Data-Over-Cable Interface Specifications

Cable Modem Termination System–Network Side Interface Specification

CM-SP-CMTS-NSI-C01-171207

CLOSED

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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.
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Closed	A static document, reviewed, tested, validated, and closed to further engineering change requests to the specification through CableLabs.

Trademarks

Contents

Figures

1 SCOPE

1.1 Introduction and Purpose

This interface specification is one of a family of interface specifications designed to facilitate the implementation of data service over Hybrid Fiber Coax (HFC) cable networks, as well as over coaxial-only cable networks. Figure 1 provides the context for this specification in relation to the data-over- cable reference architecture and the other interface specifications in the family. This specification defines the applicable communications standards and protocols as needed to implement a cable modem network termination system to backbone network transport adapter interface. It applies to cable systems employing HFC and coaxial-only architectures. Specifically, the scope of this specification is to:

- Describe the communications protocols and standards to be employed
- Specify the data communication requirements and parameters which shall be common to all units
- Describe any additional application-unique interface requirements to insure support for data-over-cable services

The intent of this document is to specify open protocols with a preference for existing, well-known, and well-accepted protocols. This interface standard is written to provide the minimal set of requirements for satisfactory communication between the headend and backbone elements in a data-over- cable system.

The term “Cable Modem Termination System–Network Side Interface” (CMTS-NSI) is the general term used to describe this interface.

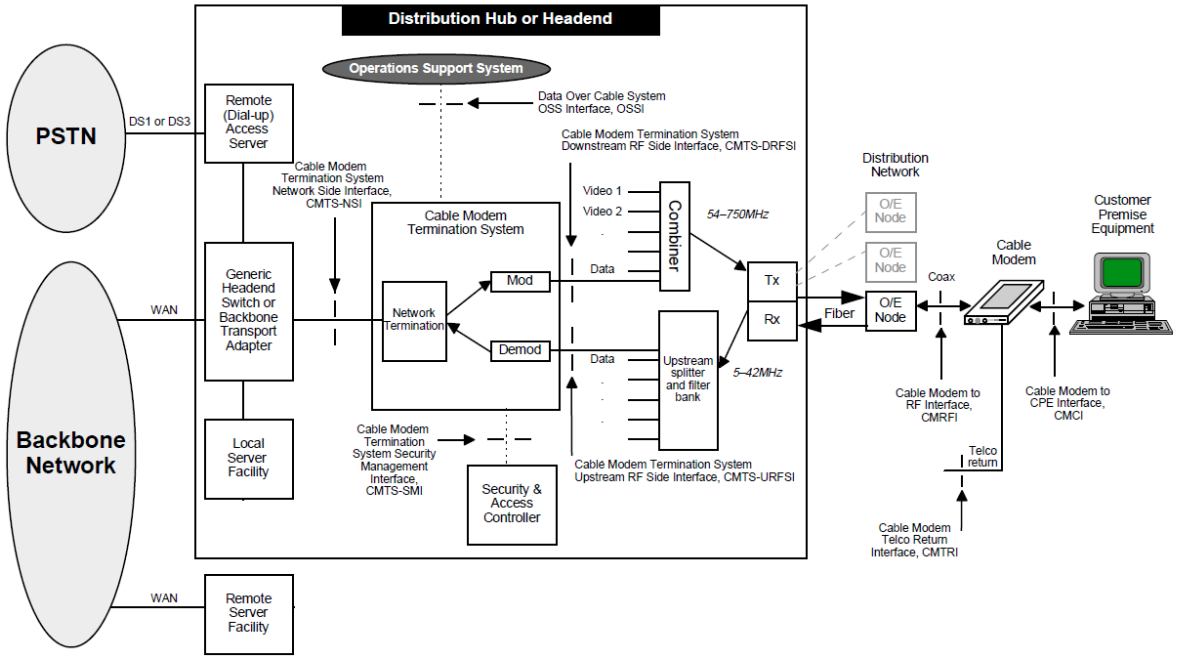

Figure 1 - Data-Over-Cable Reference Architecture

1.2 Requirements

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

"shall" This word means that the item is an absolute requirement of this specification.

2 REFERENCES

ANSI X3.139-1987, Fiber Distributed Data Interface (FDDI) — Token Ring Media Access Control (MAC).

ANSI X3.148-1988, Fiber Distributed Data Interface (FDDI) — Token Ring Physical Layer Protocol (PHY).

ANSI X3.166-1990, Fibre Data Distributed Interface (FDDI) — Token Ring Physical Layer Medium Dependent (PMD).

ATM User-Network Interface Specification Version 3.1, September 1994.

Ethernet Version 2.0, Digital, Intel, Xerox (DIX), 1982.

IEEE Std 802.3u-1995 (Supplement to ISO/IEC 8802-3: 1993 [ANSI/IEEE Std 802.3, 1993]), Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21-30).

IETF RFC 826, An Ethernet Address Resolution Protocol, D.C. Plummer, November 1982.

IETF RFC 894, A Standard for the Transmission of IP Datagrams over Ethernet Networks, C. Hornig, April 1984.

IETF RFC 1042, A Standard for the Transmission of IP Datagrams over IEEE 802 Networks, J. Postel, J. Reynolds, February 1988.

IETF RFC 1112, Host Extensions for IP Multicasting, S. Deering, August 1989.

IETF RFC 1390, Transmission of IP and ARP over FDDI Networks, D. Katz, January 1993.

IETF RFC 1541, Dynamic Host Configuration Protocol, R. Droms, October 1993.

IETF RFC 1577, Classical IP and ARP over ATM, M. Laubach.

IETF RFC 1883, Internet Protocol, Version 6 (IPv6) Specification, S. Deering, R. Hinden, December 1995.

ISO/IEC 8802-2 (ANSI/IEEE Std 802.2): 1994, Information technology —Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 2: Logical link control.

ISO/IEC 8802-3 (ANSI/IEEE Std 802.3): 1993, Information technology — Local and metropolitan area networks — Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

ISO/IEC 10038 (ANSI/IEEE Std 802.1D): 1993, Information technology —Telecommunications and information exchange between systems — Local area networks — Media access control (MAC) bridges.

3 TERMS AND DEFINITIONS

This specification uses the following terms:

Cable Modem	A modulator-demodulator at a subscriber location intended for use in conveying data communications on a cable television system.
Cable Modem Termination System	Equipment located at the cable television system headend or distribution hub, which provides complementary functionality to the cable modems to enable data connectivity to a wide-area network.
Cable Network	Cable television plant that would typically be used for data-over- cable services. Such plants generally employ a downstream path in the range of 54MHz on the low end to a high end in the 440 to 750MHz range and an upstream path in the range of 5 to 42MHz. Customers share a common communications path for upstream and a separate common path for downstream (i.e., effectively a pair of unidirectional busses).
Cable Modem Telco Return Interface	The *upstream* interface between a telco modem attached to, or inside of, a cable modem and the CMTS.
Downstream	The direction of transmission from the headend to the subscriber in cable television.
Dynamic Host Configuration Protocol	An Internet protocol used for assigning network-layer (IP) addresses
Hybrid Fiber/Coax System	A broadband bi-directional shared-media transmission system using fiber trunks between the headend and the fiber nodes, and coaxial distribution from the fiber nodes to the customer locations.
Internet Control Message Protocol	An Internet network-layer protocol.
Internet Protocol	An Internet network-layer protocol.
Logical Link Control procedure	In a local area network (LAN) or a Metropolitan Area Network (MAN), that part of the protocol that governs the assembling of data link layer frames and their exchange between data stations, independent of how the transmission medium is shared.
Media Access Control sublayer	The part of the data link layer that supports topology- dependent functions and uses the services of the Physical Layer to provide services to the logical link control (LLC) sublayer.
Subnetwork Access Protocol	An access protocol described in IEEE Std 802.2 Annex D.
Upstream	The direction from the subscriber location toward the headend.

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations:

ANSI	American National Standards Institute
ARP	Address Resolution Protocol
ATM	Asynchronous Transfer Mode
CM	Cable modem
CMCI	Cable Modem to CPE Interface
CMTRI	Cable Modem Telco Return Interface
CMTS	Cable Modem Termination System
CMTS-NSI	Cable Modem Termination System—Network Side Interface
CPE	Customer Premise Equipment
DHCP	Dynamic Host Configuration Protocol
FDDI	Fiber Distributed Data Interface (alternatively, Fibre Data Distributed Interface)
HFC	Hybrid Fiber Coax
ICMP	Internet Control Message Protocol
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet protocol
LLC	Logical Link Control
MAC	Media Access Control (also Medium Access Control)
RFC	Request for Comments
SNAP	Subnetwork Access Protocol
SNMP	Simple Network Management Protocol
UDP	User Datagram Protocol

5 FUNCTIONAL REFERENCE MODEL

The intended service will allow IP traffic (version 4 with migration to version 6) to achieve transparent bi-directional transfer between the Cable Modem Termination System – Network Side Interface (CMTS-NSI) and the Cable Modem to CPE interface (CMCI), as illustrated in Figure 2.

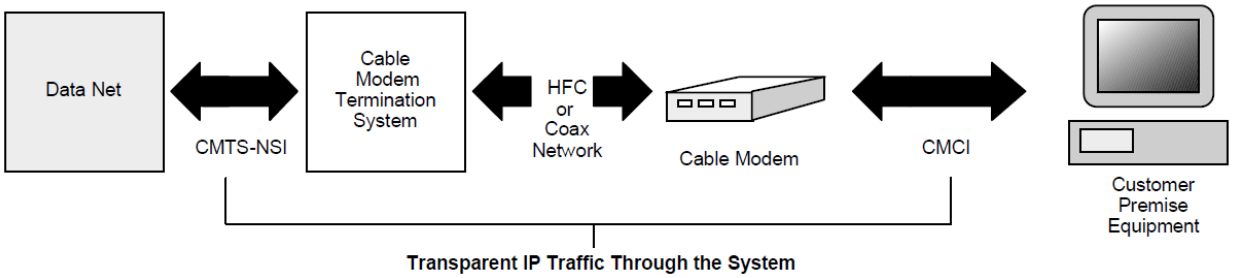

Figure 2 - IP Traffic Flow

6 COMMUNICATIONS SPECIFICATIONS

The Internet Protocol (IP) version 4 standard is required at the network layer. This specification will evolve to support IP version 6 (IETF RFC 1883) as it becomes an accepted standard.

Several data link and physical layer combinations are required to carry the IP traffic:

- ATM over STS-3c
- ATM over DS3
- FDDI
- 802.3 over 10BASE-T
- 802.3 over 100BASE-T
- Ethernet over 10BASE-T
- Ethernet over 100BASE-T

To be considered compliant with this specification, equipment shall be available with any data link and physical layer combination selected from the above list. The selected configuration shall be specified by the customer at the time of purchase order (for example: a customer may order a CMTS with an FDDI interface or, alternatively, a customer might order a CMTS with an Ethernet over 100BASE-T interface).

All data link and physical layer combinations shall support and be transparent to IP datagrams in accordance with the specified standard(s).

Network layer requirements for the CMTS exist beyond transparency to IP traffic. The CMTS shall also support:

- variable length subnet masks
- classless addressing
- IP multicast addressing and forwarding
- Internet Group Management Protocol (IGMP)
- proxy ARP
- filtering of DHCP downstream-bound broadcast packets to protect against BOOTP server spoofing

6.1 IP Over ATM

The required protocols for IP over ATM implementations are illustrated in Figure 3.

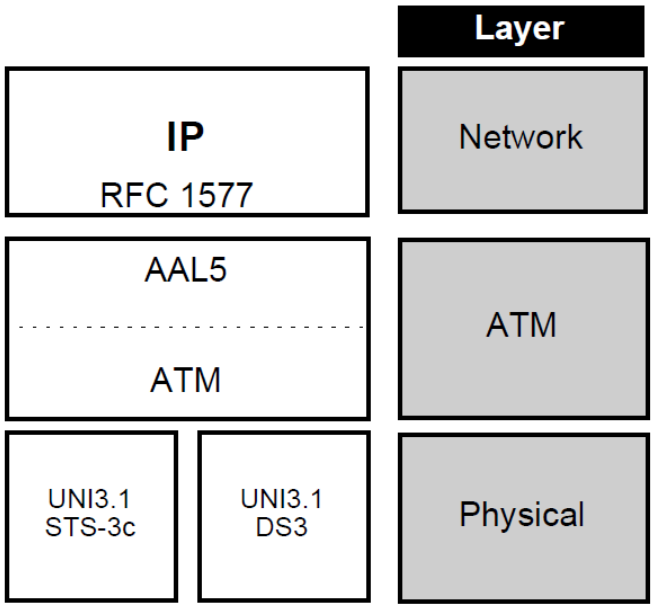

Figure 3 - IP over ATM Protocol Stack

6.1.1 Network Layer

The IP shall be utilized in accordance with IETF RFC 1577, "Classical IP and ARP over ATM."

6.1.2 ATM Adaptation Layer

The ATM Adaptation Layer interface shall be in accordance with IETF RFC 1577, "Classical IP and ARP over ATM" and ATM UNI 3.1. ATM Adaptation Layer Type 5 (AAL5) shall be utilized.

6.1.3 ATM Layer

The ATM layer implementation shall be in accordance with ATM UNI 3.1.

6.1.4 Physical Layer

Two physical layer implementations are required. The selected configuration shall be specified by the customer at the time of purchase.

6.1.5 STS-3c

The STS-3c physical layer implementation shall be in accordance with ATM UNI 3.1.

6.1.6 DS3

The DS3 physical layer implementation shall be in accordance with ATM UNI 3.1.

6.2 IP Over FDDI

The required protocols for IP over FDDI implementations are illustrated in Figure 4.

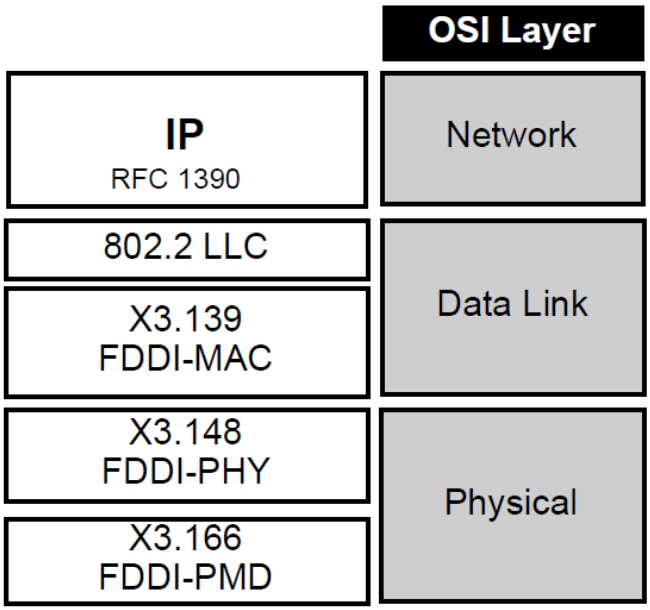

Figure 4 - IP over FDDI Protocol Stack

6.2.1 Network Layer

The IP shall be utilized in accordance with IETF RFC 1390, "Transmission of IP and ARP over FDDI Networks."

6.2.2 Data Link Layer

The FDDI MAC sublayer interface shall be in accordance with ANSI X3.139-1987, Fiber Distributed Data Interface (FDDI) — Token ring media access control (MAC).

6.2.3 Physical Layer

The FDDI physical layer interface shall be in accordance with ANSI X3.166-1990, Fibre Data Distributed Interface (FDDI) — Token Ring Physical Layer Medium Dependent (PMD) and ANSI X3.148-1988, Fiber Distributed Data Interface (FDDI) — Token Ring Physical Layer Protocol (PHY).

6.3 IP over IEEE 802

The required protocols for IP over IEEE 802 implementations are illustrated in Figure 5.

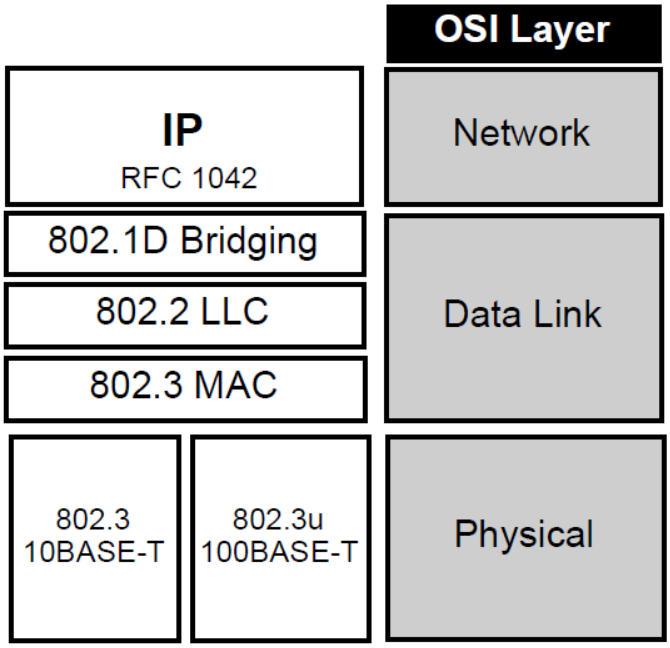

Figure 5 - IP over IEEE 802 Protocol Stack

6.3.1 Network Layer

The IP shall be utilized in accordance with IETF RFC 1042, "A Standard for the Transmission of IP Datagrams over IEEE 802 Networks."

6.3.1.1 Address Resolution

Address Resolution shall be achieved in accordance with IETF RFC 826, "An Ethernet Address Resolution Protocol."

6.3.2 Data Link Layer

6.3.2.1 802.2 LLC

The LLC sublayer interface shall be in accordance with ISO/IEC 8802-2: 1994, Class I, with Subnetwork Access Protocol (SNAP).

6.3.2.2 802.3 MAC

The MAC sublayer interface shall be in accordance with ISO/IEC 8802-3: 1995. A 48-bit address shall be utilized.

6.3.2.3 Bridging

The CMTS shall perform MAC bridging in accordance with ISO/IEC 10038 (ANSI/IEEE Std 802.1D): 1993.

6.3.3 Physical Layer

Two physical layer implementations are required. The selected configuration shall be specified by the customer at the time of purchase.

6.3.3.1 10Base-T

The physical layer interface shall be in accordance with ISO/IEC 8802-3: 1995 for 10BASE-T operation.

6.3.3.2 100BASE-T

The physical layer interface shall be in accordance with IEEE Std 802.3u-1995 for 100BASE-T operation. Auto-negotiation per IEEE Std 802.3u-1995 is required.

6.3.3.2.1 Connectors

The interface shall be capable of supporting the T4, TX and FX Medium Dependent Interface alternatives for 100BASE-T operation.

6.4 IP over Ethernet

The required protocols for IP over Ethernet implementations are illustrated in Figure 6.

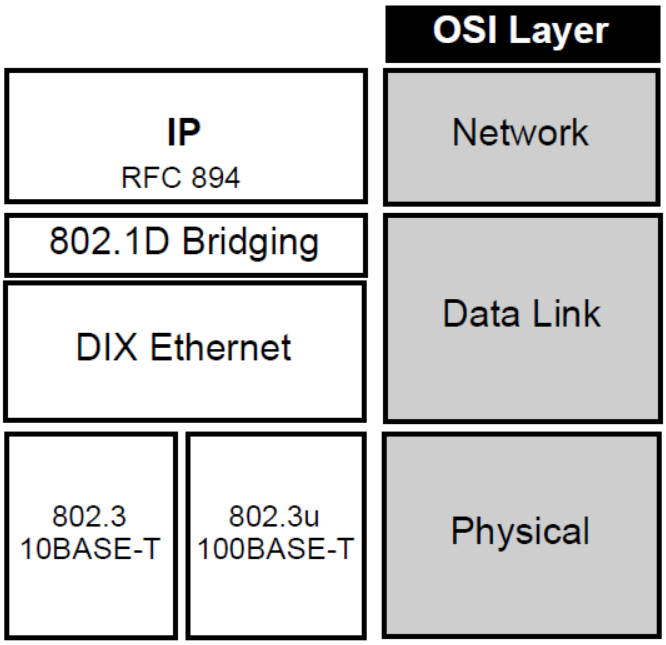

Figure 6 - IP over Ethernet Protocol Stack

6.4.1 Network Layer

The IP shall be utilized in accordance with IETF RFC 894, "A Standard for the Transmission of IP Datagrams over Ethernet Networks."

6.4.1.1 Address Resolution

Ethernet Address Resolution shall be achieved in accordance with IETF RFC 826, "An Ethernet Address Resolution Protocol."

6.4.2 Data Link Layer

The data link layer interface shall be in accordance with DIX Ethernet Version 2.0.

6.4.2.1 Address Length

A 48-bit address shall be utilized.

6.4.2.2 Bridging

The CMTS shall perform MAC bridging in accordance with ISO/IEC 10038 (ANSI/IEEE Std 802.1D): 1993.

6.4.3 Physical Layer

Two physical layer implementations are required. The selected configuration shall be specified by the customer at the time of purchase.

6.4.3.1 10BASE-T

The physical layer interface shall be in accordance with ISO/IEC 8802-3: 1995 for 10BASE-T operation.

6.4.3.2 100BASE-T

The physical layer interface shall be in accordance with IEEE Std 802.3u-1995 for 100BASE-T operation. Auto-negotiation per IEEE Std 802.3u-1995 is required.

6.4.3.2.1 Connectors

The interface shall be capable of supporting the T4, TX and FX Medium Dependent Interface alternatives for 100BASE-T operation.

Appendix I Acknowledgements

We wish to thank Arthur D. Little, Inc., under contract to Multimedia Cable Network System (MCNS) Holdings, L.P. for the preparation of this interface specification. MCNS Holdings, L.P. was a consortium of Comcast Cable Communications, Inc., Cox Communications, Tele-Communications, Inc., and Time Warner Cable, interested in deploying high-speed data communications systems on cable television systems. Neither MCNS Holdings, L.P. nor Arthur D. Little, Inc., provides any representation or warranty, express or implied, regarding its accuracy, completeness, or fitness for a particular purpose.