUST support the concurrent tagging of at least 16 communities for each announced or received route for IP routes for iBGP. DPoE Systems MUST support route policy controls including prefix filtering, filter lists, and route maps DPoE Systems MUST support basic comparative logic for policy controls including at least:

- Less Than (lt)
- Less Than or Equal To (lte)
- Greater Than (gt)
- Greater Than or Equal To (gte)
- Equal To (et)

DPoE Systems SHOULD use VLSM or CIDR subnet length notation in the form of:

/ <masklen>

Where <masklen> is the length of the subnetwork mask.

DPoE Systems MUST support the following policy control settings:

- IP TOS
- DSCP
- Local Preference
- Metric
- Metric Type
- Weight
- Next Hop (NH)
- Origin
- Tag
- Traffic Index

DPoE Systems MUST support blocking, filtering, suppression, aggregation, and summarization of IP routes based on BGP policy matches.

9.3.9 BGP Routing

Although multi-protocol forwarding for non-IPv4 traffic is not required in this version of the DPoE specifications, the DPoE System MUST support BGP [RFC 4271] routing for IP traffic engineering and routing.

9.3.10 MPLS

This version of the specification does not require MPLS.

9.4 IP Routing Debug

The DPoE System MUST provide IP routing debug tools including:

- Local log and syslog for IP routing state changes for adjacencies
- Local log and syslog for configuration changes that affect IP routing protocols

The DPoE System SHOULD provide IP-routing debug tools including local log and syslog for IP routing “events”, where an “event” is defined as a state change in an IP routing protocol.

The DPoE System SHOULD provide a configurable IP routing debug tool for “trace” capability for each IP routing protocol (independently). The IP routing debug tool SHOULD show received messages, state changes, parameters, and statistics in near real time to the console, to the local log, and to syslog (if logging is enabled for trace in the configuration for IP routing debug).

9.5 Host Routing

The DPoE System typically treats IP(HSD) clients on the DPoE ONU CMCI interface as hosts on the DPoE System IP router.

The DPoE System MUST be configurable to disable Address Resolution Protocol (ARP) individually for each DPoE ONU CMCI port. The DPoE System MUST be capable of disabling ARP individually for each DPoE ONU CMCI port by DPoE ONU (EPON) MAC address and a port index. If a DPoE ONU has only one CMCI port or has only one CMCI port configured, the DPoE System MUST be configurable to disable ARP for that CMCI port based only on the DPoE ONU CMCI port.

The DPoE System SHOULD be configurable to disable ARP individually (filter ARP requests) for each IP address when there are multiple IP addresses assigned on a single DPoE ONU CMCI port.

9.6 CMCI Routing²⁴

DPoE Systems MUST support Routing Information Protocol (RIPv2 [RFC 2453] and [RFC 4822]) for dynamic IP address learning from a CPE running RIP. The DPoE System MUST act as an IP router (peer) to the CPE running RIP.

A DPoE System that supports RIP MUST provide a method of verifying the source IP addresses and source CMCI port from which each IP packet is sourced in order to secure the IP forwarding path when IP routing is operating over CMCI interface.

DPoE Systems MUST support static IP routing for the CMCI interface.

DPoE Systems MUST support source policy based routing for IP forwarding from CMCI. That is routing decisions based on the CPE source IP address rather than destination IP address based lookup only.

²⁴ Revised per IPNEv1.0-N-12.0044-2 on 8/14/12 by JB.

9.7 IP Traffic Engineering

The DPoE System MUST support IPv4 Terms of Service (TOS) marking of all IP traffic on the D interface by configuration based on the common parameters described below. The DPoE System MUST support IPv4 Diff-Serv Code Point (DSCP) [RFC 2474] marking of all IP traffic on the D interface by configuration based on the common parameters described below.

- Management Traffic
- Loopback IP address
- TU interface
- IP ACLs

Appendix I CMTS Example Configuration File A

Following is the majority of a complete configuration file for a typical DOCSIS 2.0 CMTS used in production today. When <angle brackets> are used, the actual text in the configuration file varies among operators or was removed to make the configuration generic to all operators. Other comments indicate if other sections were purposefully omitted to keep the example brief and readable.

```
!!!!
!
! DOCSIS 2.0 Example Configuration File A
!
!!!!
no service pad
service timestamps debug datetime
service timestamps log datetime
service password-encryption
service sequence-numbers
!
hostname <hostname>.<Site Name>.<State>
!
boot-start-marker
boot system flash <device name>:<image name.bin>
boot system flash
!
no logging console
enable secret
!
aaa new-model
aaa authentication login default group radius local
aaa authorization config-commands
aaa authorization exec default group tacacs+ none
aaa authorization commands 15 default group tacacs+ none
aaa accounting exec default start-stop group tacacs+
aaa accounting commands 0 default stop-only group tacacs+
aaa accounting commands 1 default stop-only group tacacs+
aaa accounting commands 15 default stop-only group tacacs+
aaa accounting system default start-stop group tacacs+
!
cable admission-control preempt priority-voice
cable flap-list aging 1440
cable modem max-cpe 6
cable modem vendor 00.<nn>.<nn> "Vendor Name"
! additional cable modem vendor <nn>.<nn>.<nn> "Vendor Name" for each MAC range for
each vendor
!
! Modulation profiles (omitted)
!
cable service class 100 name
cable service class 100 upstream
cable service class 100 tos-overwrite 20 20
cable service class 100 priority 1
cable service class 100 max-rate <Peak Rate>
cable service class 100 max-burst <PB Bucket Size>
cable service class 100 max-concat-burst 3044
cable service class 101 name
cable service class 101 downstream
cable service class 101 priority 1
cable service class 101 max-rate <Peak Rate>
cable service class 101 max-burst <PB Bucket Size>
cable service class 102 name
cable service class 102 upstream
cable service class 102 tos-overwrite 20 20
```



```
cable service class 102 priority 1
cable service class 102 max-rate <Peak Rate>
cable service class 102 max-burst <PB Bucket Size>
cable service class 102 max-concat-burst 4096
cable service class 103 name
cable service class 103 downstream
cable service class 103 priority 1
cable service class 103 max-rate <Peak Rate>
cable service class 103 max-burst <PB Bucket Size>
cable service class 104 name
cable service class 104 upstream
cable service class 104 tos-overwrite 20 20
cable service class 104 priority 1
cable service class 104 max-rate <Peak Rate>
cable service class 104 max-burst <PB Bucket Size>
cable service class 104 max-concat-burst 16384
cable service class 105 name
cable service class 105 downstream
cable service class 105 priority 1
cable service class 105 max-rate <Peak Rate>
cable service class 105 max-burst <PB Bucket Size>
!
cable service class 106 name
cable service class 106 upstream
cable service class 106 tos-overwrite 20 20
cable service class 106 priority 0
cable service class 106 max-rate <Peak Rate>
cable service class 106 max-burst <PB Bucket Size>
cable service class 106 max-concat-burst 3044
cable service class 107 name
cable service class 107 downstream
cable service class 107 priority 0
cable service class 107 max-rate <Peak Rate>
cable service class 107 max-burst <PB Bucket Size>
cable service class 108 name
cable service class 108 upstream
cable service class 108 tos-overwrite 20 20
cable service class 108 priority 0
cable service class 108 max-rate <Peak Rate>
cable service class 108 max-burst <PB Bucket Size>
cable service class 108 max-concat-burst 4096
cable service class 109 name
cable service class 109 downstream
cable service class 109 priority 0
cable service class 109 max-rate <Peak Rate>
cable service class 109 max-burst <PB Bucket Size>
cable service class 110 name
cable service class 110 upstream
cable service class 110 tos-overwrite 20 20
cable service class 110 priority 0
cable service class 110 max-rate <Peak Rate>
cable service class 110 max-burst <PB Bucket Size>
cable service class 110 max-concat-burst 16384
cable service class 111 name
cable service class 111 downstream
cable service class 111 priority 0
cable service class 111 max-rate <Peak Rate>
cable service class 111 max-burst <PB Bucket Size>
cable service class 112 name
cable service class 112 upstream
cable service class 112 tos-overwrite 20 20
cable service class 112 priority 1
cable service class 112 max-rate <Peak Rate>
```

```
cable service class 112 max-burst <PB Bucket Size>
cable service class 112 max-concat-burst 16384
cable service class 113 name
cable service class 113 downstream
cable service class 113 priority 1
cable service class 113 max-rate <Peak Rate>
cable service class 113 max-burst <PB Bucket Size>
cable service class 114 name
cable service class 114 upstream
cable service class 114 tos-overwrite 20 20
cable service class 114 priority 0
cable service class 114 max-rate <Peak Rate>
cable service class 114 max-burst <PB Bucket Size>
cable service class 114 max-concat-burst 16384
cable service class 115 name
cable service class 115 downstream
cable service class 115 priority 0
cable service class 115 max-rate <Peak Rate>
cable service class 115 max-burst <PB Bucket Size>
!
cable service class 122 name
cable service class 122 upstream
cable service class 122 max-concat-burst 8192
cable service class 122 tos-overwrite 20 20
cable service class 122 max-rate <Peak Rate>
cable service class 122 max-burst <PB Bucket Size>
cable service class 122 priority 1
cable service class 123 name
cable service class 123 downstream
cable service class 123 max-rate <Peak Rate>
cable service class 123 max-burst <PB Bucket Size>
cable service class 123 priority 1
cable service class 124 name
cable service class 124 upstream
cable service class 124 max-concat-burst 8192
cable service class 124 tos-overwrite 20 20
cable service class 124 max-rate <Peak Rate>
cable service class 124 max-burst <PB Bucket Size>
cable service class 124 priority 0
cable service class 125 name
cable service class 125 downstream
cable service class 125 max-rate <Peak Rate>
cable service class 125 max-burst <PB Bucket Size>
cable service class 125 priority 0
!
cable service class 126 name
cable service class 126 upstream
cable service class 126 max-concat-burst 8192
cable service class 126 tos-overwrite 20 20
cable service class 126 max-rate <Peak Rate>
cable service class 126 max-burst <PB Bucket Size>
cable service class 126 priority 1
cable service class 127 name
cable service class 127 downstream
cable service class 127 max-rate <Peak Rate>
cable service class 127 max-burst <PB Bucket Size>
cable service class 127 priority 1
cable service class 128 name
cable service class 128 upstream
cable service class 128 max-concat-burst 8192
cable service class 128 tos-overwrite 20 20
cable service class 128 max-rate <Peak Rate>
cable service class 128 max-burst <PB Bucket Size>
```

```
cable service class 128 priority 0
cable service class 129 name
cable service class 129 downstream
cable service class 129 max-rate <Peak Rate>
cable service class 129 max-burst <PB Bucket Size>
cable service class 129 priority 0
!
cable service class 130 name
cable service class 130 upstream
cable service class 130 tos-overwrite 28 28
cable service class 130 priority 2
cable service class 131 name
cable service class 131 upstream
cable service class 131 tos-overwrite 58 58
cable service class 131 priority 2
cable service class 132 name
cable service class 132 upstream
cable service class 132 tos-overwrite b8 b8
cable service class 132 priority 2
cable service class 133 name
cable service class 133 downstream
cable service class 133 priority 2
!
cable service class 134 name
cable service class 134 downstream
cable service class 134 max-rate 13200000
cable service class 134 max-burst 3044
cable service class 134 priority 1
cable service class 135 name
cable service class 135 upstream
cable service class 135 max-concat-burst 3044
cable service class 135 tos-overwrite 70 70
cable service class 135 max-rate 2200000
cable service class 135 max-burst 3044
cable service class 135 priority 1
!Legacy
cable service class 201 name
cable service class 201 upstream
cable service class 201 tos-overwrite 20 20
cable service class 201 priority 1
cable service class 202 name
cable service class 202 upstream
cable service class 202 tos-overwrite 70 70
cable service class 202 priority 1
!DMCA Notification
cable service class 203 name
cable service class 203 upstream
cable service class 203 tos-overwrite 0 24
cable service class 203 max-rate 1000000
cable service class 203 max-burst 3044
cable service class 203 priority 1
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable multicast group-encryption 1 algorithm 56bit-des
cable multicast group-qos default scn def_sclass aggregate
!
cable submgmt default filter-group cpe upstream 2
cable submgmt default filter-group cpe downstream 1
cable submgmt default filter-group cm upstream 4
cable submgmt default filter-group cm downstream 3
cable submgmt default filter-group mta upstream 10
```

```
cable submgmt default filter-group mta downstream 9
cable submgmt default filter-group ps upstream 2
cable submgmt default filter-group ps downstream 1
cable submgmt default active
cable default-tos-qos10 tos-overwrite 0x20 0x20
cable load-balance group 1 threshold load 3
cable load-balance group 1 threshold load minimum 1
cable load-balance group 2 threshold load 3
cable load-balance group 2 threshold load minimum 1
cable load-balance group 3 threshold load 3
cable load-balance group 3 threshold load minimum 1
!
cable sflog max-entry 59999 entry-duration 3600
cable metering destination <IPDR coll IP Addr> 2000 2 15 non-secure
cable metering source-interface loopback 0
!
ip subnet-zero
no ip source-route
no ip gratuitous-arps
ip telnet source-interface Loopback0
ip tcp path-mtu-discovery
no ip finger
!
ip tftp source-interface Loopback0
ip ftp source-interface Loopback0
no ip domain lookup
ip domain-name <state.operator.net>
ip name-server
ip name-server
ip dhcp relay information option
no ip dhcp relay information check
!
no ip bootp server
crypto key generate rsa general-keys modulus 1024
ip ssh time-out 60
packetcable
packetcable multimedia
multilink bundle-name authenticated
call rsvp-sync
!
key chain ubr-rip
  key 1
    key-string 7
username <name> <password>
access-list 20 remark For SNMP
!
no crypto isakmp enable
!
buffers small permanent 1000
buffers small max-free 1500
buffers middle permanent 1000
buffers middle max-free 1500
!
interface Loopback0
  ip address <Loopback IP> 255.255.255.255
!
interface GigabitEthernet0/1
  description <remote side interface/port>
  ip address <IP address & subnet mask>
  no ip redirects
  no ip unreachable
  no ip proxy-arp
  ip ospf hello-interval 1
```

```
ip ospf network point-to-point
ip ospf cost <1 for the Sandvine interface, 3 for the other>
load-interval 30
no ip mroute-cache
duplex full
speed 1000
media-type <gbic or rj45>
no negotiation auto
hold-queue 1024 in
hold-queue 1024 out
!
interface GigabitEthernet0/2
description <remote side interface/port>
ip address <IP address & subnet mask>
no ip redirects
no ip unreachable
no ip proxy-arp
ip ospf hello-interval 1
ip ospf network point-to-point
ip ospf cost <1 for the xxxxx interface, 3 for the other>
load-interval 30
no ip mroute-cache
duplex full
speed 1000
media-type <gbic or rj45>
no negotiation auto
hold-queue 1024 in
hold-queue 1024 out
!
interface GigabitEthernet0/3
no ip address
shutdown
duplex auto
speed auto
media-type rj45
no negotiation auto
!
interface Bundle10
ip address <secondary subnet and mask> secondary
ip address <primary subnet and mask>
ip rip receive version 2
ip rip authentication mode md5
ip rip authentication key-chain ubr-rip
no cable arp filter request-send
no cable arp filter reply-accept
ip igmp access-group 70
cable source-verify dhcp
cable dhcp-parse option-43
cable dhcp-parse option-60
cable dhcp-giaddr primary
cable helper-address <helper address>
cable helper-address <helper address>
!
router ospf 65300
router-id <loopback 0 IP address>
log-adjacency-changes
redistribute rip metric 20 metric-type 1 subnets route-map COMM-SVC-NETS
passive-interface default
no passive-interface GigabitEthernet0/1
no passive-interface GigabitEthernet0/2
network 0.0.0.0 255.255.255.255 area 1
!
router rip
```

```

version 2
passive-interface default
network <ip network>
network <ip network>
network <ip network>
distribute-list 35 in bundle10
no auto-summary
!
ip classless
no ip http server
no ip http secure-server
ip tacacs source-interface Loopback0
!
ip radius source-interface Loopback0
logging trap notifications
logging facility local6
logging source-interface Loopback0
logging
!
nls resp-timeout 1
cpd cr-id 1
route-map COMM-SVC-NETS permit 35
  match ip address 35
!
snmp-server trap-source Loopback0
snmp-server view reset-view cdxCmCpeEntry.8 included
snmp-server view set-utilization-mib docsIfCmtsObjects.8 included
snmp-server community view block_bad_mib RO 20
snmp-server community view block_bad_mib RO 20
snmp-server view block_bad_mib iso included
snmp-server view block_bad_mib docsQosPHSEntry excluded
snmp-server view block_bad_mib ccqmEnfRuleViolateEntry excluded
snmp-server view block_bad_mib ccqmCmtsIfBwUtilEntry excluded
snmp-server view block_bad_mib ccacUsConfigRevEntry excluded
snmp-server view block_bad_mib ccacUsRevEntry excluded
snmp-server view block_bad_mib ccacDsRevEntry excluded
snmp-server community view set-utilization-mib RW 20
snmp-server community view reset-view RW 21
snmp-server location <location name>
snmp-server contact <location contact>
snmp-server queue-length 20
snmp-server chassis-id <chassis host name>
snmp-server enable traps snmp linkdown linkup coldstart warmstart
no snmp-server enable traps tty
no snmp-server enable traps config
snmp-server enable traps entity
snmp-server enable traps envmon shutdown supply temperature voltage
no snmp-server enable traps cable
snmp-server enable traps rtr
snmp-server enable traps alarms major
snmp-server host <NOC Trap Server #1>
snmp-server host <NOC Trap Server #2>
tacacs-server host
tacacs-server host
tacacs-server key 7
radius-server host auth-port 1645 acct-port 1646 key 7
radius-server host auth-port 1645 acct-port 1646 key 7
radius-server retransmit 0
radius-server timeout 3
radius-server authorization permit missing Service-Type
cops listener access-list vty-access
banner motd ^C
*****

```

WARNING

This system is solely for the use of authorized <operator> employees and
<>

LOCATION : Site name, State

*****^C

```

privilege exec level 0 squeeze
privilege exec level 0 slip
privilege exec level 0 systat
privilege exec level 0 ping docsis
privilege exec level 0 ping
privilege exec level 0 send
privilege exec level 5 terminal monitor
privilege exec level 0 terminal length
privilege exec level 0 terminal
privilege exec level 0 show interfaces Cable6/1 modem
privilege exec level 0 show interfaces Cable6/1 sid
privilege exec level 0 show interfaces Cable6/0 modem
privilege exec level 0 show interfaces Cable6/0 sid
privilege exec level 0 show interfaces Cable5/1 modem
privilege exec level 0 show interfaces Cable5/1 sid
privilege exec level 0 show interfaces Cable5/0 modem
privilege exec level 0 show interfaces Cable5/0 sid
privilege exec level 0 show interfaces Cable4/1 modem
privilege exec level 0 show interfaces Cable4/1 sid
privilege exec level 0 show interfaces Cable4/0 modem
privilege exec level 0 show interfaces Cable4/0 sid
privilege exec level 0 show interfaces Cable3/1 modem
privilege exec level 0 show interfaces Cable3/1 sid
privilege exec level 0 show interfaces Cable3/0 modem
privilege exec level 0 show interfaces Cable3/0 sid
privilege exec level 0 show interfaces
privilege exec level 0 show
privilege exec level 0 clear cable host
privilege exec level 0 clear cable
privilege exec level 0 clear
privilege exec level 0 show cable flap-list sort-flap
privilege exec level 0 show cable flap-list Cable6/1 sort-flap
privilege exec level 0 show cable flap-list Cable6/0 sort-flap
privilege exec level 0 show cable flap-list Cable5/1 sort-flap
privilege exec level 0 show cable flap-list Cable5/0 sort-flap
privilege exec level 0 show cable flap-list Cable4/1 sort-flap
privilege exec level 0 show cable flap-list Cable4/0 sort-flap
privilege exec level 0 show cable flap-list Cable3/1 sort-flap
privilege exec level 0 show cable flap-list Cable3/0 sort-flap
privilege exec level 0 show cable flap-list
privilege exec level 0 show cable modem
privilege exec level 0 show cable qos profile
privilege exec level 0 show cable qos
privilege exec level 0 show cable
!
line con 0
  session-timeout 15 output
  stopbits 1
line aux 0
  no exec
line vty 0 4
  access-class vty-access in
  session-timeout 15 output
  transport input all
line vty 5 15

```

```
access-class vty-access in
session-timeout 15 output
transport input all
!
scheduler allocate 4000 400
ntp access-group peer 40
ntp source Loopback0
ntp update-calendar
ntp server
ntp server
end
```


Appendix II CMTS Example Configuration B

II.1 CMTS Example Configuration B File with Explanations

Following is the majority of a complete configuration file for a typical DOCSIS 1.1 CMTS used in production today with explanatory text added following each bang “!” symbol. When <angle brackets> are used, the actual text in the configuration file varies among operators or was removed to make the configuration generic to all operators. Other comments indicate if other sections were purposefully omitted to keep the example brief and readable.

```
!!!!
!
! DOCSIS 1.1 Example Configuration File B
!
!!!!
no service single-slot-reload-enable
service nagle
service sequence-numbers
no service pad
service timestamps debug datetime msec localtime show-timezone
service timestamps log datetime msec localtime show-timezone
service password-encryption
no ip bootp server
no ip gratuitous-arps
no service tcp-small-servers      ! default, does not show in
! configuration
no service udp-small-servers      ! default, does not show in
! configuration
no scheduler heapcheck process    ! default, does not show in
! configuration. If enabled, will
! show towards the end of the
! configuration
scheduler allocate 4000 400       ! Improves processing of interrupts
! when large numbers of modems are
! online; default 4000 400
no ip forward-protocol udp ! improve modem registration times
hostname <local Hostname> ! local hostname
!
boot system flash disk: <image name>.bin
boot bootldr bootflash: <image name>.bin
!
! TACACS Configuration
hostname <hostname>
no ip domain lookup
ip domain name <domain name>.<sub-domain>.com
aaa new-model
!
! SSH Enable
crypto key zeroize rsa
crypto key generate rsa
line vty 0 15
transport input all
transport output all
!
! Global Cable Commands
! The following command causes the CMTS to enforce a MAX-CPE value of 10 for each
cable modem. If a value
! greater than 10 is specified in the modem configuration file, the higher value will
be enforced. Note: The
! default value of 1 for max-cpe will not show in the running configuration.
! cable modem max-cpe 10
no cable qos permission create      ! default IOS entries
no cable qos permission update
```

```

cable qos permission modems
ip dhcp relay information option ! Insert relay information in DHCP
! This following command modifies the non-packetcable DOCSIS 1.1 service flow timeout
behavior. It allows a
! user-definable Active QoS Timeout to be set from the CMTS to prevent stale service
flows. See Cisco
! documentation for detailed information on this configurable timer.
cable service flow activity-timeout 300
!
! Buffer Configuration
! The following configurations more optimally tune the buffers than that of default
such that buffer failures
! are minimized:
buffers small permanent 310
buffers small max-free 515
buffers small min-free 65
buffers middle permanent 258
buffers middle max-free 360
buffers middle min-free 80
buffers big permanent 528
buffers big max-free 828
buffers big min-free 180
buffers verybig permanent 42
buffers verybig max-free 43
buffers verybig min-free 6
!
! Flap-List Configuration
! The following configuration tunes the operation of the flap-list command.
cable flap-list insertion-time 180
cable flap-list power-adjust threshold 3
! Power adjust using different thresholds requires a locally created CR and should
be temporary until the
! plant has been stabilized.
cable flap-list aging 1440
cable flap-list size 8191
!
! Network Time
! omitted from this example
!
! Global Routing Commands
ip subnet-zero
no ip source-route
ip cef
ip classless
!
! Name Resolution
no ip finger
ip domain-lookup ! Default, does not show in
! configuration
ip domain-name <local domain name>
ip name-server <primary server> | Only one name server
!
! Multicast Routing
ip multicast-routing
ip multicast route-limit 250
no cable ip-multicast-echo ! default, does not show in
! configuration
!
! Route Authentication Key Strings
key chain ubr-rip ! Key string for Static IP Solution
key 1
key-string <key string 1>
key 2

```

```

    key-string <key string 2>
! Note: Multiple key strings are supported. Key ID must match. Key-string should be 16
alphanumeric characters ! or less.
!
! Generic Interface Configuration
interface <interface name and index>
    description <description> ! include destination and circuit ID info if applicable
    no ip directed-broadcast ! Does not show in running-config
    no ip proxy-arp
    no ip redirects
    keepalive
    no ip mroute-cache
!
! Loopback Interface Configuration
! The loopback interface is a virtual interface that is independent of all hardware
interfaces. Since this
! interface will always be "up", it is used by SNMP and routing protocols to gather
information. The netmask
! should be /32. The Description text should include serial number, model of router,
local contact and contact
! phone number, and the location of the equipment. It is not necessary to include the
generic interface
! configuration on a loopback as all commands are not fully supported nor needed.
!
interface loopback0
description <s/n, Contact, phone #, location>
ip address <ip address> <netmask>
!
! Fast Ethernet Interface Configuration
! The following commands apply only to the Fast Ethernet port on the uBR's I/O
controller.
interface fastethernet 0/0
duplex full ! Ensure hub or switch is set to full duplex
ip ospf cost 20 ! Needed to ensure fastethernet is
! not used for transit traffic |(except when used for legacy | equipment or uBR
to uBR |
! connections)
!
! NPE-G1 Gigabit Ethernet Interfaces
! The following commands apply only to the 3 onboard Gigabit Ethernet interfaces on
the NPE-G1 processor. If
! you want to use these interfaces to replace the Fast Ethernet interfaces on the
existing I/O controller, you
! will have to configure the new interfaces before they can be used to access the
network. If you are also
! removing the existing I/O controller, you will need to remove the configuration for
its Fast Ethernet
! interfaces. Note, The RJ-45 ports and GBIC ports are both reported in software as
GigabitEthernet 0/1,
! GigabitEthernet 0/2, and GigabitEthernet 0/3. Only one of the pair of interface
ports can be used at a time.
! For example, you can use either the GBIC 0/2 port or the RJ-45 0/2 port, but not
both. All generic interface
! configurations still apply but are not shown below (e.g. ospf cost, priority).
!
interface GigabitEthernet<slot/port> ! Configure for FastEthernet
    ! using rj45
duplex full ! Force full duplex operation
speed 100 ! Force 100 Mbps operation
media-type rj45 ! Set media to use rj45
no negotiation auto
!
interface GigabitEthernet<slot/port> ! Configure for Gigabit Ethernet

```

```

! using gbic
duplex full ! Force full duplex operation
speed 1000 ! Force 1000 Mbps operation
media-type gbic ! Set media to use gbic
no negotiation auto
!
! Dedicated Access
! The dedicated access solution for commercial services customers using the 3550 can
be connected directly as a ! Fast Ethernet connection to one of the GigabitEthernet
ports available on the NPE-G1. This connection MUST
! be configured as FastEthernet only provided the following conditions are met:
! 1. Hubsite must not have an existing aggregation router connected to the
distribution network, i.e.
! 10720, 75XX, or 12XXX.
! 2. CMTS must have an NPE-G1 processor running at a n monthly max CPU five minute
average of less than 50%
! (as reported by MRTG).
! 3. Uplink to CMTS is limited to a single full-duplex 100Mb/sec FastEthernet
segment. GE is not permitted.
! Standard OSPF configurations still apply.
!
! Generic Cable Interface Configuration
interface Cable <slot>/<port> ! Commands should be repeated for all cable
interfaces.
!
no ip unreachable | To prevent unnecessary ICMP replies
no cable ip-multicast-echo | Disable multicast echoing( on all master bundles.
!
cable shared-secret <z> <authen-key string>
! Used to reduce theft of service by non-subscribers. It works by using a single
shared-secret key configured
! in both the CMTS and the DOCSIS config file that is sent down to cable modems prior
to them coming online
!
cable map-advance dynamic !re-enable dynamic map advance on
!all line cards. This command is the
!default and does not show in the
! running configuration.
!
cable arp filter request-send 4 2
cable arp filter reply-accept 4 2 !ARP filtering limits ARP traffic per SID. This must
be configured on all downstream interfaces including both master and slave interfaces
! Cable Interface Downstream Configuration (without Bundling)
interface cable <ds interface>/0 ! Commands should be repeated for all interfaces.
! Each cable interface should be configured with at least one primary and one
secondary address. The primary
! address must always be used for cable modems. The secondary addresses are used for
customer premise
! equipment. Please contact <> if your configuration does not match this standard.
! Under circumstances when the primary cable modem scope becomes insufficient to
support all devices and needs
! to be expanded, a secondary CM scope may be configured to allow for additional
growth. The <> operations
! manual should be consulted for configuration guidelines.
! All ingress interfaces should be configured to verify the reverse path of incoming
packets. This is done to
! prevent "spoofing" attacks. Ingress interfaces would be those interfaces, which
connect the Road Runner
! network to either customers or other public networks. This is different from the
"cable source-verify"
! feature, however the two perform a similar function.
!
! Multinet

```

```

ip address <address> <mask> secondary      | CM (secondary added for growth)
ip address <address> <mask> secondary      | CPE (secondary)
ip address <address> <mask>                | Cable Modem (primary)
!
cable insertion-interval automatic
cable dhcp-giaddr primary ! If this is not the case, please
!
ip verify unicast reverse-path allow-self-ping
cable helper-address <primary cpe dhcp server> host
cable helper-address <secondary cpe dhcp server> host
cable helper-address <primary cm dhcp server> cable-modem
cable helper-address <secondary cm dhcp server> cable-modem
!
! RIP
ip rip authentication mode md5
ip rip authentication key-chain <key string name>
default cable downstream rate-limit      ! Does not show in configuration
cable downstream annex B
!
! The downstream modulation may be set to either 64QAM or 256QAM depending on the
capabilities of the local RF
! plant (256qam is the preferred setting). Please contact <> before changing from
64QAM to 256QAM due to the
! increased carrier to noise ratio requirements.
! cable downstream modulation <64qam or 256qam>      | 256qam preferred
cable downstream interleave-depth 32
cable downstream frequency <ds frequency>          | Note this is a comment only and
cable privacy kek life-time 604800                | Default, does not show in
cable privacy kek grace-time 600 | Default, does not show in
cable privacy tek life-time 43200 | Default, does not show in
cable privacy tek grace-time 600 | Default, does not show in
!
no cable downstream rf-power
! Cable Interface Downstream Configuration (with Bundling)
! Cable Interface Bundling allows multiple interfaces to share a single IP network
number. A given CMTS may
! have multiple bundles depending on the number of hosts per interface. For example,
a newly deployed CMTS
! could have all four interfaces in a single bundle. If after a period of time, the
user population could be
! segmented into two groups of 500 to 700 users, each using two interfaces, it would
be more efficient to split
! the configuration into two bundles. The commands used with Interface Bundling are
identical to those used
! without Interface Bundling with some minor exceptions.
! The bundled interfaces must be assigned to a Virtual Bundle by the commands:
interface cable <ds interface>/0
cable bundle <bundle id>
! The remaining configuration of the bundled interfaces would be identical to the
configuration used on the
! unbundled interface without the layer-3 configurations such as:
! 1. IP addresses are not required
! 2. Cable Helper addresses are not required
! 3. RIPv2 authentication is not required
! 4. Source-Verify and Lease-Timer functions
! 5. PIM
! 6. Access-lists (ACLs)
! 7. Sub-interfaces
! 8. Cable ARP filters
! The upstream configuration does not change in any way if bundling is enabled.
!
! Virtual Bundle Interface

```

! In IOS 12.3(17b)BC4, Virtual Bundle Interface supports bundled cable interfaces to allow multiple cable ! interfaces to share a single IP network number. Virtual interface bundling supports and governs the following ! Layer 3 settings for the bundle member interfaces:

- ! 1. IP address scopes
 - ! 2. Cable Helper addresses
 - ! 3. RIPv2 authentication
 - ! 4. Source-Verify and Lease-Timer functions
 - ! 5. PIM
 - ! 6. Access-lists (ACLs)
 - ! 7. Sub-interfaces
 - ! 8. Cable ARP filters
- ! Ex:

```
interface Bundle1
    ip address 10.200.200.1 255.255.255.0 secondary
    ip address 10.200.111.1 255.255.255.0 secondary
    ip address 10.200.112.1 255.255.255.0 secondary
    ip address 24.28.219.1 255.255.255.128 secondary
    ip address 10.200.2.1 255.255.255.0
    ip verify unicast reverse-path allow-self-ping
    ip rip send version 2
    ip rip receive version 2
    ip rip authentication mode md5
    ip rip authentication key-chain ubr-rip
    ip pim sparse-mode
    cable arp filter request-send 4 2
    cable arp filter reply-accept 4 2
    no cable ip-multicast-echo
    cable dhcp-giaddr primary
    cable helper-address 10.203.3.6
```

! The bundled cable interfaces must be assigned to a Virtual Bundle by the commands:

```
interface cable <ds interface>/0
cable bundle <bundle id>
```

```
!
interface Cable3/0
cable bundle 1
```

```
!
interface Cable3/1
    cable bundle 1
```

```
!
! Cable Interface Upstream Configuration
cable upstream <us channel> description <Fiber Node(s) connected>
cable upstream <us channel> frequency <us frequency> ! All upstream should be
configured
cable upstream <us channel> power-level 0 ! Please work with local RF team to
cable upstream <us channel> channel-width 3200000
no cable upstream <us channel> shutdown
cable upstream <us channel> data-backoff 3 5 ! Default, does not show in
configuration.
cable upstream <us channel> connector <physical port number>
! Unless Virtual Interfaces (VI) are
! configured, the <us channel> and
! <physical port number> should match
```

```
cable upstream minislot-size 2
cable upstream <us channel> range-backoff 3 6 ! improves registration times
```

```
!
! MC16U/X and MC28U/X Card Configuration
interface cable <interface>/<downstream port>
    cable downstream frequency <ds frequency>
    cable downstream frequency <ds frequency>
    cable downstream rf-power 52
    cable downstream rf-shutdown
```

```

no cable downstream rf-shutdown
cable upstream <us channel> ingress-noise-cancellation 200      ! default
cable upstream <us channel> channel-width <1st width> <2nd width> ! 1st and 2nd must
                                ! be same value
cable upstream <us channel> modulation-profile <index number>    ! see
Appendix A
                                ! for new index #s
cable upstream <#> range-backoff 3 6                            ! range backoff
cable upstream <us channel> sl60-atp-workaround
!
! OSPF Configuration
router ospf <PID>      ! The OSPF PID should match the local
! autonomous system number used for
! BGP
log-adjacency-changes
redistribute rip metric 20 subnets route-map COMM-SVC-NETS |
passive-interface default ! Suppress routing updates on all interfaces
no passive-interface GigabitEthernet0/2      ! Unsuppress routing updates on WAN
interface to establish ospf adjacency
network <network> <wildcard> area 0      ! There should be one net statement
! per connected network
no redistribute static      ! Default, does not show in
no redistribute connected ! Default, does not show in
! configuration. Directly connected
! interfaces that are to be
! advertised in OSPF should be
! explicitly configured
neighbor 24.93.33.114 priority 1
!
! BGP Configuration
router bgp <Public AS>
no synchronization
bgp log-neighbor-changes
bgp graceful-restart restart-time 120 ! Nonstop forwarding Awareness
bgp graceful-restart stalepath-time 360
bgp graceful-restart
network <CPE-NETS> mask <MASK>
network <VOIP-NETS> mask <MASK>
network <Residential-AOL> mask <MASK>
network <Residential-Earthlink> mask <MASK>
network <IP NET's needed in BGP> mask <mask>
network <LOCAL-NETS> mask <MASK>
redistribute rip route-map COMM-SVC-NETS
neighbor AGGREGATE-L3-RR-CLIENT peer-group
neighbor AGGREGATE-L3-RR-CLIENT remote-as <Public AS>
neighbor AGGREGATE-L3-RR-CLIENT password <password>
neighbor AGGREGATE-L3-RR-CLIENT update-source Loopback0
neighbor AGGREGATE-L3-RR-CLIENT next-hop-self
neighbor AGGREGATE-L3-RR-CLIENT send-community
neighbor AGGREGATE-L3-RR-CLIENT soft-reconfiguration inbound
neighbor AGGREGATE-L3-RR-CLIENT route-map CMTS-REG out
neighbor <AGG Router #1 IP> peer-group AGGREGATE-L3-RR-CLIENT
neighbor <AGG Router #2 IP> peer-group AGGREGATE-L3-RR-CLIENT
no auto-summary
!
ip bgp-community new-format
!
! RIP Configuration
Router RIP
Version 2
passive-interface default | Specify passive for all interfaces. You must configure
WAN interfaces non-passive.
network 10.0.0.0

```

```

no network 24.0.0.0      | Public Address Space. Default, | does not show in
configuration
distribute-list 40 in
no auto-summary
!
! Route Maps
! Route Maps should be used whenever one set of routing information is redistributed
into another set of
! routing information. Redistribution is currently required for the Static IP
solution. Access list 40 is
! used to define the networks which are permitted to be redistributed for Commercial
Services.
! Route-Map COMM-SVC-NETS permit 10      | a route map similar to that used      | for RIP
redistribution MAY be ! used | for redistribution as long as it      | corresponds to an
approved ACL
    Match ip address 40
!
route-map COMM-SVC-NETS permit 10
    match ip address 40
    set community DIV:6000
!
route-map CMTS-REG permit 5
    match ip prefix-list <prefix list name>
    set community DIV:4003
route-map CMTS-REG permit 10
    match ip prefix-list <prefix list name>
    set community DIV:5000
route-map CMTS-REG permit 15
    match ip prefix-list <prefix list name>
    set community DIV:5001
route-map CMTS-REG permit 20
    match ip prefix-list <prefix list name>
    set community DIV:4000
route-map CMTS-REG permit 25
    match ip prefix-list <prefix list name>
    set community DIV:3001
route-map CMTS-REG permit 30
    match ip prefix-list <prefix list name>
    set community DIV:4002
route-map CMTS-REG permit 35
    match ip prefix-list <prefix list name>
    set community DIV:4001
route-map CMTS-REG permit 40
    match ip prefix-list <prefix list name>
    set community DIV:4004
route-map CMTS-REG permit 45
    match ip prefix-list <prefix list name>
!
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 10 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 10 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 10 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
ip prefix-list <prefix list name> seq 10 permit <IP NET>
ip prefix-list <prefix list name> seq 5 permit <IP NET>
!
! SYSLOG Configuration
logging source-interface Loopback0

```



```

logging buffered 512000      ! Set log file size
logging facility local6
logging <primary logging server>
! logging defaults to level 7. Refer |to Monitoring Servers Definition for |Network
Devices Deployment Standard ! for a complete list of poller IP |Address
! logging <secondary logging server>      | Refer to Monitoring servers |Definition for
Network Devices
! Deployment Standard for a complete |list of syslog collector IP address
logging <local server>      ! optional third local logging server
logging host <ip address> ! this command may appear after defining a logging server
in the step above
logging monitor warnings    ! this command limits the logging messages that are
displayed on terminal lines -
!                                other then the console line - to messages with a level up
to and including the
!                                specified level argument.
logging trap informational ! Syslog level
no logging console
cable logging badipsource ! log "badipsrc" msgs to different log
cable logging layer2events 512000 ! log docsis msgs to different log
!
! Access Control Lists
Access-list compile
access-list 5 permit <ip address> <address mask>      ! ACL 5 is used to limit VTY
access to network devices
access-list 5 permit <local.subnet> <wildcard> ! Local VTY permits
access-list 6 permit <ip address> <address mask>
! This list should not be changed.
! It should be the same on all
! routers in the network
access-list 7 permit <ip address> <wildcard>    ! List for Regional SNMP access
|(optional)
access-list 8 permit <ip address> <wildcard>    ! List for Affiliate SNMP access
|(optional)
access-list 15 permit <ip address> <wildcard> | Used for legacy equipment

access-list 40 permit <ip address> <wildcard> ! List for static IP networks
!
! SNMP Configuration
snmp-server engineID local <auto-generated Key>      ! Auto generated by router, not
configurable
snmp-server contact <contact>
snmp-server location <address>
snmp-server chassis-id <server name>
no snmp-server community public RO
snmp-server community <snmp string> RO 6
snmp-server community <snmp string> RO 7
snmp-server community <Affiliate string> RO 8 ! ACL 8 lists Affiliate hosts
snmp-server trap-source Loopback0
snmp-server host <trap collector> <snmpstring> | needed for each collector
snmp-server ifindex persist      | Interface index (ifindex) is retained when router
is rebooted.
snmp-server enable traps snmp
snmp-server enable traps config
snmp-server enable traps entity
snmp-server enable traps cable
snmp-server enable traps bgp
snmp-server enable traps pim neighbor-change rp-mapping-change invalid-pim-message
snmp-server enable traps ipmulticast
snmp-server enable traps envmon
snmp-server enable traps rtr
snmp-server enable traps atm pvc
snmp-server enable traps tty      ! sometimes default

```

```

!
! Message of the Day
banner motd ^
                *****Warning Notice*****
This system is restricted solely to <operator>? authorized users for
<cut>
                ***** Network Operations Center <telephone #> *****

^
!
! Virtual Terminal Lines
Virtual Terminal access
Line console 0
  No password ! Default, does not show in
! configuration
  exec prompt timestamp      ! Gives NTP timestamp when doing CLI
line vty 0 4
  exec prompt timestamp      ! Gives NTP timestamp when doing CLI
  default session-timeout
  default exec-timeout
  access-class 5 in
line vty 5 10 | additional vty added to support |multiple access for trouble shooting
|and Polling at the same time
  default session-timeout
  default exec-timeout
  access-class 5 in
!
! Crash Dumps
! As a temporary troubleshooting measure (usually at the request of the vendor), it is
approved to place the
! following command into the configuration:
! exception crashinfo file slot0:      | slot0:/disk0: for NPE other then |G1. G1's
use disk2:
!
! Packet Cable Multi-Media (PCMM)
access-list 6 permit host <ip address> | grant SNMP RO access from PCMM server
packetcable authorize vanilla-docsis-mta      | enable PCMM
packetcable multimedia      | enable PCMM
ip access-list extended cops      | specify acl to allow access
    permit ip host <VIP1 address of regional MPE> host <ubr's loopback address>
    permit ip host <VIP2 address of regional MPE> host <ubr's loopback address>
cops listener access-list cops      | apply the acl to the PCMM process

! Modulation Profile(omitted)
! Channel Width (omitted)
! Modulation Profile in interface example (omitted)
!
! Activating DHCP Relay
! The cable relay agent is for use with DOCSIS-based DHCP servers that use option 82
to automatically map the
! Ethernet MAC address of a host (end user PC) with the cable modem to which it is
connected.
!
! With the cable relay agent activated, the Cisco uBR7200 series will insert the cable
modem MAC address into a
! DHCP packet when a packet is received from a cable modem or another host. The Cisco
uBR7200 series will then
! forward the packet to a DHCP server.
! To activate the cable relay agent on each interface, use the following command
global command:
ip dhcp relay information option
!
! Tool Access

```

```
ip rcmd rsh-enable
ip rcmd remote-host cmit xx.xx.xx.xx cmit
! CMIT is the name of the remote |client and xx is the ip address |of the unit the
client is |accessing from.
! There could be |multiple entries for each ip |address and client permitted |access.
privilege exec level 1 clear
privilege exec level 1 clear cable
privilege exec level 1 clear cable flap-list
privilege exec level 1 clear cable host
privilege exec level 1 show controller
privilege exec level 1 show cable qos
privilege exec level 1 show cable modem
privilege exec level 1 show cable modem detail
privilege exec level 1 show cable modem verbose
privilege exec level 1 show cable modem offline
privilege exec level 1 show interfaces cable6/0 modem
privilege exec level 1 show interfaces cable6/1 modem
privilege exec level 1 show interfaces cable5/0 modem
privilege exec level 1 show interfaces cable5/1 modem
privilege exec level 1 show interfaces cable4/0 modem
privilege exec level 1 show interfaces cable4/1 modem
privilege exec level 1 show interfaces cable3/0 modem
privilege exec level 1 show interfaces cable3/1 modem
privilege exec level 1 show cable modem 0000.0000.0000 verbose
!
! (CALEA configuration omitted)
! (CBI configuration omitted)
!
! Spectrum Groups (omitted)
!
```

II.2 CMTS Example Configuration File B

Following is the majority of a complete configuration file for a typical DOCSIS 1.1 CMTS used in production today. When <angle brackets> are used, the actual text in the configuration file varies among operators or was removed to make the configuration generic to all operators. Other comments indicate if other sections were purposefully omitted to keep the example brief and readable.

```
!!!!
!
! DOCSIS 1.1 Example Configuration File B
!
!!!!
!
service nagle
no service pad
service timestamps debug datetime msec show-timezone
service timestamps log datetime msec show-timezone
service password-encryption
!
hostname <hostname>
!
boot-start-marker
boot system disk0:<image name>.bin
boot system disk2:<image2 name>.bin
boot bootldr bootflash:<image3 name>.bin
boot-end-marker
!
logging buffered 512000 debugging
enable secret 5 <secret key>
!
clock timezone EST -5
clock summer-time EDT recurring
fastether transmit store_and_forward enable
no cable admission-control preempt priority-voice
cable flap-list size 8191
cable flap-list power-adjust threshold 3
cable flap-list aging 1440
cable source-verify leasequery-filter downstream 10 5
cable modem max-cpe 10
cable modem vendor 00.<nn>.<nn> VendorNameCM
!
! Modulation profiles (omitted)
!
cable service flow activity-timeout 300
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable logging badipsources 10000
cable logging layer2events 512000
cable time-server
cable dsg client-list 1 id-index 1 mac-addr 0001.a6d0.0b1e
cable dsg client-list 1 id-index 2 ca-system-id E00
cable dsg client-list 2 id-index 1 mac-addr 0001.a6d0.0b01
cable dsg client-list 2 id-index 2 mac-addr 0001.a6d0.0b1e
cable dsg client-list 2 id-index 3 ca-system-id E00
cable dsg client-list 3 id-index 1 application-id 2
cable dsg client-list 11 id-index 1 ca-system-id 700
cable dsg client-list 12 id-index 1 ca-system-id 701
cable dsg client-list 13 id-index 1 application-id 18
cable dsg client-list 14 id-index 1 broadcast 2
cable dsg client-list 99 id-index 1 mac-addr 0001.a6fe.0000
cable dsg client-list 99 id-index 2 ca-system-id E00
cable dsg client-list 100 id-index 1 mac-addr 0001.a6ff.0064
```

```
cable dsg client-list 100 id-index 2 ca-system-id E00
cable dsg client-list 101 id-index 1 mac-addr 0001.a6ff.0065
cable dsg client-list 101 id-index 2 ca-system-id E00
cable dsg client-list 102 id-index 1 mac-addr 0001.a6ff.0066
cable dsg client-list 102 id-index 2 ca-system-id E00
cable dsg tg 1 channel 30
cable dsg tg 1 channel 50
cable dsg tg 1 channel 50 ucid 1 2
cable dsg tg 1 channel 60
cable dsg tg 2 channel 30
cable dsg tg 3 channel 50
cable dsg tg 3 channel 50 ucid 3 4
cable dsg tg 3 channel 60
cable dsg tg 3 channel 60 ucid 2
cable dsg tg 3 channel 61
cable dsg tg 4 channel 50
cable dsg tg 5 channel 60
cable dsg tg 5 channel 61
cable dsg tg 11 channel 30
cable dsg tg 11 channel 51
cable dsg tg 11 channel 60
cable dsg tg 11 channel 61
cable dsg tg 12 channel 30
cable dsg tg 12 channel 51
cable dsg tg 12 channel 51 ucid 1 2
cable dsg tg 12 channel 60
cable dsg tg 12 channel 61
cable dsg tg 13 channel 51
cable dsg tg 13 channel 51 ucid 3 4
cable dsg tg 13 channel 60
cable dsg tg 13 channel 61
cable dsg tg 14 channel 30
cable dsg tg 15 channel 51
cable dsg tg 16 channel 60
cable dsg tg 16 channel 61
cable dsg tg 100 channel 60
cable dsg tg 100 channel 61
cable dsg tg 999 channel 999
cable dsg tunnel 1 mac-addr 1001.0dcd.0001 tg 1 clients 1
cable dsg tunnel 2 mac-addr 1001.0dcd.0002 tg 2 clients 2
cable dsg tunnel 3 mac-addr 1001.0dcd.0003 tg 3 clients 1
cable dsg tunnel 4 mac-addr 1001.0dcd.0004 tg 4 clients 2
cable dsg tunnel 5 mac-addr 1001.0dcd.0005 tg 5 clients 2
cable dsg tunnel 6 mac-addr 1001.0dcd.0030 tg 100 clients 3
cable dsg tunnel 11 mac-addr 1001.0dcd.0011 tg 11 clients 11
cable dsg tunnel 12 mac-addr 1001.0dcd.0012 tg 12 clients 12
cable dsg tunnel 13 mac-addr 1001.0dcd.0013 tg 13 clients 12
cable dsg tunnel 14 mac-addr 1001.0dcd.0014 tg 11 clients 13
cable dsg tunnel 15 mac-addr 1001.0dcd.0015 tg 14 clients 14
cable dsg tunnel 16 mac-addr 1001.0dcd.0016 tg 15 clients 14
cable dsg tunnel 17 mac-addr 1001.0dcd.0017 tg 16 clients 14
cable dsg tunnel 100 mac-addr 0100.5e41.fd64 tg 100 clients 99
cable dsg tunnel 102 mac-addr 0100.5e41.fd66 tg 100 clients 101
cable dsg tunnel 103 mac-addr 0100.5e41.fd67 tg 100 clients 100
cable dsg tunnel 104 mac-addr 0100.5e41.fd68 tg 100 clients 102
cable dsg tunnel 105 mac-addr 0100.5e41.fd69 tg 100 clients 100
cable dsg tunnel 106 mac-addr 0100.5e41.fd6a tg 100 clients 100
cable dsg tunnel 107 mac-addr 0100.5e41.fd6b tg 100 clients 102
cable dsg tunnel 108 mac-addr 0100.5e41.fd6c tg 100 clients 101
cable dsg tunnel 9998 mac-addr 9998.9998.9998 tg 999 clients 14
cable dsg tunnel 9999 mac-addr 9999.9999.9999 tg 999 clients 12
cable dsg cfr 1 dest-ip <ip address> tunnel 1 priority 0 src-ip <ip address> in-dcd
yes
```

```

cable dsg cfr 2 dest-ip <ip address> tunnel 2 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 3 dest-ip <ip address> tunnel 3 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 4 dest-ip <ip address> tunnel 4 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 5 dest-ip <ip address> tunnel 5 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 6 dest-ip <ip address> tunnel 6 priority 1 src-ip <ip address> in-dcd
yes
cable dsg cfr 11 dest-ip <ip address> tunnel 11 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 12 dest-ip <ip address> tunnel 12 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 13 dest-ip <ip address> tunnel 13 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 14 dest-ip <ip address> tunnel 14 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 15 dest-ip <ip address> tunnel 15 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 16 dest-ip <ip address> tunnel 16 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 17 dest-ip <ip address> tunnel 17 priority 0 src-ip <ip address> in-dcd
yes
cable dsg cfr 100 dest-ip <ip address> tunnel 100 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 102 dest-ip <ip address> tunnel 102 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 103 dest-ip <ip address> tunnel 103 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 104 dest-ip <ip address> tunnel 104 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 105 dest-ip <ip address> tunnel 105 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 106 dest-ip <ip address> tunnel 106 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 107 dest-ip <ip address> tunnel 107 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 108 dest-ip <ip address> tunnel 108 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 9998 dest-ip <ip address> tunnel 9998 priority 0 src-ip <ip address> in-
dcd yes
cable dsg cfr 9999 dest-ip <ip address> tunnel 9999 priority 0 src-ip <ip address> in-
dcd yes
cable dsg timer 1 Tdsg1 2 Tdsg2 60 Tdsg3 30 Tdsg4 180
cable load-balance group 1
cable load-balance group 2 method utilization
cable load-balance group 2 threshold load 10 enforce 20
cable load-balance group 3 method utilization
cable load-balance group 3 threshold load 10 enforce 20
cable load-balance group 5 method utilization
cable load-balance group 5 dcc-init-technique 4
cable load-balance group 5 threshold load 10 enforce 20
cable load-balance group 6 method utilization
cable load-balance group 6 dcc-init-technique 4
cable load-balance group 6 threshold load 10 enforce 20
cable load-balance group 6 policy us-groups-across-ds
!
cable config-file AD SG-staging
service-class 1 max-upstream 2000
service-class 1 max-downstream 10000
service-class 1 max-burst 1600
cpe max 2

```

```
!  
aaa new-model  
!  
!  
aaa authentication login default group tacacs+ enable  
aaa authentication enable default enable  
aaa authorization config-commands  
aaa authorization exec default group tacacs+ none  
aaa authorization commands 15 default group tacacs+ none  
aaa accounting exec default start-stop group tacacs+  
aaa accounting commands 1 default start-stop group tacacs+  
aaa accounting commands 15 default start-stop group tacacs+  
aaa accounting network default start-stop group tacacs+  
aaa accounting system default start-stop group tacacs+  
aaa session-id common  
ip subnet-zero  
no ip source-route  
no ip gratuitous-arps  
!  
!  
ip cef  
ip tftp source-interface Loopback0  
ip domain name <domain name>.<sub-domain>.com  
ip host riverstone <ip address>  
ip name-server <ip address>  
ip name-server <ip address>  
ip name-server <ip address>  
ip dhcp relay information option  
!  
ip dhcp pool AD SG-eCM  
    network <ip address> <netmask>  
    bootfile AD SG-staging.bin  
    next-server <ip address>  
    default-router <ip address>  
    option 2 hex ffff.aaaa  
    option 4 ip <ip address>  
    option 7 ip <ip address>  
!  
ip dhcp pool AD SG-host  
    network <ip address> <netmask>  
    default-router <ip address>  
!  
no ip bootp server  
ip multicast-routing  
ip multicast route-limit 250  
ip igmp limit 500  
ip igmp ssm-map enable  
no ip igmp ssm-map query dns  
ip igmp ssm-map static VLC3 <ip address>  
ip igmp ssm-map static groups1 <ip address>  
ip igmp ssm-map static VLC1 <ip address>  
ip igmp ssm-map static VLC2 <ip address>  
packetcable authorize <list name>  
packetcable multimedia  
!  
! Certificate Entry  
!  
crypto ca trustpoint DOCSIS-ROOT-CERT  
!  
crypto ca trustpoint CN==<vendor name>,-OU==<vendor address>,-OU-  
=-DOCSIS,-O==<short vendor name>,-C==US  
! followed by other vendor certificates  
!
```

[illegible]


```
no ip mroute-cache
no keepalive
!
interface FastEthernet0/0
no ip address
no ip redirects
no ip proxy-arp
load-interval 30
shutdown
duplex full
!
interface GigabitEthernet0/1
no ip address
shutdown
duplex auto
speed auto
media-type rj45
negotiation auto
!
interface GigabitEthernet0/2
no ip address
shutdown
duplex auto
speed auto
media-type rj45
negotiation auto
!
interface GigabitEthernet0/3
no ip address
shutdown
duplex auto
speed auto
media-type rj45
negotiation auto
!
interface Cable3/0
description SPECIAL CLIENT AREA INTERFACE
no ip address
load-interval 30
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 99
cable downstream rate-limit
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 603000000
cable downstream channel-id 30
cable downstream description SA + Moto non-straddled
cable downstream dsg tg 1 channel 30
cable downstream dsg tg 2 channel 30
cable downstream dsg tg 11 channel 30
cable downstream dsg tg 12 channel 30
cable downstream dsg tg 14 channel 30
cable upstream 0 description CLIENT AREA
cable upstream 0 frequency 33008000
cable upstream 0 channel-width 3200000
cable upstream 0 minislot-size 2
cable upstream 0 power-level 0
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 9
```

```
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 description CLIENT AREA
cable upstream 1 frequency 20704000
cable upstream 1 channel-width 3200000
cable upstream 1 minislot-size 2
cable upstream 1 power-level 0
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 9
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 frequency 33008000
cable upstream 2 channel-width 3200000
cable upstream 2 minislot-size 2
cable upstream 2 power-level 0
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 9
no cable upstream 2 shutdown
cable upstream 3 frequency 33008000
cable upstream 3 channel-width 3200000
cable upstream 3 minislot-size 2
cable upstream 3 power-level 0
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 9
no cable upstream 3 shutdown
cable upstream 4 frequency 33008000
cable upstream 4 channel-width 3200000
cable upstream 4 minislot-size 4
cable upstream 4 power-level 0
cable upstream 4 range-backoff 3 6
cable upstream 4 modulation-profile 8
no cable upstream 4 shutdown
cable upstream 5 frequency 33008000
cable upstream 5 channel-width 3200000
cable upstream 5 minislot-size 4
cable upstream 5 power-level 0
cable upstream 5 range-backoff 3 6
cable upstream 5 modulation-profile 8
no cable upstream 5 shutdown
no keepalive
!
interface Cable4/0
description SPECIAL CLIENT AREA INTERFACE
no ip address
cable shared-secret 7 000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 99
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 615000000
cable downstream channel-id 40
no cable downstream rf-shutdown
cable upstream 0 description CLIENT AREA
cable upstream 0 connector 0
cable upstream 0 frequency 10000000
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 docsis-mode tdma-atdma
cable upstream 0 channel-width 3200000 3200000
cable upstream 0 minislot-size 2
cable upstream 0 range-backoff 3 6
```

```
cable upstream 0 modulation-profile 143
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 description CLIENT AREA
cable upstream 1 connector 1
cable upstream 1 frequency 14000000
cable upstream 1 ingress-noise-cancellation 200
cable upstream 1 docsis-mode tdma-atdma
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 minislot-size 2
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 143
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 connector 2
cable upstream 2 frequency 22000000
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 docsis-mode tdma-atdma
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 minislot-size 2
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 143
cable upstream 2 load-balance group 3
cable upstream 2 shutdown
cable upstream 3 connector 3
cable upstream 3 frequency 18000000
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 docsis-mode tdma-atdma
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 minislot-size 2
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 143
cable upstream 3 load-balance group 3
cable upstream 3 shutdown
!
interface Cable4/1
description SPECIAL CLIENT AREA INTERFACE
no ip address
shutdown
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 99
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 603000000
cable downstream channel-id 41
no cable downstream rf-shutdown
cable upstream 0 connector 4
cable upstream 0 frequency 26000000
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 docsis-mode tdma-atdma
cable upstream 0 channel-width 3200000 3200000
cable upstream 0 minislot-size 2
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 143
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 connector 5
cable upstream 1 frequency 30000000
cable upstream 1 ingress-noise-cancellation 200
```

```
cable upstream 1 docsis-mode tdma-atdma
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 minislot-size 2
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 143
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 connector 6
cable upstream 2 frequency 34000000
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 docsis-mode tdma-atdma
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 minislot-size 2
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 143
cable upstream 2 load-balance group 3
cable upstream 2 shutdown
cable upstream 3 connector 7
cable upstream 3 frequency 38000000
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 docsis-mode tdma-atdma
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 minislot-size 2
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 143
cable upstream 3 load-balance group 3
cable upstream 3 shutdown
!
interface Cable5/0
description STANDARD PURPOSE INTERFACE
no ip address
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 1
cable downstream rate-limit
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 603000000
cable downstream channel-id 50
cable downstream description SA straddled
cable downstream dsg tg 1 channel 50
cable downstream dsg tg 3 channel 50
cable downstream dsg tg 4 channel 50
no cable downstream rf-shutdown
cable upstream 0 connector 0 shared
cable upstream 0 frequency 10000000
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 channel-width 3200000 3200000
cable upstream 0 minislot-size 2
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 49
cable upstream 0 load-balance group 2
cable upstream 0 shutdown
cable upstream 1 connector 0 shared
cable upstream 1 frequency 14000000
cable upstream 1 ingress-noise-cancellation 200
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 minislot-size 2
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 49
```

```
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 connector 2 shared
cable upstream 2 frequency 22000000
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 minislot-size 2
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 49
cable upstream 2 load-balance group 2
cable upstream 2 shutdown
cable upstream 3 connector 2 shared
cable upstream 3 frequency 18000000
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 minislot-size 2
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 49
cable upstream 3 load-balance group 2
no cable upstream 3 shutdown
!
interface Cable5/1
description STANDARD PURPOSE INTERFACE
no ip address
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 1
cable downstream rate-limit
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 615000000
cable downstream channel-id 51
cable downstream description Moto straddled
cable downstream dsg tg 11 channel 51
cable downstream dsg tg 12 channel 51
cable downstream dsg tg 13 channel 51
cable downstream dsg tg 15 channel 51
no cable downstream rf-shutdown
cable upstream 0 connector 4 shared
cable upstream 0 frequency 26000000
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 channel-width 3200000 3200000
cable upstream 0 minislot-size 2
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 49
cable upstream 0 load-balance group 3
no cable upstream 0 shutdown
cable upstream 1 connector 4 shared
cable upstream 1 frequency 30000000
cable upstream 1 ingress-noise-cancellation 200
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 minislot-size 2
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 49
cable upstream 1 load-balance group 3
no cable upstream 1 shutdown
cable upstream 2 connector 6 shared
cable upstream 2 frequency 34000000
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 channel-width 3200000 3200000
```

```
cable upstream 2 minislot-size 2
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 49
cable upstream 2 load-balance group 3
cable upstream 2 shutdown
cable upstream 3 connector 6 shared
cable upstream 3 frequency 38000000
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 minislot-size 2
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 49
cable upstream 3 load-balance group 3
cable upstream 3 shutdown
!
interface Cable6/0
description P.ARNTS TEST
no ip address
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 1
cable downstream rate-limit
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 603000000
cable downstream channel-id 60
cable downstream description SA + Moto non-straddled
cable downstream dsf timer 1
cable downstream dsf tg 11 channel 60
cable downstream dsf tg 12 channel 60
cable downstream dsf tg 16 channel 60
cable downstream dsf tg 100 channel 60
no cable downstream rf-shutdown
cable upstream 0 description P.ARNTS TEST
cable upstream 0 connector 0 shared
cable upstream 0 frequency 10000000
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 channel-width 3200000 3200000
cable upstream 0 minislot-size 2
cable upstream 0 power-level 15
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 41
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 description P.ARNTS TEST
cable upstream 1 connector 0 shared
cable upstream 1 frequency 14000000
cable upstream 1 ingress-noise-cancellation 200
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 minislot-size 2
cable upstream 1 power-level 15
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 41
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 connector 2
cable upstream 2 frequency 18000000
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 minislot-size 2
cable upstream 2 power-level 15
```

```
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 41
cable upstream 2 load-balance group 3
no cable upstream 2 shutdown
cable upstream 3 connector 3
cable upstream 3 frequency 22000000
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 minislot-size 2
cable upstream 3 power-level 15
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 41
cable upstream 3 load-balance group 3
no cable upstream 3 shutdown
cable privacy accept-self-signed-certificate
cable load-balance group 1
!
interface Cable6/1
description MC28U
no ip address
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
cable bundle 1
cable downstream rate-limit
cable downstream annex B
cable downstream modulation 256qam
cable downstream interleave-depth 32
cable downstream frequency 609000000
cable downstream channel-id 61
cable downstream description SA + Moto non-straddled
cable downstream dsg timer 1
cable downstream dsg tg 11 channel 61
cable downstream dsg tg 12 channel 61
cable downstream dsg tg 16 channel 61
cable downstream dsg tg 100 channel 61
no cable downstream rf-shutdown
cable upstream 0 connector 4
cable upstream 0 frequency 26000000
cable upstream 0 ingress-noise-cancellation 200
cable upstream 0 channel-width 3200000 3200000
cable upstream 0 minislot-size 2
cable upstream 0 range-backoff 3 6
cable upstream 0 modulation-profile 41
cable upstream 0 load-balance group 2
no cable upstream 0 shutdown
cable upstream 1 connector 5
cable upstream 1 frequency 30000000
cable upstream 1 ingress-noise-cancellation 200
cable upstream 1 channel-width 3200000 3200000
cable upstream 1 minislot-size 2
cable upstream 1 range-backoff 3 6
cable upstream 1 modulation-profile 41
cable upstream 1 load-balance group 2
no cable upstream 1 shutdown
cable upstream 2 connector 6 shared
cable upstream 2 frequency 34000000
cable upstream 2 ingress-noise-cancellation 200
cable upstream 2 channel-width 3200000 3200000
cable upstream 2 minislot-size 2
cable upstream 2 range-backoff 3 6
cable upstream 2 modulation-profile 41
```

```
cable upstream 2 load-balance group 3
no cable upstream 2 shutdown
cable upstream 3 connector 6 shared
cable upstream 3 frequency 38000000
cable upstream 3 ingress-noise-cancellation 200
cable upstream 3 channel-width 3200000 3200000
cable upstream 3 minislot-size 2
cable upstream 3 power-level 15
cable upstream 3 range-backoff 3 6
cable upstream 3 modulation-profile 41
cable upstream 3 load-balance group 3
no cable upstream 3 shutdown
cable load-balance group 1
!
interface Bundle1
description STANDARD CABLE BUNDLE
ip address <network> <mask> secondary
ip address <network> <mask> secondary
ip address <network> <mask> secondary
ip address <network> <mask> secondary
ip address <network> <mask>
ip access-group 157 in
ip verify unicast reverse-path allow-self-ping
ip rip authentication mode md5
ip rip authentication key-chain <chain name>
ip pim sparse-mode
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp version 3
cable match address list1
cable match address list2
cable match address list3
cable match address list4
cable arp filter request-send 4 2
cable arp filter reply-accept 4 2
no cable arp
no cable ip-multicast-echo
cable dhcp-giaddr primary
cable helper-address <ip address>
cable helper-address <ip address>
!
interface Bundle99
description SPECIAL CLIENT AREA BUNDLE
ip address <ip address> <netmask> secondary
ip address <ip address> <netmask> secondary
ip address <ip address> <netmask>
```



```
ip access-group 157 in
ip verify unicast reverse-path allow-self-ping
ip rip authentication mode md5
ip rip authentication key-chain ubr-rip
ip pim sparse-mode
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
ip igmp static-group <group ip> source <ip address>
cable arp filter request-send 4 2
cable arp filter reply-accept 4 2
no cable ip-multicast-echo
cable dhcp-giaddr primary
cable helper-address <ip address>
cable helper-address <ip address>
!
router ospf <ospf id>
router-id <ip address>
log-adjacency-changes
passive-interface default
no passive-interface SRP1/0
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
network <network> <bit mask> area 1
!
router rip
version 2
passive-interface default
network 10.0.0.0
distribute-list 40 in
no auto-summary
!
router bgp <asn>
no synchronization
bgp log-neighbor-changes
bgp graceful-restart restart-time 120
bgp graceful-restart stalepath-time 360
bgp graceful-restart
network <ip address> mask <netmask>
network <ip address> mask <netmask>
network <ip address> mask <netmask>
network <ip address> mask <netmask>
redistribute rip route-map COMM-SVC-NETS
neighbor RR-client peer-group
neighbor RR-client remote-as <asn>
neighbor RR-client update-source Loopback0
neighbor RR-client next-hop-self
neighbor RR-client send-community
neighbor RR-client soft-reconfiguration inbound
neighbor RR-client route-map CMTS-REG out
neighbor <ip address>peer-group RR-client
neighbor <ip address>peer-group RR-client
no auto-summary
!
ip classless
```

```
ip route <ip address> <network mask> FastEthernet0/0
no ip http server
no ip http secure-server
ip tacacs source-interface Loopback0
!
ip pim rp-address <ip address>div-multicast
ip pim ssm range SSM-ALLOW-SRV
!
ip prefix-list <list name> seq 5 permit <ip network>/<short mask>
ip prefix-list <list name> seq 10 permit <ip network>/<short mask>
!
ip prefix-list VOIP-NETS seq 5 permit <ip network>/<short mask>
ip prefix-list VOIP-NETS seq 10 permit <ip network>/<short mask>
!
ip access-list standard SSM-ALLOW-SRV
 permit <ip network><ip network mask>
 permit <ip network><ip network mask>
 permit <ip network><ip network mask>
ip access-list standard VLC1
 permit <ip address>
 permit <ip address>
 permit <ip address>
ip access-list standard VLC2
 permit <ip address>
 permit <ip address>
 permit <ip address>
ip access-list standard VLC3
 permit <ip address>
 permit <ip address>
 permit <ip address>
 permit <ip address>
 permit <ip address>
 permit <ip address>
 permit <ip address>
 permit <ip address>
 permit <ip address>
ip access-list standard div-multicast
 permit <ip network> <ip network mask>
 permit <ip network><ip network mask>
ip access-list standard groups1
 permit <ip address>
 permit <ip address>
ip access-list standard groups2
 permit <ip address>
!
ip access-list extended cops
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
 permit ip host <ip address> host <ip address>
ip access-list extended list1
 permit ip any host <ip address>
 permit ip any host <ip address>
 permit ip any host <ip address>
 permit ip any host <ip address>
 permit ip any host <ip address>
ip access-list extended list2
 permit ip any host <ip address>
```

```
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
ip access-list extended list3
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
ip access-list extended list4
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
logging facility local6
logging source-interface Loopback0
logging <ip address>
logging <ip address>
logging <ip address>
logging <ip address>
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 6 permit <ip address>
access-list 6 permit <ip address>
access-list 6 permit <ip address>
access-list 6 permit <ip address>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 8 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 40 permit <ip network> <ip network mask>
access-list 40 permit <ip network> <ip network mask>
access-list 157 permit udp any eq rip any eq rip
access-list 157 permit igmp any <ip network> <ip network mask>
access-list 157 permit igmp any <ip network> <ip network mask>
access-list 157 permit igmp any <ip network> <ip network mask>
access-list 157 permit udp any host <ip address>
access-list 157 deny igmp any any
access-list 157 deny icmp any <ip network> <ip network mask>
access-list 157 deny tcp any <ip network> <ip network mask>
access-list 157 deny udp any <ip network> <ip network mask>
access-list 157 permit ip any any
access-list 160 permit ip <ip network> <ip network mask> any
access-list 160 permit ip <ip network> <ip network mask> any
```

```

access-list 160 permit udp any any range bootps bootpc
access-list 160 deny ip any any log
!
nls resp-timeout 1
cpd cr-id 1
!
route-map COMM-SVC-NETS permit 10
  match ip address 40
!
route-map CMTS-REG permit 10
  match ip address prefix-list <list name>
!
route-map CMTS-REG permit 20
  match ip address prefix-list <list name>
!
route-map CMTS-REG permit 30
  match ip address 40
!
snmp-server engineID local 000000000000000000000000
snmp-server community <string name> RO
snmp-server community <string name>RO 6
snmp-server community <string name>RO
snmp-server trap-source Loopback0
snmp-server location <address or description>
snmp-server contact <first name> <last name> <tel #>
snmp-server chassis-id <id>
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart
snmp-server enable traps atm pvc
snmp-server enable traps config
snmp-server enable traps entity
snmp-server enable traps envmon
snmp-server enable traps rtr
snmp-server host <ip address> <hostname or description>
snmp-server host <ip address> <hostname or description>
snmp-server host <ip address> <hostname or description>
snmp-server host <ip address> <hostname or description>
snmp-server host <ip address> <hostname or description>
snmp-server host <ip address> <hostname or description>
snmp-server manager
tftp-server disk2:<image name>.bin
tacacs-server host <ip address>
tacacs-server host <ip address>
tacacs-server directed-request
tacacs-server key 7 <key>
!
cops listener access-list cops
banner motd ^CCCCC

```

*****Warning Notice*****

This system is restricted solely to <operator> authorized users for
<>

***** Network Operations Center <> *****

```

^C
alias exec scm show cable modem
alias exec sci show interface cable
alias exec scr show int cable 3/0 | in rate
alias exec scr4 show int cable 4/0 | in rate
alias exec scr5 show int cable 5/0 | in rate
alias exec scr6 show int cable 6/0 | in rate
alias exec shost show int cable 3/0 modem 0 | in host
alias exec shost3 show int cable 3/0 modem 0 | in host
alias exec shost4 show int cable 4/0 modem 0 | in host
alias exec shost5 show int cable 5/0 modem 0 | in host
alias exec shost6 show int cable 6/0 modem 0 | in host

```

```
alias exec sh% show proc cpu | ex 0.00
alias exec scmt show cable modem sum total
alias exec ccm clear cable modem
alias exec scmq show cable modem remote-query
alias exec scf show cable flap-list
alias exec sclb show cable load-balance all
privilege exec level 1 show ip interface brief
privilege exec level 1 show ip interface
privilege exec level 1 show ip
privilege exec level 1 show cable flap-list
privilege exec level 1 show cable modem
privilege exec level 1 show cable qos profile
privilege exec level 15 show cable qos
privilege exec level 1 show cable
privilege exec level 1 show controllers
privilege exec level 1 show interfaces
privilege exec level 1 show running-config
privilege exec level 1 show
privilege exec level 15 clear cable host
privilege exec level 15 clear cable flap-list all
privilege exec level 15 clear cable flap-list
privilege exec level 15 clear cable
privilege exec level 15 clear
!
line con 0
  exec-timeout 30 0
  logging synchronous
  transport preferred telnet
  transport output telnet
  stopbits 1
line aux 0
  transport preferred none
  transport output none
  stopbits 1
line vty 0 4
  access-class 5 in
  exec-timeout 60 0
  password 7 000000000000
  exec prompt timestamp
  transport preferred telnet
  transport input all
  transport output all
line vty 5 15
  access-class 5 in
  exec-timeout 30 0
  password 7 000000000000
  exec prompt timestamp
  transport preferred telnet
  transport input telnet
  transport output telnet
!
exception crashinfo file disk0:crashinfo
scheduler allocate 3999 400
ntp clock-period 17179904
ntp source Loopback0
ntp update-calendar
ntp server <ip address>
ntp server <ip address>
ntp peer <ip address>
end
```

Appendix III Example of IS-IS Configuration

Following are examples of additional commands used to configure IS-IS in a CMTS configuration. When <angle brackets> are used, the actual text in the configuration file varies among operators or was removed to make the configuration generic to all operators.

```

!!!!
!
! IS-IS Example Configuration
!
!!!!
!
! Sample Configuration IPv6 ISIS
!
!
! To enable the forwarding of IPv6 unicast datagrams
ipv6 unicast-routing
! IPv6 Interface Configuration
!
! Loopback interface configuration
interface Loopback0
    ipv6 address <X:X:X:X::X>/128
    ipv6 enable
!
! Interface connecting to hub equipment (such as 10720)
interface GigabitEthernet x/x
    ipv6 enable
!
! Loopback interface configuration
!
interface Loopback0
    ipv6 router isis
!
! Interface connecting to hub equipment (such as CMTS)
!
interface GigabitEthernet x/x
    ipv6 router isis
    isis network point-to-point
    isis hello-interval 1 level-1
    isis hello-multiplier 3 level-1      ! by default, it won't show here
!
! IPv6 ISIS Global Configuration
! Configuration example for ISIS instance level-1
!
router isis
    net <network-entity-title>
    is-type level-1
    metric-style wide      ! build the IS-IS route table using the traffic engineering
wide 24-bit metric style
!
address-family ipv6
multi-topology
exit-address-family

```

Appendix IV DPoE Example Configuration File

Following is an example of a configuration for a DPoE System. When <angle brackets> are used, the actual text in the configuration file varies among operators or was removed to make the configuration generic to all operators.

```
!!!!
!
! DPoE Example Configuration File
!
! This is the same as a DOCSIS configuration with RF parameters and some DOCSIS
parameters removed and
! with DPoE parameters added.
!
!!!!
!
service timestamps debug datetime msec show-timezone
service timestamps log datetime msec show-timezone
service password-encryption
!
hostname dpoe-sys1
!
boot-start-marker
boot system disk0:<image name>.bin
boot system disk2:<image2 name>.bin
boot bootldr bootflash:<image3 name>.bin
boot-end-marker
!
logging buffered 512000 debugging
enable secret 5 <secret key>
!
clock timezone EST -5
clock summer-time EDT recurring
fastether transmit store_and_forward enable
no cable admission-control preempt priority-voice
cable flap-list size 8191
cable flap-list power-adjust threshold 3
cable flap-list aging 1440
cable source-verify leasequery-filter downstream 10 5
cable modem max-cpe 10
cable modem vendor 00.<nn>.<nn> DPoE-ONU-Vendor-A
!
cable service flow activity-timeout 300
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable logging badipsources 10000
cable logging layer2events 512000
cable time-server
!
! DSG configurations not shown, but could be present if supported
!
aaa new-model
!
aaa authentication login default group tacacs+ enable
aaa authentication enable default enable
aaa authorization config-commands
aaa authorization exec default group tacacs+ none
aaa authorization commands 15 default group tacacs+ none
aaa accounting exec default start-stop group tacacs+
aaa accounting commands 1 default start-stop group tacacs+
aaa accounting commands 15 default start-stop group tacacs+
aaa accounting network default start-stop group tacacs+
```

```
aaa accounting system default start-stop group tacacs+
aaa session-id common
ip subnet-zero
no ip source-route
no ip gratuitous-arps
!
ip tftp source-interface Loopback0
ip domain name <domain name>.<sub-domain>.com
ip host riverstone <ip address>
ip name-server <ip address>
ip name-server <ip address>
ip name-server <ip address>
ip dhcp relay information option
!
no ip bootp server
ip multicast-routing
ip multicast route-limit 250
ip igmp limit 500
!
! Certificate Entry
!
crypto ca trustpoint DOCSIS-ROOT-CERT
!
crypto ca trustpoint CN==<vendor name>,-OU==<vendor address>,-OU-
=-DPoE,-O==<short vendor name>,-C==US
! followed by other vendor certificates
!
crypto ca trustpoint ffffffffffffffffffffffffffffffffffffffffff
!
crypto ca certificate chain DPoE-ROOT-CERT
certificate ca ffffffffffffffffffffffffffffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff ffffffff
quit
```



```
!  
! followed by additional certificates  
!  
key chain dpoe-chain  
  key 1  
    key-string 7 000000000000  
  key 2  
    key-string 7 000000000000  
!  
buffers small permanent 310  
buffers small max-free 515  
buffers small min-free 65  
buffers middle permanent 258  
buffers middle max-free 360  
buffers middle min-free 80  
buffers big permanent 528  
buffers big max-free 828  
buffers big min-free 180  
buffers verybig permanent 42  
buffers verybig max-free 43  
buffers verybig min-free 6  
!  
! I-BEB configuration for DPoE  
ibeb 0000.0010.FF3C.ABCD  
!  
interface Loopback0  
  description Loopback 0  
  ip address 10.0.0.1/32  
  no ip redirects  
  no ip proxy-arp  
  no ip mroute-cache  
  no keepalive  
!  
interface FastEthernet0/0  
  no ip address  
  no ip redirects  
  no ip proxy-arp  
  load-interval 30  
  shutdown  
  duplex full  
!  
interface GigabitEthernet0/1  
  no ip address  
  shutdown  
  duplex auto  
  speed auto  
  media-type rj45  
  negotiation auto  
!  
interface GigabitEthernet0/2  
  no ip address  
  shutdown  
  duplex auto  
  speed auto  
  media-type rj45  
  negotiation auto  
!  
interface GigabitEthernet0/3  
  no ip address  
  shutdown  
  duplex auto  
  speed auto  
  media-type rj45
```

```
negotiation auto
!
interface tu0/0
description EPON interface Slot 0, Port 0
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu0/1
description EPON interface Slot 0, Port 1
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu0/2
description EPON interface Slot 0, Port 2
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu0/3
description EPON interface Slot 0, Port 3
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu0/4
description EPON interface Slot 0, Port 4
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu0/5
description EPON interface Slot 0, Port 5
cable shared-secret 7 00000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
```

```
interface tu0/6
description EPON interface Slot 0, Port 6
cable shared-secret 7 000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu0/7
description EPON interface Slot 0, Port 7
cable shared-secret 7 000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface tu1/0
description EPON interface Slot 1, Port 0
cable shared-secret 7 000000000000000000
cable enable-trap cmonoff-notification
cable enable-trap cmonoff-interval 600
no cable packet-cache
load-interval 30
no shutdown
bundle 1
!
interface bundle 1.1
Description "Example bundle configuration for default IP-HSD"
s-vlan 1001
docsis attribute-mask 80000001
[ip configuration parameters]
ip address <primary subnet and mask>
ip rip receive version 2
ip rip authentication mode md5
ip rip authentication key-chain <chain name>
cable source-verify dhcp
cable dhcp-parse option-43
cable dhcp-parse option-60
cable dhcp-giaddr primary
cable helper-address <ip address>
cable helper-address <ip address>
!
interface bundle 1.2
Description "Example bundle configuration for default MTA"
s-vlan 1002
docsis attribute-mask 80000002
[ip configuration parameters]
ip address <primary subnet and mask>
ip rip receive version 2
ip rip authentication mode md5
ip rip authentication key-chain <chain name>
cable source-verify dhcp
cable dhcp-parse option-43
cable dhcp-parse option-60
cable dhcp-giaddr primary
cable helper-address <ip address>
cable helper-address <ip address>
```

```

!
interface bundle 1.3
  Description "Example bundle configuration for DEMARC Auto Config (DAC)"
  s-vlan 1003
  bundle-type dac
  [ip configuration parameters]

  ip address <primary subnet and mask>
  ip rip receive version 2
  ip rip authentication mode md5
  ip rip authentication key-chain <chain name>
  no cable arp filter request-send
  no cable arp filter reply-accept
  cable source-verify dhcp
  cable dhcp-parse option-43
  cable dhcp-parse option-60
  cable dhcp-giaddr primary
  cable helper-address <ip address>
  cable helper-address <ip address>
!
router ospf <ospf id>
  router-id <ip address>
  log-adjacency-changes
  passive-interface default
  no passive-interface SRP1/0
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
  network <network> <bit mask> area 1
!
router rip
  version 2
  passive-interface default
  network 10.0.0.0
  distribute-list 40 in
  no auto-summary
!
router bgp <asn>
  no synchronization
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 120
  bgp graceful-restart stalepath-time 360
  bgp graceful-restart
  network <ip address> mask <netmask>
  network <ip address> mask <netmask>
  network <ip address> mask <netmask>
  network <ip address> mask <netmask>
  redistribute rip route-map COMM-SVC-NETS
  neighbor RR-client peer-group
  neighbor RR-client remote-as <asn>
  neighbor RR-client update-source Loopback0
  neighbor RR-client next-hop-self
  neighbor RR-client send-community
  neighbor RR-client soft-reconfiguration inbound
  neighbor RR-client route-map CMTS-REG out
  neighbor <ip address>peer-group RR-client

```

```
neighbor <ip address>peer-group RR-client
no auto-summary
!
ip classless
ip route <ip address> <network mask> FastEthernet0/0
no ip http server
no ip http secure-server
ip tacacs source-interface Loopback0
!
ip prefix-list <list name> seq 5 permit <ip network>/<short mask>
ip prefix-list <list name> seq 10 permit <ip network>/<short mask>
!
ip access-list standard SSM-ALLOW-SRV
  permit <ip network><ip network mask>
  permit <ip network><ip network mask>
  permit <ip network><ip network mask>
ip access-list standard VLC1
  permit <ip address>
  permit <ip address>
  permit <ip address>
ip access-list standard VLC2
  permit <ip address>
  permit <ip address>
  permit <ip address>
ip access-list standard VLC3
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
  permit <ip address>
ip access-list standard div-multicast
  permit <ip network> <ip network mask>
  permit <ip network><ip network mask>
ip access-list standard groups1
  permit <ip address>
  permit <ip address>
ip access-list standard groups2
  permit <ip address>
!
ip access-list extended cops
  permit ip host <ip address> host <ip address>
  permit ip host <ip address> host <ip address>
  permit ip host <ip address> host <ip address>
  permit ip host <ip address> host <ip address>
  permit ip host <ip address> host <ip address>
  permit ip host <ip address> host <ip address>
  permit ip host <ip address> host <ip address>
ip access-list extended list1
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
ip access-list extended list2
  permit ip any host <ip address>
  permit ip any host <ip address>
  permit ip any host <ip address>
```

```
permit ip any host <ip address>
permit ip any host <ip address>
ip access-list extended list3
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
ip access-list extended list4
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
permit ip any host <ip address>
logging facility local6
logging source-interface Loopback0
logging <ip address>
logging <ip address>
logging <ip address>
logging <ip address>
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 5 permit <ip network> <ip network mask> log
access-list 6 permit <ip address>
access-list 6 permit <ip address>
access-list 6 permit <ip address>
access-list 6 permit <ip address>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 6 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 7 permit <ip network> <ip network mask>
access-list 8 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 20 permit <ip network> <ip network mask>
access-list 40 permit <ip network> <ip network mask>
access-list 40 permit <ip network> <ip network mask>
access-list 157 permit udp any eq rip any eq rip
access-list 157 permit igmp any <ip network> <ip network mask>
access-list 157 permit igmp any <ip network> <ip network mask>
access-list 157 permit igmp any <ip network> <ip network mask>
access-list 157 permit udp any host <ip address>
access-list 157 deny igmp any any
access-list 157 deny icmp any <ip network> <ip network mask>
access-list 157 deny tcp any <ip network> <ip network mask>
access-list 157 deny udp any <ip network> <ip network mask>
access-list 157 permit ip any any
access-list 160 permit ip <ip network> <ip network mask> any
access-list 160 permit ip <ip network> <ip network mask> any
access-list 160 permit udp any any range bootps bootpc
access-list 160 deny ip any any log
```

```
!  
nls resp-timeout 1  
cpd cr-id 1  
!  
route-map COMM-SVC-NETS permit 10  
  match ip address 40  
!  
route-map CMTS-REG permit 10  
  match ip address prefix-list <list name>  
!  
route-map CMTS-REG permit 20  
  match ip address prefix-list <list name>  
!  
route-map CMTS-REG permit 30  
  match ip address 40  
!  
snmp-server engineID local 000000000000000000000000  
snmp-server community <string name> RO  
snmp-server community <string name>RO 6  
snmp-server community <string name>RO  
snmp-server trap-source Loopback0  
snmp-server location <address or description>  
snmp-server contact <first name> <last name> <tel #>  
snmp-server chassis-id <id>  
snmp-server enable traps snmp authentication linkdown linkup coldstart warmstart  
snmp-server enable traps atm pvc  
snmp-server enable traps config  
snmp-server enable traps entity  
snmp-server enable traps envmon  
snmp-server enable traps rtr  
snmp-server host <ip address> <hostname or description>  
snmp-server host <ip address> <hostname or description>  
snmp-server host <ip address> <hostname or description>  
snmp-server host <ip address> <hostname or description>  
snmp-server host <ip address> <hostname or description>  
snmp-server host <ip address> <hostname or description>  
snmp-server manager  
tftp-server disk2:<image name>.bin  
tacacs-server host <ip address>  
tacacs-server host <ip address>  
tacacs-server directed-request  
tacacs-server key 7 <key>  
!  
banner motd ^CCCCC  
                *****Warning Notice*****  
This system is restricted solely to <operator> authorized users for  
<>  
                ***** Network Operations Center <> *****  
^C  
  
! alias commands not shown  
privilege exec level 1 show ip interface brief  
privilege exec level 1 show ip interface  
privilege exec level 1 show ip  
privilege exec level 1 show cable flap-list  
privilege exec level 1 show cable modem  
privilege exec level 1 show cable qos profile  
privilege exec level 15 show cable qos  
privilege exec level 1 show cable  
privilege exec level 1 show controllers  
privilege exec level 1 show interfaces  
privilege exec level 1 show running-config  
privilege exec level 1 show
```

```
privilege exec level 15 clear cable host
privilege exec level 15 clear cable flap-list all
privilege exec level 15 clear cable flap-list
privilege exec level 15 clear cable
privilege exec level 15 clear
!
line con 0
  exec-timeout 30 0
  logging synchronous
  transport preferred telnet
  transport output telnet
  stopbits 1
line aux 0
  transport preferred none
  transport output none
  stopbits 1
line vty 0 4
  access-class 5 in
  exec-timeout 60 0
  password 7 000000000000
  exec prompt timestamp
  transport preferred telnet
  transport input all
  transport output all
line vty 5 15
  access-class 5 in
  exec-timeout 30 0
  password 7 000000000000
  exec prompt timestamp
  transport preferred telnet
  transport input telnet
  transport output telnet
!
exception crashinfo file disk0:crashinfo
scheduler allocate 3999 400
ntp clock-period 17179904
ntp source Loopback0
ntp update-calendar
ntp server <ip address>
ntp server <ip address>
ntp peer <ip address>
end
```


Appendix V Acknowledgements

On behalf of our industry, we would like to thank the following individuals for their contributions to the development of this specification.

Contributor	Company Affiliation
John Dickinson, Edwin Mallette	Bright House Networks
Shamim Akhtar, Phillip Chang, Jason Combs, Doug Jones, Saif Rahman, Matt Scully, Rashid Siddiqui, Mehmet Toy, Bin Wen	Comcast
Victor Blake	Independent Consultant
Ron daSilva, Robert Harris, Shan Huang, Mike Kelsen, Tushar Nakhre, Karen Rice	Time Warner Cable

Appendix VI Revision History

VI.1 Engineering Change for DPoE-SP-IPNEv1.0-I02-120607

The following Engineering Change was incorporated into DPoE-SP-IPNEv1.0-I02-120607:

ECN	Date Accepted	Summary	Author
IPNEv1.0-N-12.0029-1	05/12/12	SNMPv3 Requirement Relaxation within DPOE IPNE	Kirk Erichsen

VI.2 Engineering Change for DPoE-SP-IPNEv1.0-I03-120830

The following Engineering Change was incorporated into DPoE-SP-IPNEv1.0-I03-120830:

ECN	Date Accepted	Summary	Author
IPNEv1.0-N-12.0044-2	08/13/12	IPNE-EC	Edwin Mallette

VI.3 Engineering Change for DPoE-SP-IPNEv1.0-I04-121115

The following Engineering Change was incorporated into DPoE-SP-IPNEv1.0-I04-121115:

ECN	Date Accepted	Summary	Author
IPNEv1.0-N-12.0045-1	10/18/12	Clarification to zero suppression feature	Marek Hajduczenia

VI.4 Engineering Change for DPoE-SP-IPNEv1.0-I05-130328

The following Engineering Change was incorporated into DPoE-SP-IPNEv1.0-I05-130328:

ECN	Date Accepted	Summary	Author
IPNEv1.0-N-13.0064-1	02/14/13	Remove references to Annex F in MULPI	Marek Hajduczenia

VI.5 Engineering Change for DPoE-SP-IPNEv1.0-I06-130808

The following Engineering Change was incorporated into DPoE-SP-IPNEv1.0-I06-130808:

ECN	Date Accepted	Summary	Author
IPNEv1.0-N-13.0085-1	06/06/13	Align IPNE DPoEv1.0 and v2.0 semantics, reqs and description	Edwin Mallette
IPNEv1.0-N-13.0096-1	07/11/13	Remove hard and soft reboot config file requirement	Curtis Knittle