



DELTA Fiber Nederland B.V

DOCSIS Interface Specification

Version: 1.0

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Disclaimer

When a new version of this specification is published it supersedes all previous versions of this specification. Users are advised to regularly check for updates on this specification.

DELTA Fiber Nederland reserves the right to deviate from this specification, in certain geographical areas for technical tests and network development purposes.

DELTA Fiber Nederland does not take any responsibility for the correctness of the reference values included in this specification.

This interface specification implements the following (in Dutch):

- Besluit van 12 december 2016, houdende regels inzake eindapparaten ter implementatie van richtlijn 2008/63/EG (Besluit eindapparaten).
- ACM Beleidsregel handhaving besluit randapparaten (bepaling van het netwerkaansluitpunt en de vrije keuze van eindapparaten) – Staatscourant nr. 26456, 27 juli 2021.
- Nota van bevindingen – Beleidsregel handhaving besluit eindapparaten (bepaling van het netwerkaansluitpunt en de vrije keuze van eindapparaten) – Zaaknr. ACM/19/036305/ Documentnr. ACM/UIT/558420.

and is intended for cable modem device manufacturers. The declaration of conformity with this interface specification is the sole responsibility of the manufacturer.

The interface specification does not apply under abnormal operating conditions such as:

- operating conditions arising as a result of operating services other than DOCSIS 3.x over the dedicated data RF interface.
- operating conditions arising as a result of a fault, maintenance and construction work or to minimize the extend of interruption of service.
- operating conditions arising as a result of force majeure or third-party interference.
- operating conditions arising as a result of test signal injection governed by regulation.
- In case of non-compliance of a network user's installation or non-compliance of equipment with the relevant standards or non-compliance with the technical requirements for connection, established either by this interface specification or the public authorities including the relevant limits for electromagnetic compatibility.

The characteristics given in this interface specification are intended to be used to derive and specify requirements for equipment such as cable modems to connect them to the dedicated data RF interface or Ethernet interface. The values in this interface specification take precedence over requirements in equipment product standards and installation standards. The given characteristics are not intended to be used as electromagnetic compatibility levels or user emission limits in the DELTA Fiber Nederland network.

This interface specification may be changed at any time and may break backward compatibility with previous versions. Manufacturers are therefore recommended to provide regular software updates to

the end users. This interface specification may be superseded in total or in part by the terms of a contract between the individual network user and DELTA Fiber Nederland.

Contact Information

This contact information is for cable modem device manufacturers only.

DELTA Fiber Nederland B.V.

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Information for individual customers regarding the use of own cable modems on the DELTA Fiber networks is available at:

<https://www.delta.nl/klantenservice/vrije-modemkeuze/>

<https://www.caiway.nl/klantenservice/vrije-modemkeuze/>

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Conventions

Throughout this document, key words need to be interpreted in accordance with [6]:

“MUST, SHALL”	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 list 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.

In the tables with detailed requirements the following abbreviations are used:

- Rel: relevant, this section is relevant to understand the interface specification
- Inf: informational, this section provides informational content only
- Mand: mandatory, content of this section MUST be supported
- Opt: optional, the section contains optional content only

1. References

1.1. Normative

[1] DOCSIS 3.1 Physical Layer Specification, CM-SP-PHYv3.1-I19-21110, available at www.cablelabs.com

[2] DOCSIS 3.1 MAC and Upper Layer Protocols Interface Specification, CM-SP-MULPIv3.1-I22-21110, available at www.cablelabs.com

[3] DOCSIS 3.1 Security Specification, CM-SP-SECv3.1-I10-21110, available at www.cablelabs.com

[4] DOCSIS 3.1 Cable Modem Operations Support Systems Interface Specification, CM-SP-CM-OSSSIv3.1-I21-211022, available at www.cablelabs.com

[5] EXCENTIS BPI+ requirements at www.excentis.com

[6] RFC2119, Key words for use in RFCs to Indicate Requirement Levels, available at www.ietf.org

[7] IPv4 and IPv6 eRouter Specification CM-SP-eRouter-I20-190515 available at www.cablelabs.com

2. Scope

This document describes the basic requirements to be met by cable modem equipment for using data and voice services at the “fixed network termination point” (vaste netwerkaansluitpunt) as meant in the “ACM Beleidsregel Handhaving Besluit Eindapparaten” on the DELTA Fiber DOCSIS networks.(DELTA and Caiway)

This document covers the basic physical requirements as well as DOCSIS protocol requirements for using Internet Protocol services (IP) over the Operator Cable Network. Additionally the requirements for Internet access service are covered.

These requirements may change from time to time to reflect changes in the network. Anyone using this specification should therefore regularly consult the website of DELTA Fiber Nederland to look for the latest version of this document.

3. Definitions and Abbreviations

Definitions

Abbreviations

AOP	Abonnee Overname Punt (vaste netwerkaansluitpunt) eng: passive Network Termination Point
CM	Cable Modem
CMTS	Cable Modem Termination System
DOCSIS	Data-over-Cable Service Interface Specification
dB	decibel
dBc	dB relative to carrier
DHCP	Dynamic Host Configuration Protocol
DS	Downstream
DSx	Dynamic Service Flow transaction message (x = Add,Change or Delete)
FQDN	Fully Qualified Domain Name
MULPI	Mac and Upper Layer Requirements
RF	Radio Frequency
OSS	Operation System Support
SC-QAM	Single Carrier QAM
US	Upstream
QAM	Quadrature Amplitude Modulation

4. General

The cable modem MUST be connected to the outlet of the cable operator (AOP) using the push on filter and coaxial cable assembly supplied by DELTA Fiber Nederland.

Delta Fiber Nederland uses two different technology options (section 5.1) for providing data services over HFC networks.

Modems MUST automatically detect the type of network they are operating on (based on the bandwidth used for the SC-QAM channel) and adjust their operating mode automatically.

Any device that is connected to the network that is in violation of this specification can be refused access to the network.

DELTA Fiber Nederland will not perform or facilitate software updates for the cable modems.

4.1. Industry certifications

Devices MUST be certified for DOCSIS 3.1 with Euro-DOCSIS 3.0 backwards compatibility by CableLabs with the required support for a switchable diplexer as defined in this document.

5. Network RF characteristics

5.1. General

DELTA Fiber Nederland uses two types of technologies in the network.

Type A networks use the European technology option of the DOCSIS 3.1 technology (Annex C of [1])

Type B networks use the North-American technology option of the DOCSIS 3.0 technology.

Type B networks may be upgraded to type A networks in the future.

5.2. Switchable Diplexer

As is clear in the following section DELTA Fiber Nederland is currently operating different upstream frequency ranges and the effective frequency range in use is changing as DELTA Fiber Nederland makes enhancements to the network. To support this all devices MUST support a switchable diplexer with the following possible diplexer settings:

Options:

Setting 1: Upstream band 5-204 MHz, downstream band 258-1218 MHz

Setting 2: Upstream band 5-85 MHz, downstream band 108-1218 MHz

The diplexer setting can be changed/defined based on the mechanisms (MDD-information or config-file TLVs) defined in the MULPI specification [2].

5.3. Characteristics for type A networks

There are currently two frequency bands in use for type A networks as defined below:

	DS frequency range	US frequency range
Band 1	108-1218 MHz	5-65 MHz
Band 2	258-1218 MHz	5-204 MHz

The specific Downstream Performance ratings are given in the table below:

Parameter	Nominal rating	Absolute maximum rating
Total downstream power	N/A	< 40 dBmV
Signal tilt (end-to-end)	N/A	< 14 dB
Power level backoff between adjacent SC-QAM channels	< 6 dB	N/A
64 QAM signal level	46 – 70 dB μ V	43-73 dB μ V
256 QAM signal level	50 – 74 dB μ V	47-77 dB μ V

In the downstream micro-reflections might be present with the nominal values provided in the table below:

Time	Nominal reflection value
≤ 35 ns	< -12 dBc
35 ns to 0.3μs	-12 to -42 dBc
0.3 μs to 0.5μs	< -42 dBc

5.4. Characteristics for type B networks

There are currently two frequency bands in use for type B networks as defined below:

	DS frequency range	US frequency range
Band 1	108-1002 MHz	5-42 MHz

Type B networks may be upgraded to type A networks in the future.

The specific Downstream Performance ratings are given in the table below:

Parameter	Nominal rating	Absolute maximum rating
Total downstream power	N/A	< 40 dBmV
Signal tilt (end-to-end)	N/A	< 27 dB
Power level backoff between adjacent SC-QAM channels	< 6 dB	N/A
64 QAM signal level	48 – 72 dBμV	45-75 dBμV
256 QAM signal level	48 – 72 dBμV	45-75 dBμV

In the downstream micro reflections might be present with the nominal values provided in the table below:

Time	Nominal reflection value
≤ 35 ns	< -12 dBc
35 ns to 0.3μs	-12 to -42 dBc
0.3 μs to 0.5μs	< -42 dBc

6. DOCSIS 3.1 Physical interface requirements

6.1. Type A networks

For type A networks the following table defines the applicable sections of [1]

Section		Description	Rel	Inf	Mand	Opt
1		Scope		x		
	1.1	Introduction and purpose	x	x		
	1.2	Background	x	x		
	1.3	Requirements	x		x	
	1.4	Conventions	x		x	
	1.5	Organization of Document	x	x		
2		REFERENCES				
	2.1	Normative References	x		x	
	2.2	Informative References	x	x		
	2.3	Reference Acquisition	x	x		
3		TERMS AND DEFINITIONS	x		x	
4		ABBREVIATIONS AND ACRONYMS	x		x	
5		OVERVIEW AND FUNCTIONAL ASSUMPTIONS	x		x	
6		PHY SUBLAYER FOR SC-QAM	x		x	
	6.1	Scope	x		x	
	6.2	Upstream transmit and receive	x		x	
	6.2.1	Overview	x		x	
	6.2.2	Signal Processing requirements	x		x	
	6.2.3	Modulation formats	x		x	
	6.2.4	R-S encode	x		x	
	6.2.5	Upstream R-S Frame structure (Multiple Transmit Channel Mode Enabled)	x		x	
	6.2.6	Upstream R-S Frame structure (Multiple Transmit Channel Mode Disabled)	x		x	
	6.2.7	TDMA Byte Interleaver	x		x	
	6.2.8	Scrambler (Randomizer)	x		x	
	6.2.9	TCM Encoder		x		
	6.2.10	Preamble Prepend	x		x	
	6.2.11	Modulation Rates	x		x	
	6.2.12	S-CDMA Framer and Interleaver	x	x		
	6.2.13	S-CDMA Framer	x	x		
	6.2.14	Symbol mapping	x		x	
	6.2.15	S-CDMA spreader	x	x		
	6.2.16	Transmit Pre-Equalizer	x		x	

Section		Description	Rel	Inf	Mand	Opt
	6.2.17	Spectral Shaping	x		x	
	6.2.18	Relative processing delays	x	x		
	6.2.19	Transmit Power Requirements	x		x	
	6.2.20	Burst Profiles	x		x	
	6.2.21	Burst Timing Convention	x		x	
	6.2.22	Fidelity Requirements	x		x	
	6.2.23	Upstream Demodulator Input power characteristics	x	x		
	6.2.24	Upstream Electrical Output from the CM	x		x	
	6.2.25	Upstream CM Transmitter Capabilities	x		x	
	6.3	Downstream transmit		x		
	6.4	Downstream receive	x		x	
7		PHY Sublayer for OFDM				
	7.1	Scope	x		x	
	7.2	Upstream and downstream frequency plan				
	7.2.1	Downstream CM spectrum	x		x	
	7.2.2	Downstream CMTS spectrum	x	x		
	7.2.3	Upstream CM Spectrum	x		x	
	7.2.4	Upstream CMTS spectrum	x	x		
	7.2.5	Channel Band Rules	x	x		
	7.3	OFDM Numerology	x		x	
	7.4	Upstream transmit and receive				
	7.4.1	Signal processing requirements	x		x	
	7.4.2	Time and Frequency Synchronization	x		x	
	7.4.3	Forward Error Correction	x		x	
	7.4.4	Data Randomization	x		x	
	7.4.5	Time and Frequency Interleaving and De-interleaving	x		x	
	7.4.6	Mapping of Bits to Cell Words	x		x	
	7.4.7	Mapping and De-mapping its t/from QAM Subcarriers	x		x	
	7.4.8	REQ Messages	x		x	
	7.4.9	IDFT	x		x	
	7.4.10	Cyclic Prefix and Windowing	x		x	
	7.4.11	Burst Timing Convention	x		x	
	7.4.12	Fidelity Requirements	x		x	
	7.4.13	Cable Modem Transmitter Output Requirements	x		x	
	7.4.14	CMTS receiver capabilities	x	x		
	7.4.15	Ranging	x		x	
	7.4.16	Upstream Pilot Structure	x		x	
	7.4.17	Upstream Pre-Equalization	x		x	
	7.5	Downstream Transmit and receive				
	7.5.1	Overview	x		x	
	7.5.2	Signal Processing	x		x	

Section		Description	Rel	Inf	Mand	Opt
	7.5.3	Time and Frequency Synchronization	x		x	
	7.5.4	Downstream Forward Error Correction	x		x	
	7.5.5	Mapping Bits to QAM Constellations	x		x	
	7.5.6	Interleaving and De-interleaving	x		x	
	7.5.7	IDFT	x		x	
	7.5.8	Cyclic Prefix and Windowing	x		x	
	7.5.9	Fidelity Requirements	x	x		
	7.5.10	Independence of Individual Channels within Multiple Channels on a Single RF Port	x	x		
	7.5.11	Cable Modem Receiver Input Requirements	x		x	
	7.5.12	Cable Modem Receiver Capabilities	x		x	
	7.5.13	Physical Layer Link Channel (PLC)	x		x	
	7.5.14	Next Codeword Pointer	x		x	
	7.5.15	Downstream Pilot Patterns	x		x	
8		PHY-MAC Convergence	x		x	
9		Proactive Network Maintenance				
	9.1	Scope	x		x	
	9.2	System Description	x		x	
	9.3	Downstream PNM Requirements				
	9.3.1	Downstream Symbol Capture	x		x	
	9.3.2	Downstream Wideband Spectrum Analysis	x		x	
	9.3.3	Downstream Noise Power Ratio (NPR) measurement	x	x		
	9.3.4	Downstream Channel Estimate Coefficients	x		x	
	9.3.5	Downstream Constellation Display	x		x	
	9.3.6	Downstream Receive Modulation Error Ratio (RxMER) per Subcarrier	x		x	
	9.3.7	Downstream FEC statistics	x		x	
	9.3.8	Downstream Histogram	x		x	
	9.3.9	Downstream Received Power	x		x	
	9.4	Upstream PNM Requirements				
	9.4.1	Upstream Capture for Active and Quiet Probe	x	x		
	9.4.2	Upstream Triggered Spectrum Analysis	x	x		
	9.4.3	Upstream Impulse Noise Statistics	x	x		
	9.4.4	Upstream Equalizer Coefficients	x		x	
	9.4.5	Upstream FEC Statistics	x	x		
	9.4.6	Upstream Histogram	x	x		
	9.4.7	Upstream Channel power	x	x		
	9.4.8	Upstream Receive Modulation Error Ratio (RxMER) Per Subcarrier	x	x		
ANNEX A		QAM Constellations Mappings (Normative)	x		x	
ANNEX B		RFOG Operating mode (Normative)	x	x		

Section		Description	Rel	Inf	Mand	Opt
ANNEX C		Additions and modifications for European Specifications with SC-QAM operation (NORMATIVE)	x		x	
ANNEX D		Additions and modifications for Chinese Specification with SC-QAM operation (NORMATIVE)	x	x		
ANNEX E		24-bit Cyclic Redundancy Check (CRC) code (Normative)	x		x	
Appendix I		Downstream Frequency Interleaver Sample C Code (Informative)	x	x		
Appendix II		Uses cases: Maximum number of simultaneous transmitters (Informative)	x	x		
Appendix III		Upstream Time and Frequency Interleaver Sample C Code (informative)	x	x		
Appendix IV		FEC Codework Selection Algorithm Upstream Time and Frequency Interleaver Sample C Code (Informative)	x	x		
Appendix V		CMTS Proposed Configuration Parameters (Informative)	x	x		
Appendix VI		Suggested Algorithm to Compute Signal-to-Noise (SNR) Margin for Candidate Profile (Informative)	x	x		
Appendix VII		Acknowledgements (Informative)	x	x		
Appendix VIII		Revision History (Informative)	x	x		

6.2. Type B Networks

The only difference between the physical layer requirements between type A and type B networks is that Annex C of [1] is not used on type B networks, instead these networks use DOCSIS 3.0. As DELTA Fiber Nederland might make changes to the network and to avoid customer confusion the CM MUST automatically detect the type of network they are operating on and based on that operate in Annex C mode or not.

7. DOCSIS 3.1 Upper Layer requirements

The following table describes the DOCSIS MULPI interface requirements for the passive interconnection points based on [2].

Section		Description	Rel	Inf	Mand	Opt
1		Scope				
	1.1	Introduction and purpose	x	x		
	1.2	Background	x	x		
	1.3	Requirements	x		x	
	1.4	Conventions	x		x	
	1.5	Organization of Document	x	x		
2		REFERENCES				
	2.1	Normative References	x		x	
	2.2	Informative References	x	x		
	2.3	Reference acquisition	x	x		
3		Terms and definitions	x		x	
4		Abbreviations and Theory of Operations	x		x	
5		Overview and Theory of Operations				
	5.1	MULPI Key Features	x	x		
	5.2	Technical Overview				
	5.2.1	CMTS and CM models	x	x		
	5.2.2	Downstream Convergence Layer	x		x	
	5.2.3	OFDMA Upstream	x		x	
	5.2.4	QoS	x		x	
	5.2.5	Multicast Operation	x		x	
	5.2.6	Network and Higher Layer Protocols	x		x	
	5.2.7	CM and CPE Provisioning and Management	x		x	
	5.2.8	Enhanced Support for Timing Protocol	x	x		
	5.2.9	Energy Management	x		x	
	5.2.10	Relationship to Physical HFC Plant Topology	x		x	
	5.2.11	Cable Modem Service Group	x		x	
	5.2.12	CMTS Downstream Service Model Example	x	x		
6		Media Access Control Specification				
	6.1	Introduction				
	6.1.1	Overview	x		x	
	6.1.2	Definition	x		x	
	6.1.3	Future Use	x	x		
	6.2	MAC Frame Formats	x		x	
	6.3	Segment Header Format	x		x	
	6.4	MAC Management Messages				

Section		Description	Rel	Inf	Mand	Opt
	6.4.1	MAC Management Message Header	x		x	
	6.4.2	Time Synchronization	x		x	
	6.4.3	Upstream Channel Descriptor	x		x	
	6.4.4	Upstream Bandwidth Allocation MAP	x		x	
	6.4.5	Ranging Request Messages	x		x	
	6.4.6	Ranging Responses (RNG-RSP)	x		x	
	6.4.7	Registration Request Messages	x		x	
	6.4.8	Registration Response Messages	x		x	
	6.4.9	Registration Acknowledge	x		x	
	6.4.10	Upstream Channel Change Request (UCC-REQ)	x		x	
	6.4.11	Upstream Channel Change Response (UCC-RSP)	x		x	
	6.4.12	Dynamic Service Addition – Request (DSA-REQ)	x		x	
	6.4.13	Dynamic Service Addition – Response (DSA-RSP)	x		x	
	6.4.14	Dynamic Service Addition – Acknowledge (DSA-ACK)	x		x	
	6.4.15	Dynamic Service Change – Request (DSC-REQ)	x		x	
	6.4.16	Dynamic Service Change – Response (DSC-RSP)	x		x	
	6.4.17	Dynamic Service Change – Acknowledge (DSC-ACK)	x		x	
	6.4.18	Dynamic Service Deletion – Request (DSD-REQ)	x		x	
	6.4.19	Dynamic Service Deletion – Response (DSD-RSP)	x		x	
	6.4.20	Dynamic Channel Change – Request (DCC-REQ)	x		x	
	6.4.21	Dynamic Channel Change – Response (DCC-RSP)	x		x	
	6.4.22	Dynamic Channel Change – Acknowledge (DCC-ACK)	x		x	
	6.4.23	Device Class Identification Request (DCI-REQ)	x		x	
	6.4.24	Device Class Identification Response (DCI-RSP)	x		x	
	6.4.25	Upstream Transmitter Disable (UP-DIS)	x		x	
	6.4.26	Test Request (TST-REQ)	x		x	
	6.4.27	Downstream Channel Descriptor	x	x		
	6.4.28	MAC Domain Descriptor	x		x	
	6.4.29	Dynamic Bonding Change Request (DBC-REQ)	x		x	

Section		Description	Rel	Inf	Mand	Opt
	6.4.30	Dynamic Bonding Change Response (DBC-RSP)	x		x	
	6.4.31	Dynamic Bonding Change Acknowledge (DBC-ACK)	x		x	
	6.4.32	DOCSIS Path Verify Request (DPV-REQ)	x		x	
	6.4.33	DOCSIS Path Verify Response (DPV-RSP)	x		x	
	6.4.34	Status Report (CM-STATUS)	x		x	
	6.4.35	CM Control Request (CM-CTRL-REQ)	x		x	
	6.4.36	CM Control Response (CM-CTRL-RSP)	x		x	
	6.4.37	Energy Management Request (EM-REQ)	x		x	
	6.4.38	Energy Management Response (EM-RSP)	x		x	
	6.4.39	Status Report Acknowledge (Cm-STATUS-ACK)	x		x	
	6.4.40	OFDM Channel Descriptor (OCD)	x		x	
	6.4.41	Downstream Profile Descriptor (DPD)	x		x	
	6.4.42	OFDM Downstream Spectrum Request Message (ODS-REQ)	x	x		
	6.4.43	OFDM Downstream Spectrum Response (ODS-RSP)	x	x		
	6.4.44	OFDM Downstream Profile Test Request (OPT-REQ)	x		x	
	6.4.45	OFDM Downstream Profile Test Response (OPT-RSP)	x		x	
	6.4.46	OFDM Downstream Profile Test Acknowledge (OPT-ACK)	x		x	
	6.4.47	DOCSIS Time Protocol – Request (DTP-REQ)	x			x
	6.4.48	DOCSIS Time Protocol – Response (DTP-RSP)	x			x
	6.4.49	DOCSIS Time Protocol – Info (DTP-INFO)	x			x
	6.4.50	DOCSIS Time Protocol – (DTP-ACK)	x			x
	6.5	PHY Link Channel	x		x	
7		Media Access Control Protocol Operation				
	7.1	Timing and Synchronization	x		x	
	7.2	Upstream Data Transmission				
	7.2.1	Upstream Bandwidth Allocation	x		x	
	7.2.2	Upstream Transmission and contention resolution	x		x	
	7.2.3	Upstream Service Flow Scheduling Services	x		x	
	7.2.4	Continuous Concatenation and Fragmentation	x		x	
	7.2.5	Pre-3.0 DOCSIS Concatenation and Fragmentation	x	x		
	7.3	Upstream – Downstream Channel Association within a MAC Domain	x		x	

Section		Description	Rel	Inf	Mand	Opt
	7.4	DSID Definition	x		x	
	7.5	Quality of Service				
	7.5.1	Concept	x		x	
	7.5.2	Object Model	x	x		
	7.5.3	Service Classes	x		x	
	7.5.4	Authorization	x		x	
	7.5.5	States of Service Flows	x		x	
	7.5.6	Service Flows and Classifiers	x		x	
	7.5.7	General Operation	x		x	
	7.6	Hierarchical QoS	x		x	
	7.7	Low Latency Support	x		x	
	7.8	Active Queue Management	x		x	
	7.9	QoS Support for Multicast and Broadcast Traffic	x		x	
	7.10	Downstream Traffic Priority	x		x	
	7.11	Data Link Encryption Support	x		x	
	7.12	Downstream Profiles	x		x	
8		Channel Bonding				
	8.1	Upstream and downstream common aspects	x	x		
	8.2	Downstream Channel Bonding	x		x	
	8.3	Upstream Channel Bonding	x		x	
	8.4	Partial Service	x		x	
9		Data Forwarding				
	9.1	General Forwarding Requirements	x		x	
	9.1.1	CMTS Forwarding Rules	x	x		
	9.1.2	CM Address Acquisition, Filtering and Forwarding rules	x		x	
	9.2	Multicast Forwarding	x		x	
	9.2.1	Introduction Multicast Forwarding	x	x		
	9.2.2	Downstream Multicast Forwarding	x		x	
	9.2.3	Downstream Multicast Traffic Encryption	x		x	
	9.2.4	Static Multicast Session Encodings	x		x	
	9.2.5	IGMP and MLD support	x		x	
	9.2.6	Encrypted Multicast Downstream Forwarding Example	x	x		
	9.2.7	IP Multicast Join Authorization	x	x		
	9.2.8	Multicast in a DOCSIS 3.1 OFDM Channel with Multiple Downstream Profiles	x		x	
10		Cable Modem – CMTS Interaction				
	10.1	CMTS Initialization	x	x		
	10.2	Cable Modem Initialization and Reinitialization	x		x	
	10.3	Periodic Maintenance	x		x	
	10.4	OFDM Profile Usability Testing Process	x		x	

Section		Description	Rel	Inf	Mand	Opt
	10.5	Upstream OFDMA Data Profile Assignment and Testing	x		x	
	10.6	Fault Detection and Recovery	x		x	
	10.7	DOCSIS Path Verification	x		x	
	10.8	DOCSIS Time Protocol	x			x
11		Dynamic Operations				
	11.1	Upstream Channel Descriptor Changes	x		x	
	11.2	Dynamic Service Flow Changes	x		x	
	11.3	Pre-3.0 DOCSIS Upstream Channel Changes	x	x		
	11.4	Dynamic Downstream and/or Upstream Channel Changes	x		x	
	11.5	Dynamic Bonding Change	x		x	
	11.6	Autonomous Load Balancing	x	x		
	11.7	Energy Management Operations	x		x	
	11.7.1	Energy Management Features	x		x	
	11.7.2	Entry and Exit for Energy Management Modes	x		x	
	11.7.3	Energy management 1x1 Feature	x		x	
	11.7.4	DOCSIS Light Sleep (DLS) Feature	x		x	
	11.7.5	Interaction between Battery Backup and DLS	x	x		
	11.8	Downstream Profile Descriptor Changes	x		x	
12		Supporting Future New Cable Modem Capabilities				
	12.1	Downloading Cable Modem Operating Software	x		x	
	12.2	Future Capabilities	x		x	
Annex A		Well-known addresses (Normative)	x		x	
Annex B		Parameters and Constants (Normative)	x		x	
Annex C		Common TLV Encodings (Normative)	x		x	
Annex D		CM Configuration Interface Specification (Normative)	x		x	
Annex E		Standard Receive Channel Profile Encodings (Normative)	x		x	
Annex F		The DOCSIS MAC/PHY Interface (DMPI)	x	x		
Annex G		Compatibility with Previous Versions of DOCSIS (Normative)	x		x	
Annex H		DHCPv6 Vendor Specific Information Options for DOCSIS 3.0 (Normative)	x		x	
Annex I		Blank annex				
Annex J		DHCPv4 Vendor Identifying Vendor Specific Options for DOCSIS 3.0 (Normative)	x		x	

Section		Description	Rel	Inf	Mand	Opt
Annex K		The Data-over-Cable Spanning Tree Protocol (Normative)	x		x	
Annex L		Additions and Modifications for Chinese Specification (Normative)		x		
Annex M		Proportional-Integral-Enhanced Active Queue Management Algorithm (Normative)	x		x	
Annex N		Immediate Active Queue Management (Normative)	x		x	
Annex O		AQM Utility Functions (Normative)	x		x	
Annex P		Queue Protection Algorithm (Normative)	x		x	
Annex Q		ASF Classifier Expansion (Normative)		x		
Appendix I		MAC Service Definition (Informative)	x	x		
Appendix II		Plant Topologies (Informative)	x	x		
Appendix III		DOCSIS Transmission and Contention Resolution (Informative)	x	x		
Appendix IV		Unsolicited Grant Service (Informative)	x	x		
Appendix V		Error Recovery Examples (Informative)	x	x		
Appendix VI		SDL Notation (Informative)	x	x		
Appendix VII		Notes on Address Configuration in DOCSIS 3.1 (Informative)	x	x		
Appendix VIII		IP Multicast Replication Examples (Informative)	x	x		
Appendix IX		IMP Examples for DOCSIS 2.0 Backwards Compatibility Mode (Informative)	x	x		
Appendix X		CM Multicast DSID Filtering Summary (Informative)	x	x		
Appendix XI		Example DHCPv6 Solicit Message Contents (Informative)	x	x		
Appendix XII		Dynamic Operations Examples (Informative)	x	x		
Appendix XIII		Acknowledgements (Informative)	x	x		
Appendix XIV		Revision History (Informative)	x	x		

8. DOCSIS 3.1 OSS Requirements

The following table describes the DOCSIS OSSI requirements based on [3]

Section		Description	Rel	Inf	Mand	Opt
1		Scope	x	x		
2		References	x			
	2.1	Normative References	x		x	
	2.2	Informative References	x	x		
	2.3	Reference Acquisition	x	x		
3		Terms and Definitions	x	x		
4		Abbreviations and Acronyms	x	x		
5		Overview	x		x	
	5.1	DOCSIS 3.1 OSSI Key Features	x		x	
		5.1.1 Fault Management Features	x		x	
		5.1.2 Configuration Management Features	x		x	
		5.1.3 Performance Management Features	x		x	
		5.1.4 Security Management Features	x		x	
		5.1.5 Accounting Management Features	x	x		
	5.2	Technical Overview	x	x		
6		OSSI Management Protocols				
	6.1	SNMP Protocol	x		x	
7		OSSI Management Objects				
	7.1	SNMP Management Information Bases (MIBS)	x		x	
8		OSSI for PHY, MAC and Network Layers				
	8.1	Fault Management	x		x	
	8.2	Configuration Management	x		x	
	8.3	Accounting Management	x	x		
	8.4	Performance Management	x		x	
	8.5	Security Management	x		x	
9		OSSI For CMCI	x		x	
10		OSSI for LED Indicators	x			x
Annex A		Detailed MIB requirements (normative)	x		x	
Annex B		IP Protocol and LLC Filtering and Classification (Normative)	x		x	
Annex C		Format and Content for Event, SYSLOG and SNMP notification (Normative)	x		x	
Annex D		Proactive Network Maintenance Requirements (Normative)	x		x	
Annex E		DOCSIS 3.1 Data Type Definitions (Normative)	x		x	
Annex F		CM Status Reporting Requirements (Normative)	x		x	

Section		Description	Rel	Inf	Mand	Opt
Annex G		MAC and Upper Layer Protocols Interface (MULPI) Requirements (normative)	x		x	
Appendix I		Spectrum Analysis Use Case (Informative)	x	x		
Appendix II		Information Model Notation (Informative)	x	x		
Appendix III		Acknowledgements (Informative)	x	x		
Appendix IV		Revision History	x	x		

9. DOCSIS 3.1 Security Requirements

The following table describes DOCSIS security requirements based on [4]. The Excentis BPI+ requirements [5] define the necessary modifications that are required for the legacy certificate. Anything specified in [5] takes precedence over information specified in [4].

Euro-DOCSIS certificates (as specified on Excentis BPI+) on type B networks are needed for the legacy (non DOCSIS3.1) certificates.

Section		Description	Rel	Inf	Mand	Opt
1		Scope	x	x		
2		References	x		x	
	2.1	Normative References	x		x	
	2.2	Informative References	x	x		
	2.3	Reference Acquisition	x		x	
3		Terms and Definitions	x		x	
4		Abbreviations and Acronyms	x		x	
5		Overview	x		x	
6		Encrypted DOCSIS MAC Frame Formats				
	6.1	CM Requirements	x		x	
	6.2	CMTS Requirements	x	x		
	6.3	Variable-Length PDU MAC Frame Format	x		x	
	6.4	Fragmentation MAC Frame Format	x		x	
	6.5	Registration Request (REG-REQ-MP) MAC Management Messages	x		x	
	6.6	Use of the baseline Privacy Extended Header in the MAC Header	x		x	
7		Baseline Privacy Key Management (BPKM) Protocol	x		x	
8		Early Authentication and Encryption (EAE)	x		x	
9		Secure Provisioning				
	9.1	Introduction	x	x		
	9.2	Encryption of Provisioning Messages	x		x	
	9.3	Securing DHCP	x		x	
	9.4	TFTP Configuration file Security	x	x		
	9.5	Securing REG-REQ-MP Messages	x		x	
	9.6	Source Address Verification	x	x		
	9.7	Address Resolution Security Consideration	x	x		
10		Using Cryptographic Keys				
	10.1	CMTS	x	x		
	10.2	Cable Modem	x		x	
	10.3	Authentication of Dynamic Service Requests				
	10.3.1	CM	x		x	
	10.3.2	CMTS	x	x		

Section		Description	Rel	Inf	Mand	Opt
11		Cryptographic Methods				
	11.1	Packet Data Encryption	x		x	
	11.2	Encryption of the TEK	x		x	
	11.3	HMAC-Digest Algorithm	x		x	
	11.4	TEKs, KEKs, and Message Authentication Keys	x		x	
	11.5	Public-Key Encryption of Authorization Key	x		x	
	11.6	Digital Signatures	x		x	
	11.7	The MMH-MIC	x	x		
12		Physical Protection of Keys in the CM	x		x	
13		BPI+ X.509 Certificate Profile and Management	x		x	
	13.1	BPI+ Certificate Management Architecture Overview	x		x	
	13.2	Cable Modem Certificate Storage and Management in the CM	x		x	
	13.3	Certificate Processing and Management in the CMTS	x	x		
	13.4	Certificate Revocation	x	x		
14		Secure Software Download				
	14.1	Introduction	x	x		
	14.2	Overview	x	x		
	14.3	Software Code Upgrade Requirements	x		x	
	14.4	Security Considerations (Informative)	x	x		
Annex A		TFTP Configuration File Extensions (Normative)	x		x	
Annex B		TFTP Options (Normative)	x		x	
Annex C		DOCSIS 1.1/2.0 Dynamic Security Associations (Normative)	x		x	
Annex D		Additions and Modifications for Chinese Specification (Normative)		x		
Appendix I		Example Messages, Certificates, PDUs and Code File (Informative)	x	x		
Appendix II		Example of Multilinear Modular Hash (MMH) Algorithm Implementation (Informative)	x	x		
Appendix III		Certification Authority and Provisioning Guidelines (Informative)	x		x	
Appendix IV		Acknowledgements	x		x	
Appendix V		Revision History	x		x	

10. Miscellaneous requirements

10.1. Software updates

DELTA Fiber Nederland will not perform or facilitate software updates for the cable modems.

The cable modem MUST include a software update mechanism that allows the end-user to perform software updates. An optionally automatic software update mechanism which may be enabled by default is recommended.

Cable modems MUST NOT accept new firmware/software unless it has been digitally signed by the original manufacturer of the cable modem. Alteration of the software itself MUST NOT be possible in any way.

10.2. Voice services

The SIP UE MUST use the same IP interface that is provisioned for data service.

The SIP UE MUST NOT announce itself as a PacketCable device by containing strings like “pktc1.0”, “pktc1.5” or “pktc2.0” in DHCP option 60.

Further information about the VOIP service can be found in DELTA Fiber Voice Interface Specification.

10.3. Quality of Service

Quality of Service for voice calls (telephony service) for both media and signaling will be taken care of by the network.

It MUST NOT be possible to initiate DOCSIS DSx transactions from the modem device.

10.4. System descriptor stability

The VENDOR and MODEL fields of the sysDescr.0 value of the CM MUST NOT change over the lifetime of the product.

11. IP-services

The IP configuration for the internet service can be assigned in two different ways, both MUST be supported:

1. IPv4-only configuration
2. Dual-stack IPv4 + IPv6

Specific information on each of the 2 options is provided below.

11.1. IPv4-only

Each allowed device will receive a native IPv4 address and other corresponding configuration to use for inbound/outbound IPv4-based traffic.

DHCPv4 needs to be used to obtain the IP-address. The following information MUST be requested by the DHCPv4-client:

- IP-address
- DNS-server
- Subnet mask
- Gateway address (default router)

11.2. Dual-stack

Each allowed device can receive both a native IPv4 and global IPv6 address as well as a delegated prefix in the range of /48 to /64 to use for inbound/outbound traffic.

DHCPv4 MUST be used for obtaining the IPV4 address, the requirements on the DHCP-client are the same as those for IPv4-only.

DHCPv6 MUST be used to obtain the global IPv6-address. The following information MUST be requested by the DHCPv6 client:

- IPv6-address
- DNS-server
- Delegated prefix

Note that any configuration of the interfaces/devices behind the cable modem MUST also be done using DHCP to avoid configuration conflict. Static configuration MUST NOT be used.

11.3. IGMP / Multicast

In some networks multicast is used for the IPTV service. If an eRouter is part of the cable modem, it should conform to CM-SP-eRouter-I20-190515 [7] section 9.6 for proxying IGMP and multicast forwarding.