TLN WRO Specification type Document

< Hybrid Fiber Coax ***(HFC***) and Euro-Docsis 3.0 interface specification for connection of AO Euro-Docsis equipment to TLN network >

Document Housekeeping

Document Category and type

CAT	TYPE	DOC ID	Comment
Broadband	SPEC	TLN-WRO-TA-B-S-PAAB	Specification type documents (-SPEC) are documents specifying logical / physical interfaces / protocols, etc.., to which AO equipment/systems need to comply

Document Authorization

EDITION	DATE	APPRAISAL AUTHORITY	STATUS	ORIGINATOR
0.6	10.09.2012	Director TLN Wholesale	Draft	TLN WRO Engineering

Document Effective Date

This document has come into effect as of xx/xx/2012 and remains valid until a valid subsequent Telenet Wholesale Reference offer, substituting this document is published.

Legal Disclaimer

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List of Appendixes

This document may refer to further detailed documents that are added in Appendixes to this document.
A reference to an appendix is in this document highlighted with grey background.

A. Appendix A, <APP-B-S-PAAB-A> contains :
    1) Appendix A1 – < Telenet Downstream spectrum plan >
    2) Appendix A2 – < Telenet upstream spectrum plan >

The appendix(es) referred to in this section List of Appendixes, contain(s) detailed technical information which is only relevant when a Beneficiary enters in a concrete implementation project to become Beneficiary of the Telenet Reference Offer and/or Annex.

List of References

This document may refer to external documents or information sources.
A reference to an external document or information source is in this document highlighted with grey background.
The list of referred external documents or information sources in this document:
Reference 1 : TLN WRO CAT: Broadband: TLN-WRO-TA-B-C-PAAB
Reference 2 : TLN WRO CAT: Broadband: TLN-WRO-TA-B-C-PAAA

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1 Abstract

This document describes Euro-Docsis 3.0 CPE HFC interconnection architecture and physical layer functional properties including the TLN Docsis spectrum plan, signaling requirements and AO Docsis CPE – TLN CMTS initial interconnectivity mechanism on Docsis Physical Layer.

This document has a corresponding certification document with reference: TLN-WRO-TA-B-C-PAAB which is used to test AO WO equipment compliance against this specification.

The feasibility of the technical designs and methods described in this document are subject to verification by a Proof of Concept (POC) test organized by Telenet and may be changed or updated depending on the outcome of this POC.

2 Glossary and Abbreviations

CM: Cable modem
CMTS: Cable Modem Termination System
CPE: Customer Premises Equipment
DOCSIS: Data over Cable Service Interface Specification
DS: Downstream
FM: Frequency Modulation
HFC: Hybrid Fiber Coax
HRC: Harmonic Related Carrier
IP: Internet Protocol
MAC: Media Access Control
MSO: Multiple Systems Operator
PAL: Phase Alternating Line
QAM: Quadrature Amplitude Modulation
QPSK: Quadrature Phase Shift Keying
S-CDMA: Synchronous Code Division Multiple Access
SD: Standard definition
SECAM: Séquentiel couleur à mémoire (Sequential Color with Memory)
SID: System Identifier
TLV: Type/Length/Value
US: Upstream

3 AO Euro-Docsis 3.0 CPE HFC and Euro-Docsis 3.0 Physical Layer Functional Description

(1) The overall function of a Docsis CPE is to enable IP data communication between devices in a customer home and the Internet. Two major distinct interfaces and communication layers are present in a Docsis device. The first one addresses the HFC and Docsis physical layers, the second one addresses the MAC and IP layer interfaces. As TLN operates in a Euro-Docsis environment, all references to Docsis or Docsis specifications implicitly refer to the Euro-Docsis variant.

(2) This specification addresses the HFC and Docsis physical layers. It describes the electrical requirements for signal transmission between an AO Docsis CPE and the TLN HFC network as well as the basic Docsis ranging, registration and scheduling procedures and protocols that are used to establish a MAC layer communication between the AO Docsis CPE and TLN CMTS

4 AO Euro-Docsis 3.0 CPE HFC and Euro-Docsis 3.0 Physical Layer Functional Requirements

4.1 Euro-Docsis 3.0 Physical Layer

4.1.1 Euro-Docsis 3.0 physical layer general requirements

(3) In order to ensure successful interoperability on the physical layer the AO Euro-Docsis CPE device must conform to the Docsis 3.0 physical layer specifications (Euro-Docsis variant) as published in the public Docsis 3.0 specification library on www.cablelabs.com.

(4) As a minimum the AO CPE should be able to support an 8 x 4 Docsis downstream/upstream carrier system with a tuner receive window of at least 200Mhz. Full spectrum capture tuners are recommended for future flexibility.

4.1.2 Euro-Docsis 3.0 physical layer TLN specific requirements

(5) TLN requires the use of 256QAM modulation on Docsis downstream carriers, as such the support of 256QAM is a mandatory requirement. TLN requires the use of 16QAM, 64QAM and A-TDMA modulation on Docsis upstream carriers, with fallback to 8QAM and QPSK as such support of those modulations and the fall back mechanisms are mandatory requirements.

(6) TLN also requires the support of S-CDMA, with an as broad as possible range of supported modulation schemes developed for data transmission across coaxial cable networks. S-CDMA disperses a wide frequency band for up and down digital data traffic and allows multiple subscribers connected to the network to transmit and receive concurrently. This method of data transmission was developed to be secure and extremely resistant to noise.

(7) TLN requires the support of TLV1 en TLV41 redirection mechanisms.

4.2 Older Docsis versions

(8) The TLN network is closed for deployment of Docsis 2.0, Docsis 1.0, Docsis 1.1 or any other non Docsis 3.0 compliant CPE equipment

4.3 TLN Docsis spectrum plan

4.3.1 Docsis downstream carriers frequency plan

(9) There are typically two frequency plans that Docsis downstream carriers frequency plans should comply with. These are Harmonic Related Carrier (HRC) and Incremental Related Carrier (IRC).

(10) Operational frequencies may include all channels between, and including center frequencies of 57 MHz to 999 MHz. But at least they must include 91 MHz to 1002 MHz. Spacing of possible center frequencies shall be 250KHz. AO Docsis CPE must satisfy these specs.

(11) In the below figures, as an illustration of the explained concepts a typical generic downstream and upstream spectrum configuration in an HFC network, supporting a mix of analogue and digital services can be seen.

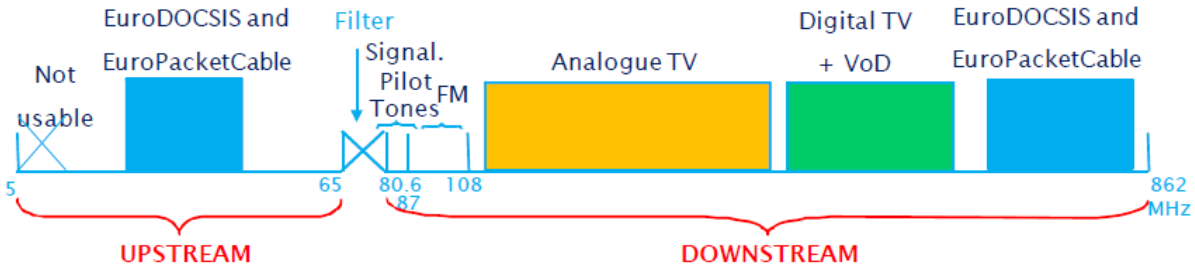

Figure 4 - 1

Region	Channel Plan	Radio Frequency (RF)1Modulation Format	Downstream Frequency Range	Upstream Frequency Range
European (EuroDOCSIS)	8 MHz PAL[3]/SECAM[4]	ITU J.112 Annex A	85 MHz to 860 MHz	5 MHz to 65 MHz

Figure 4 - 2

4.3.2 Docsis downstream RF signal coding and signal levels

(12) TLN requires AO Docsis CPE to communicate with TLN CMTS on the downstream path of TLN HFC network on a 8-MHz wide as a Euro-Docsis standard, 64-QAM or 256-QAM digitally encoded RF signal with detailed RF signal requirements as specifiend in appendix A1.

4.3.3 Docsis upstream carrier low and high band plan

(13) The Telenet network uses two RF spectrum ranges in the upstream part of the HFC spectrum for transmission of upstream Docsis carriers. Those are called the “low” upstream band and the “high” upstream band.

(14) The “low” upstream band ranges from 5-25 Mhz and the “high” upstream band from 25-65 Mhz.

(15) An AO modem may have to attach either to the Docsis carriers in the “low” band or in the “high” band depending on the local situation of the cable plant which differs from region to region. RF signal conditions and used modulation schemes may differ in the different bands.

(16) The possibility for a modem to connect to a given band also depends on “local” conditions such as for example the presence of NIU types with a 5-25 MHz low pass upstream filter or

eventually outside plant network elements that might block access to the “high” band. This will imply that not all advertised upstream channels will be available to the AO CPE in a uniform way over the entire Telenet Network.

(17)Telenet is actively using network management techniques to allocate and switch modems from time to time between low and high bands to keep the upstream spectrum as clean as possible from RF ingress noise and to balance traffic. The AO modems should be fully capable of supporting and responding to all those Docsis management instructions received from the Telenet CMTS.

4.3.4 Docsis upstream carriers frequency plan

(18)According to Euro-Docsis standards, the upstream (US) part of the spectrum range is in between 5 MHz and 65 MHz.

(19)Upstream frequency spectrum is relatively smaller than downstream spectrum since most of the data is transmitted from the TLN CMTS to AO Docsis CPE side. The AO Docsis CPE should meet the related frequency plan for upstream traffic.

(20)In the figures above, the frequency specifications (US/DS) for Euro-Docsis standard can be seen.

4.3.5 Docsis upstream RF signal coding and signal levels

(21)AO Docsis CPE will communicate with TLN CMTS on the upstream path of TLN HFC network on a 8-MHz wide as a Euro-Docsis standard, using a phase shift keying modulation (QPSK), a quadruple amplitude modulation(8-QAM, 16-QAM, 32-QAM or 64-QAM), a A-TDMA or S-CDMA (both with a wide range of modulation schemes) digitally encoded RF signal.

(22)The AO Docsis CPE will have to support the above mentioned modulation schemes to successfully interoperate with the TLN network

4.3.6 Docsis upstream hopping channel concept

(23)The frequencies used for the upstream traffic are under the control of the TLN CMTS and are pre-defined. Therefore, the ability for a modem to “avoid” the use of particular frequencies is under the control of TLN.

(24)Additionally, channels in the return path that are subject to ingress or to impulse noise can be (temporary) automaticlly or manually “shut down” for use and modems can be forced to re-tune to avoid this interference. This technique is referred as “frequency hopping”. Frequency hopping concept is used in upstream Channel sequence on TLN Network and should be fully supported by AO modems.

(25)Telenet uses advanced spectrum management techniques in order to adapt the network as good as possible towards dynamicly changing spectrum quality in upstream. This is done by signaling via UCD changes on the characteristics of the US channels.

(26)In addition Telenet also uses a load balancing technique (using DCC) on US channels to keep the total upstream traffic as balanced as possible, by “instructing” certain modems from time to time to change US channel.

4.4 TLN Docsis ranging and carrier signalling procedures

(27) The below description is a brief description describing in a summary way for illustration purposes and for a non channel bonded operations the complex signaling procedures and interaction flows a Docsis CPE is using to "discover" the CMTS on the HFC network and to "attach' to it. The full specification and details can be found in the earlier referred to Euro-Docsis specification library.

(28) An AO Docsis CPE will make at power up an attempt to connect to a TLN CMTS on a valid downstream DOCSIS channel by looking and trying to lock for 64-QAM or 256-QAM digital channel containing an MPTS with DOCSIS identifier in the protocol headers. TLN CMTS sends a Sync (System Timing) Broadcast for 200 msec periods, UCD (Upstream Channel Descriptor) Broadcast for 2 sec periods, MAP (Media Access Protocol) Broadcast for 2 min periods. After getting these broadcast packets successfully, an AO Docsis CM should lock to a valid DS channel of TLN CMTS. The process can be seen on below figure.

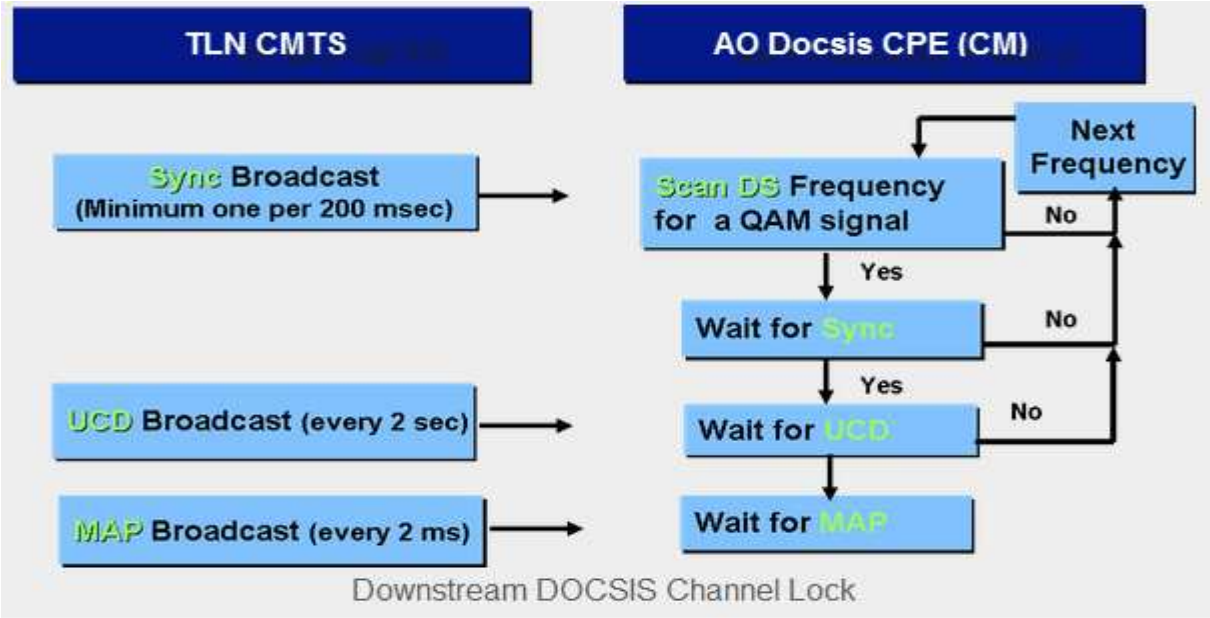

Figure 4 - 3

(29) After the successful lock - on process, the AO Docsis CM enters the ranging process, starting with the initial ranging, which starts a Range-Request with 8 dBmV power from the AO Docsis CM. This process will continue by incrementing the Range-Request power at 3dBmV higher at each time until AO Docsis CM gets a Range-Response from TLN CMTS. In the below figure, this process can be seen.

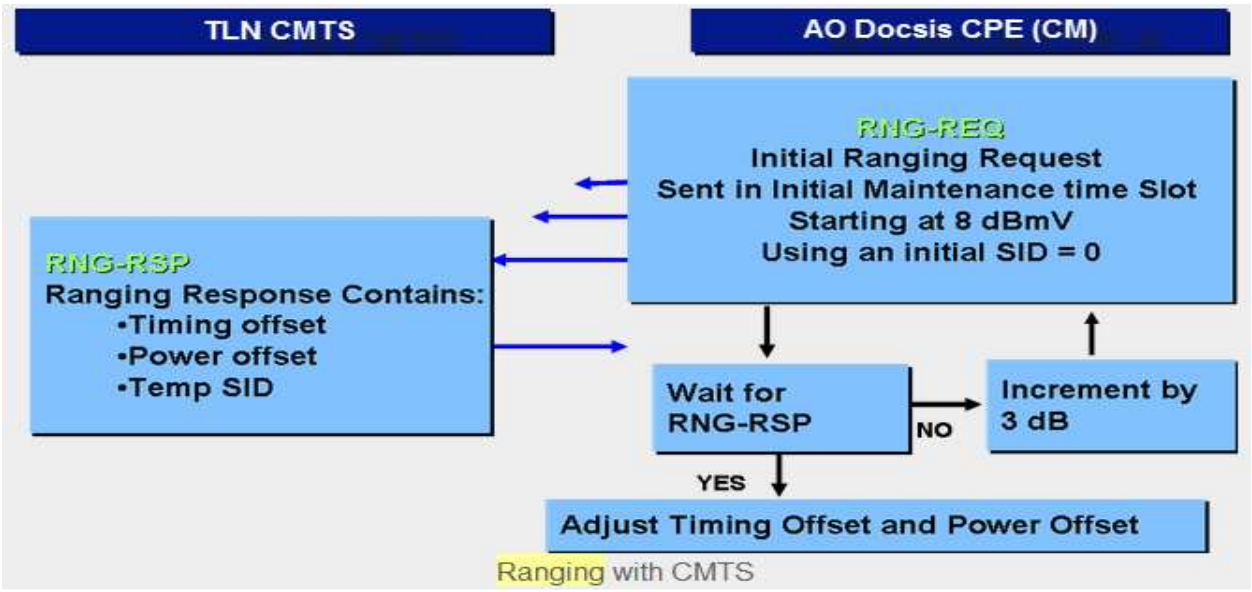

Figure 4 - 4

(30) The TLN CMTS transmits Upstream Channels Descriptor at a periodic interval to define characteristics and availability for each physical upstream channel. An AO Docsis CPE should check UCDs in the active downstreams and select a UCD with a TLV that is consistent with AO Docsis CPE (CM)'s capability. If an AO Docsis CM finds another UCD that has a more convenient TLV to the CM's capability, it shall override this UCD with existing one.

(31) Docsis 3.0 channel bonding is a scheduling mechanism that allows distributing data packets of DOCSIS service flows over multiple channels concurrently. In the DS direction, the TLN CMTS distributes individual packets over multiple channels, and usually includes a Downstream Service Extended Header that contains a packet sequence number that permits the AO Docsis CPE (CM) to resequence out-of-order packets. In the US direction, the AO Docsis CPE (CM) continuously concatenates and fragments a stream of packets into a set of "segments" and distributes those segments over the grants scheduled by the TLN CMTS for the service flow. Each segment has a sequence number to permit the TLN CMTS to re-order segments received out of order. A service flow which has information scheduled over multiple channels is called a "bonded" service flow. A set of two or more channels over which the TLN CMTS schedules the information of a service flow is called a "bonding group". At this moment Docsis 3.0 channel bonding is only activated in the downstream direction on the TLN CMTS and not in the US direction. However TLN might activate Docsis 3.0 US channel bonding in the near future, hence the AO CPE must be capable of handling this.

(32) The number of available Docsis channels and the quantity and the configuration of the bonding groups is described in Appendix A1.

(33) AO Docsis CPE (CM) is in a partial service mode of operation any time it is operating with a subset of the channels in the Receive Channel Set (RCS) and/or Transmit Channel Set (TCS) because a channel has become unusable, either due to an inability to acquire a particular channel in the bonding set or because communication on a channel was lost during normal operation (e.g. due to RF impulse noise). A typical downstream bonded service group will have four or eight channels, an upstream bonded service groups will have typically 2, 3 or 4 channels. The AO Docsis CPE (CM) must be capable of working with the remaining channels if one or more channels are temporary out of service. The AO CPE devices should also support MDD recovery (CPE must send MDD recovery with updated receive channel set in all cases, also if the channels were unavailable at registration). AO Docsis CPE (CM) initialization sequence is shown in below figure.

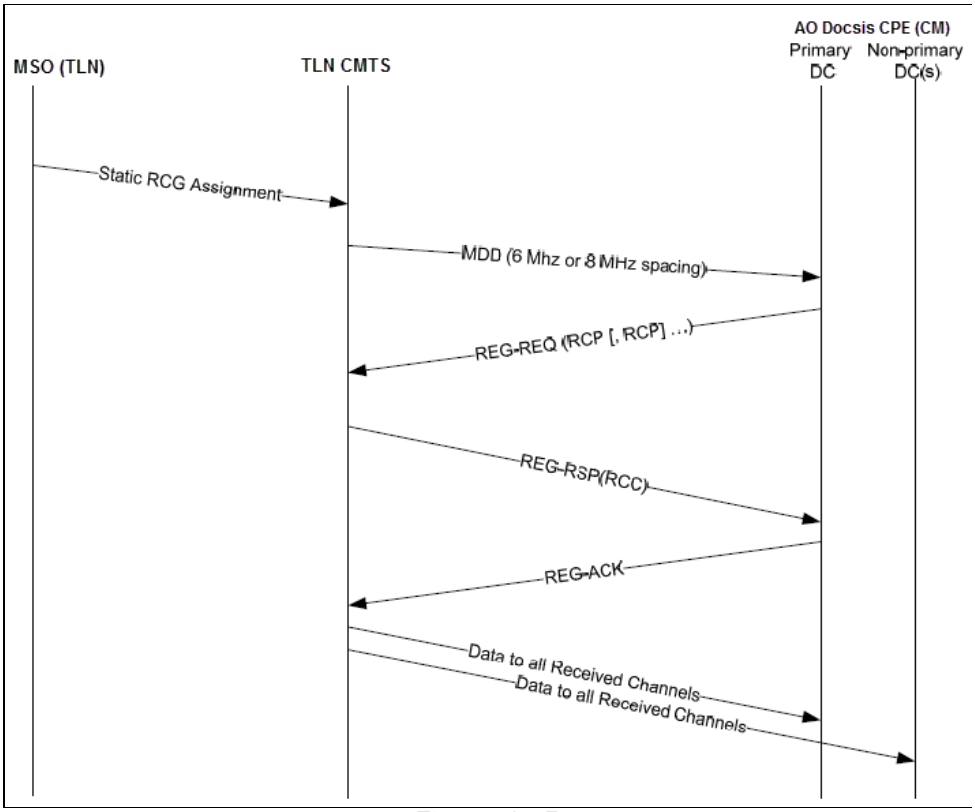
AO Docsis CPE (CM)
Primary DC
Non-primary DC(s)
MSO (TLN)
TLN CMTS
Static RCG Assignment
MDD (6 Mhz or 8 MHz spacing)
REG-REQ (RCP [, RCP] ...)
REG-RSP(RCC)
REG-ACK
Data to all Received Channels
Data to all Received Channels

Figure 4 - 5

4.5 TLN Docsis carrier spectrum plan

(34)This paragraph contains the detailed Telenet spectrum plans on a per region basis.

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(1) The Downstream Docsis spectrum plan is detailed in Appendix A1.

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(2) The Upstream Docsis spectrum plan is detailed in Appendix A2.

4.6 AO Device Management by TLN Requirements

(35)The applicable requirements are described in TLN-WRO-TA-B-S-PAAA.

5 AO Euro-Docsis 3.0 CPE – Non Functional Requirements

(36)The applicable requirements are described in TLN-WRO-TA-B-S-PAAA.