CABOVISÃO S.A.

Voice and Data Services Interface – Multimedia Terminal Adapter (MTA)

Documento: ENP-SPC-016
Departamento: Planeamento & Engenharia

Ed. 1 Revisão: 0 Data: 2004-10-22

INDEX

1 INTRODUCTION

The purpose of this document is to define Cabovisão's voice and data networks subscriber interfaces, based on the MTA (Multimedia Terminal Adapter) device.

The following circuits are available:

- Two RJ-11 telephone ports, for primary line voice services;
- One RJ-45 Ethernet port 10/100BaseT and one USB 1.1 port, for high-speed data connectivity;
- One female "F" type connector, for RF network connectivity.

2 STANDARDS AND RECOMMENDATIONS

The MTA is PacketCable 1.0 and DOCSIS 2.0 (Data-Over-Cable Service Interface Specifications) compliant.

3 SERVICE GOALS

One potential application of the PacketCable architecture is packet-based voice communications for cable system subscribers. The PacketCable architecture as a whole enables voice communications, video, and data services based on bi-directional transfer of Internet protocol (IP) traffic between the cable system headend and customer locations, over an all-coaxial or hybrid-fiber/coax (HFC) cable network as shown in simplified form in Figure 1.

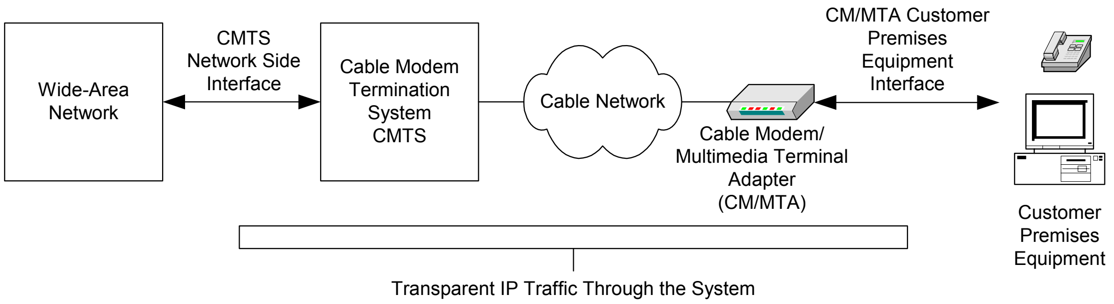

Figure 1 – Transparent IP Traffic through the Data-Over-Cable System

The transmission path over the cable system is realized at the headend by a cable modem termination system (CMTS), and at each customer location by a cable modem (CM). At the headend (or hub), the interface to the data-over-cable system is called the cable modem termination system-network-side interface (CMTS-NSI). At customer locations, the interface is called the cable-modem-to-customer-premises-equipment interface (CMCI). One purpose of the PacketCable architecture is to specify how operators may transfer IP traffic transparently between these interfaces.

4 PACKETCABLE ARCHITECTURE

The PacketCable 1.0 reference architecture contains three networks: the "DOCSIS HFC (Hybrid Fiber Coax) Access Network", the "Managed IP (Internet Protocol) Network" and the PSTN (Public Switched Telephone Network), as shown in Figure 2.

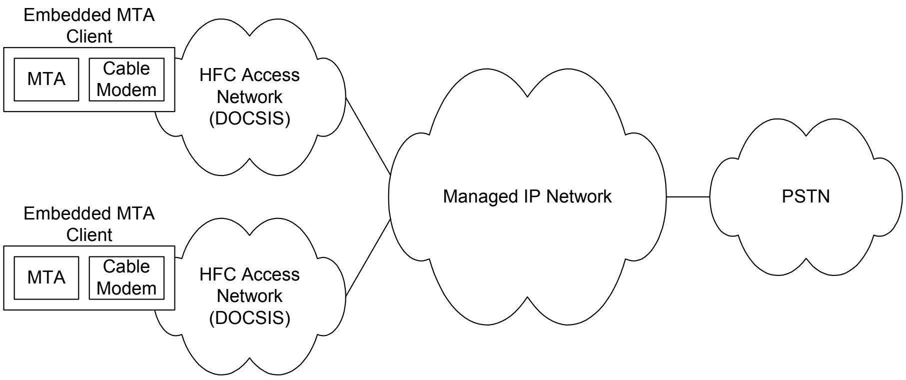

Figure 2 – PacketCable 1.0 Reference Architecture

The MTA and the CM (Cable Modem) are functional components of the DOCSIS HFC Access Network.

4.1 Multimedia Terminal Adapter (MTA)

An MTA is a PacketCable client device that contains a subscriber-side interface to the subscriber's CPE (Customer Premises Equipment) (e.g., telephone) and a network-side signaling interface to call control elements in the network. An MTA provides codecs and all signaling and encapsulation functions required for media transport and call signaling.

MTAs reside at the customer site and are connected to other PacketCable network elements via the HFC access network (DOCSIS). PacketCable 1.0 MTAs are required to support the Network Call Signaling (NCS) protocol.

An embedded MTA (E-MTA) is a single hardware device that incorporates a DOCSIS 2.0 cable modem as well as a PacketCable MTA component. Figure 3 shows a representative functional diagram of an E-MTA.

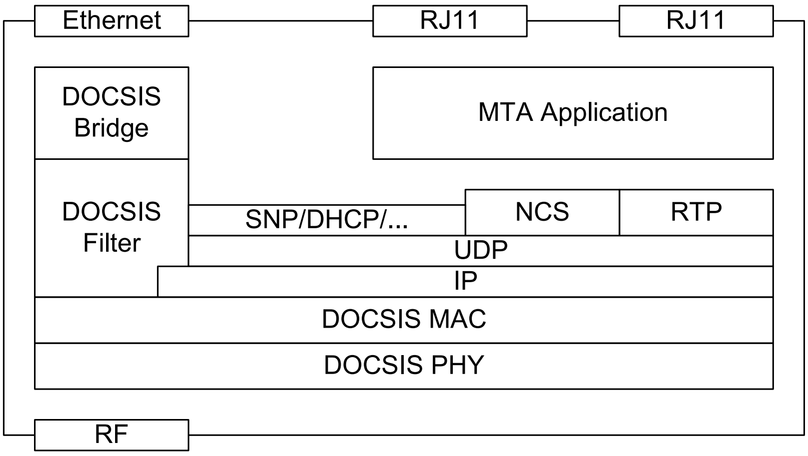

Figure 3 – E-MTA Conceptual Functional Architecture

PacketCable 1.0 specifications only require support for embedded MTAs. Throughout this document, unless otherwise noted, the term MTA refers to an embedded MTA.

4.1.1 MTA Functional Requirements

An MTA is responsible for the following functionality:

- NCS call signaling and QoS signalling;
- Authentication, confidentiality and integrity of some messages between the MTA and other PacketCable network elements;
- Mapping media streams to the MAC services of the DOCSIS access network;
- Encoding/decoding of media streams;
- Providing multiple audio indicators to phones, such as ringing tones, call-waiting tones, stutter dial tone, dial tone, etc;
- Standard PSTN analog line signaling for audio tones, voice transport, caller-id signaling, DTMF, and message waiting indicators;
- The G.711, G.726, G.728, G.729 audio codecs;
- One or more RJ11 analog interface(s), as defined by Bellcore TR-909.

Additional MTA functionality is defined in other PacketCable specifications such as NCS Signaling, Dynamic Quality-of-Service, Audio-Video Codecs, MIBS, and MTA Device Provisioning.

4.1.2 MTA Identifiers

The following identifiers characterize the E-MTA:

- An embedded MTA has two MAC addresses, one for the cable modem and one for the MTA;
- An embedded MTA has two IP addresses, one for the cable modem and one for the MTA;
- An embedded MTA has two Fully Qualified Domain Names (FQDN), one for the cable modem and one for the MTA;
- At least one telephone number per configured physical port;
- Device capabilities.

4.2 Cable Modem (CM)

The cable modem (CM) is a network element that is defined in the DOCSIS. The CM is a modulator/demodulator residing on the customer premise that provides data transmission over the cable network using the DOCSIS protocol. In PacketCable, the CM plays a key role in handling the media stream and provides services such as classification of traffic into service flows, rate shaping, and prioritized queuing.

5 CM/MTA POWER REQUIREMENTS

5.1 Power Considerations

CM/MTA powering is a critical element in providing primary line telephone service through HFC cable networks. The basic method to power the primary line CM/MTA is local with battery backup. Local power refers to utilizing the subscriber’s home AC utility power as the supply for the CM/MTA. A battery backup is utilized when the utility power fails.

In general, the power system should provide a CM/MTA with sufficient backup power (to accommodate typical power outages) for a typical CM/MTA traffic model. This creates constraints on power consumption for locally powered systems that provide battery backup. A CM/MTA’s average power consumption directly affects the size and cost of the backup batteries.

5.2 Average Power Calculations

For local powered systems with battery backup, long term average CM/MTA power can be utilized to determine the typical battery backup time for a particular CM/MTA and UPS combination. By dividing the battery's effective watt-hour rating by the CM/MTA's average power rating, and taking into account power conversion and wire I-R loss effects, the typical battery-backed operation time can be determined.

5.3 CM/MTA Average Power Requirements

The average CM/MTA power consumption should be less than or equal to 5 VA. The average power consumption refers to the typical long-term average consumption of the device and is intended to provide a reference for designing the power node architecture. Note that an average power consumption of 5 VA is considered achievable in the near future as chip and CM/MTA designs become more integrated. Furthermore, less than or equal to 5 VA goals (approaching 3 VA) are achievable longer term without requiring changes in DOCSIS.

5.4 Service Requirements under AC Fail Conditions

For local power with battery backup, the CM/MTA device is aware of AC power failure via the UPS telemetry inputs or via internal means with an embedded UPS.
Since data traffic is not considered a primary line service, data service may be deactivated immediately under local AC power fail conditions. However, voice is considered a primary line service, and all lines provided by a CM/MTA must remain operational (operational means capable of originating calls, ringing, and terminating calls, if provisioned as in-service).

6 LOCAL POWERING WITH BATTERY BACKUP

Local powering is accomplished utilizing an uninterruptible power supply (UPS) that converts household 220-240VAC power (50Hz) to DC power for the CM/MTA. The UPS also provides battery backup to bridge CM/MTA operation through typical local power outages. In addition, telemetry signals provide remote monitoring capability for local AC power and battery conditions. Outdoor CM/MTA devices will typically utilize a separate UPS such that batteries can be placed inside the customer's facility. The indoor climate controlled environment is typically desired for battery placement to maximize battery life. CM/MTA's utilizing an external UPS will require metallic connections between the two units for transmission of power and telemetry information. CM/MTA implementations may include an embedded UPS or utilize an external UPS depending on the vendor implementation.

6.1 CM/MTA to UPS Interface

A standardized interface is defined between the CM/MTA and an external UPS to allow vendor interoperability between the two devices. This interface is comprised of seven (7) conductors including two (2) for DC power, four (4) for telemetry signals, and one (1) for telemetry ground reference. The external CM/MTA-UPS interface must be included on primary line CM/MTA implementations that do not provide embedded UPS functionality. For CM/MTA's with embedded UPS functionality, there is no requirement to provide the physical CM/MTA-UPS interface signals externally; however, the embedded telemetry information must still be made available to upstream network management systems.

6.1.1 Physical Connection

Since the interface cable between the CM/MTA and UPS will typically be cut to length, the CM/MTA should provide individual connections for each conductor but may utilize a standard multi-pin connector. The specific type of connection device will not be specified; however the connection device must support 22, 24, and 26-gauge wire. The connection device may also support any other gauge wire.

6.1.2 Power Signals (External UPS)

The power interface is designed to provide 20 watts of peak power to the CM/MTA which provides ample power for CM/MTA implementations supporting a high speed data link and up to 4 telephony lines with a total ringing load of 10 REN. To enable the use of 22-26-gauge wire for the interface, 48VDC nominal power is being required.
The CM/MTA without embedded UPS functionality must support the following input voltage range:

Signal	Value
Power	+48VDC nominal, +42VDC min, +51VDC max
Power return	48 VDC Return

7 MTA ANALOG PORT REQUIREMENTS

The MTA analog port represents an interface between the PacketCable/DOCSIS/IP (internet protocol) network and devices designed to function when connected to the PSTN using standard PSTN interfaces. The subscriber side of this interface is an analog interface consistent with the PSTN and the network side of this interface is a digital interface to the IP-based PacketCable network, which rides on top of the DOCSIS transport. It is expected that many MSOs will choose to use the PacketCable architecture to offer service to customers in residential dwellings. In such applications, the MTA will reside at the subscriber premises, either inside or outside. The MTA will, in the context of the PacketCable network, be analogous to the NIU (network interface unit) or NID (network interface device) as those terms are used in connection with the PSTN. Finally, because the network side of the port interface is digital, and the device resides close to the subscriber, the analog subscriber side of the port interface will only be required to support relatively short metallic (copper twisted pair) drops (i.e., 500 feet).

This interface is similar to the Telcordia TA-909 POTS interface requirements for FITL (fiber in the loop). Therefore, the port requirements are based on TA-909. For basic PacketCable primary line service, the requirements can be divided into four categories:

- Loop Start Signaling
- General Supervision
- General Ringing
- Voice Grade Analog Transmission

The MTA analog 2-wire interface requirements are listed in the following sections.

Terminology: For the purpose of this section, the subscriber twisted pair copper wiring (typically the wiring inside the subscriber's premises) that is connected to the CM/MTA analog port will be referred to as the "loop". Note that this usage is different than the way these terms may be used in the context of the PSTN, in which the "loop" is defined as the transmission path between a telephone company central office and a customer's premises. The "loop" referred to in this section, in PSTN terms, would typically be referred to as "premises wire" or "inside wire." References here to "loops" and "transmission paths" should not be confused with links from customer premises to either a telephone company office or to an MSO's head-end.

7.1 Loop Start Signalling

7.1.1 DC Supervisory Range

The DC supervisory range must meet: RDC >= 450 ohms. RDC is the DC supervisory range. The actual value of RDC depends on the resistance of the loop wire from the CM/MTA (the subscriber's inside wiring). That is, RDC = 430 + Rloop. Note that this accommodates a drop of 500 feet of AWG 22-gauge wire at 65oC.

7.1.2 Idle State Voltage

The idle state is when the loop is open or on-hook. In this state the idle voltage satisfies:

- must be 21Vdc <= VIDLE <= 80 V dc
- should be 42.75Vdc <= VIDLE <= 80 V dc
- ring is negative with respect to tip
- ring-to-ground and tip-to-ground voltages are < 0
- meet class A2 continuous source electrical safety from section 14.6 of GR-499

Note: The VIDLE minimum recommendation has been added for PacketCable. In some cases, 21 Vdc causes interoperability problems with certain CPE devices.

7.1.3 Loop Closure Detection

Loop closure is off-hook. Detection of loop closure must meet:

- Resistance <= RDC between tip and ring is loop closure
- Resistance >= 10k ohms between tip and ring is not loop closure

When loop closure is detected, appropriate actions as defined by the Call Management will be taken.

7.1.4 Loop Open Detection

Loop open is on-hook. Detection of loop open must meet:

- Resistance >= 10k ohms is loop open
- Resistance <= RDC + 380 ohms is not loop open

The MTA must be able to distinguish between a hit, dial pulse, flash, or disconnect and signal appropriately to the Call Management.

7.1.5 Off-Hook Delay

The MTA must be able to detect a subscriber termination request (on-hook) and attempt to transmit the notification to the Call Management within 50 msec.

7.1.6 Ringsplash

When the Call Management indicates one 500 msec ringsplash, the MTA must apply one 500 +/- 50 msec ring burst to the line.

7.1.7 Distinctive Ringing

Defined ring cadences must be applied to the drop within +/-50 msec resolution.

7.1.8 Transmission Path

The MTA must support part-time on-hook transmission capabilities: part-time = within 400 msec after a ringsplash. On-hook transmission provides the capability of transmitting a voiceband signal in both directions on the loop when the loop is open (on-hook).

7.2 General Supervision

7.2.1 Off-Hook Loop Current

The MTA must provide at least 20 mA of loop current in the off-hook state.
Loop voltage is such that the ring conductor is negative with respect to the tip conductor.

7.2.2 Immunity to Line Crosses

Shorts between tip-to-tip, tip-to-ring, or ring-to-ring involving 2 or more lines must not damage the MTA.
Shorts between tip-to-ground or ring-to-ground involving 1 or more lines must not damage the MTA.

7.2.3 System Generated Open Intervals

When in the loop closure state (off-hook), interruptions to loop current feed must notexceed 100 msec unless instructed by the Call Management.

7.2.4 Open Switching Interval Distortion

When in the loop closure state and providing loop current feed, loop current feed open commands of duration T must have resolution to +/-25 msec for 50<=T<=1000 msec.

When in the above state, the MTA must continue to maintain loop closure (towards the Call Management) with no interruptions >1 msec.

Loop current feed open must not exceed 5 sec in duration.

Loop current feed open is an interruption of the loop current sourced on the drop.

TR30 (TR-NWT-000030, Issue 2, October 1992) specifies this must be satisfied for both on-hook and off-hook.

7.2.5 Dial Pulsing

Dial pulses may be collected at the MTA. Depending on Call Management instructions, the digits can either be individually sent or gathered according to the digit map and all digits sent in a single message.
If the MTA supports dial pulsing, the MTA must support 8-12 pps with 58-64% break.
Note that PacketCable does not require support for pulse dialing. Therefore, this is an optional MTA requirement.

7.2.6 DTMF Signaling

DTMF signaling will be collected at the MTA. Depending on Call Management instructions, the digits can either be individually sent or gathered according to the digit map and all digits sent in a single message.
The MTA must not amplitude overload at the maximum expected DTMF signal level. (ANSI T1.401-1988 describes the maximum DTMF signal level) Amplitude overload is any output frequency between 0 – 12 kHz greater than –28 dBm0 when the input frequency is between 600 – 1500 Hz at a power level equal to the maximum expected DTMF signal level.

7.2.7 Dialtone Removal

The MTA MUST remove dialtone within 250 msec of detecting the first dialed digit unless otherwise instructed by the Call Management.

Note: The NCS protocol provides the ability to request the MTA to play signals (in this case dialtone) in response to events (in this case off-hook). The protocol also provides the ability to instruct the MTA to “keep the signals active” after an event has been detected (in this case keep dialtone active even if a digit has been detected). Thus, it is not the intention of this specification to override the NCS protocol specification and as such, the Call Management has the ability to override this requirement.

7.3 General Ringing

7.3.1 Alerting Signals

The MTA must support unbalanced or balanced ringing.
The applied cadence must be within +/-50 msec of the defined cadence.

Nominal cadence has a 6-sec period with 1.7-2.1 sec ringing and 3.1-5.5 sec of silence.

For Unbalanced Ringing:

- Alerting cadence is applied to ring with tip grounded.
- The dc component during ringing is such that the ring conductor is negative with respect to tip.

For Balanced Ringing:

- Alerting cadence is applied to both tip and ring, typically 180 degrees out of phase.
- With or without a dc component.

7.3.2 Ringing Delay

Ringing must be applied within 200 msec of being signaled by the Call Management. The cadence may be entered at any point (i.e., the cadence may start with the silent period).

7.3.3 Ringing Source

Must meet the duration-limited source safety requirements of GR-1089.

Ringing frequency MUST be 20+/-1 Hz.

The dc component (offset) MUST be <= 75 Vdc

Must meet 1.2 <= peak-to-rms voltage ratio <= 1.6

The bridged C-weighted noise <= 90 dBrnC when referenced to 900 ohms during ringing (i.e., the 20 Hz component < 0 dBm) and the analog voiceband lead conducted emissions criteria of TR1089 must be met.

7.3.4 Ringing Capability

The MTA must support 5 REN per line.

The MTA must support at least 10 REN per device for MTAs that support 2 or more lines.

Note: It is anticipated that many MTAs will support more than 2 lines (i.e., 4 POTS lines) but it is also unreasonable to require the MTA with more than 2 lines to support 5 REN for each line for power consumption reasons. Therefore, the minimum REN requirement of 10 REN per device, across all lines, is established.

7.3.5 Ring Trip

Ringing must be removed within 200 msec of detecting loop closure.

7.3.6 Ring Trip Reporting Delay

The MTA must be able to detect a ring trip and attempt to transmit the notification to the Call Management within 300 msec.

7.3.7 Ring Trip Immunity

Ringing must not be tripped when a termination of 10k ohm in parallel with 6 uF is applied to tip and ring.

Ringing must not be tripped when a termination of 200 ohm is applied to tip and ring for <= 12 msec.

7.4 Voice Grade Analog Transmission

The PacketCable system utilizes digital transmission of voice signals to and from the MTA. The MTA converts between the digital voice signal on the IP network and the analog voice signal on the tip and ring loop. System impairments in the digital network, such as packet loss, can affect the voice signal but are outside the control of the MTA. Therefore, this section defines the analog voiceband requirements of the MTA and assumes an error-free digital network.

These requirements are derived from the PSTN which, in some cases, utilizes analog transmission from a headend central office switch to a customer. Typically, the reference point by which these requirements are measured is the middle of the switch (digital to analog). This reference point is referred to as the 0 Transmission Level Point (TLP) and could be thought of as any point in the digital portion of the network.

Note that these are not end-to-end analog requirements since they apply to a single digital to analog conversion point (a typical voice call will be analog at each end with a digital network connecting the two ends).

The 0 TLP of the PacketCable system is any point in the digital IP network. The digital IP network, for voice signal transmission purposes, extends all the way to the MTA where the digital to analog conversion occurs.

These requirements apply to the G.711, G.726, G.728, G.729 audio codecs.

Transmission requirements for the other compression algorithms are not yet defined.

General: All these requirements must be satisfied for both on-hook and off-hook.

7.4.1 Input Impedance

600 ohms nominal
ERL (echo return loss) > 26 dB (29 dB objective).
SRL (singing return loss) > 21 dB (24 dB objective).

7.4.2 Hybrid Balance

ERL > 21 dB (26 dB objective).
SRL > 16 dB (21 dB objective).
ERL = 15 + LT1 + LR1.
SRL = 10 + LT1 + LR1.
Where LT1 is transmit loss and LR1 is receive loss at 1004 Hz.

7.4.3 Longitudinal Balance

200 Hz: min > 45 dB, ave > 50 dB (ave > 61 dB objective).
500 Hz: min > 45 dB, ave > 50 dB (ave > 58 dB objective).
1000 Hz: min > 45 dB, ave > 50 dB (ave > 52 dB objective).
3000 Hz: min > 40 dB, ave > 45 dB.

7.4.4 MTA Loss

4 dB in the D/A direction (towards the subscriber).
2 dB in the A/D direction (from the subscriber).
This is the loss within the MTA.

7.4.5 MTA Loss Tolerance

Within +/-1 dB of the MTA loss.

7.4.6 Frequency Response

Off-hook transmission loss between 400-2800 Hz MUST be within –0.5 to +1 dB of the loss at 1004 Hz using a 0 dBm0 signal.

On-hook transmission loss between 400-2800 Hz MUST be within –1 to +2 dB of the loss at 1004 Hz using a 0 dBm0 signal.

(+ means more loss, - means less loss).

7.4.7 50 Hz Loss

The transmission path loss at 50 Hz must be at least 20 dB greater than the offhook transmission path loss at 1004 Hz. The intention is to limit the encoding of 50 Hz induction in the A/D direction.

7.4.8 Amplitude Tracking

The deviation of a 1004 Hz off-hook transmission path loss relative to the loss of a 0 dBm0 input signal.

-37 to –3-dBm0 input: +/-0.5 dB max (+/-0.25 dB ave).

-50 to –37-dBm0 input: +/-1.0 dB max (+/-0.5 dB ave).

-55 to –50-dBm0 input: +/-3.0 dB max (+/-1.5 dB ave).

The deviation of a 1004 Hz on-hook transmission path loss relative to the loss of a 0 dBm0 input signal.

-37 to 0 dBm0: +/-0.5 dB max.

7.4.9 Overload Compression

The increase in the off-hook transmission path loss at 1004 Hz relative to the loss of a 0 dBm0 input signal.

+3 dBm0 input: <= 0.5 dB increased loss.

+6 dBm0 input: <= 1.8 dB increased loss.

+9 dBm0 input: <= 4.5 dB increased loss.

This is to ensure the receiver off-hook signal can be transmitted.

7.4.10 Idle Channel Noise

Not to exceed 20 dBrnC at the output of the MTA (18 dBrnC objective).

7.4.11 Signal To Distortion

The ratio of the output signal to output C-notched noise with a 1004 Hz input signal while providing an on-hook and off-hook transmission path.

0 to –30-dBm0 input: >33-dB ratio.

-30 to –40-dBm0 input: >27-dB ratio.

-40 to –45-dBm0 input: >22-dB ratio.

7.4.12 Impulse Noise

<=15 impulses in 15 minutes with no holding tone applied at a threshold of 47 dBrnC0.

<=15 impulses in 15 minutes with a –13 dBm0 tone at 1004 Hz at a threshold of 65 dBrnC0.

These should be met for both the on-hook and off-hook transmission path. For a line under test, other lines on the MTA should be active (off-hook, dialing, ringing, etc.).

7.4.13 Intermodulation Distortion

R2 > 43 dB using a –13 dBm0 input signal.

R3 > 44 dB using a –13 dBm0 input signal.

R2 and R3 are the 2nd and 3rd order intermodulation products measured using the IEEE 743-1984 4-tone method.

7.4.14 Single Frequency Distortion

Using a 0 dBm0 input signal between 0-12 kHz, the output between 0-12 kHz <-28 dBm0.

Using a 0 dBm0 input signal between 1004-1020 Hz, the output between 0-4 kHz <- 40 dBm0.

7.4.15 Generated Tones

<-50 dBm0 between 0-16 kHz.

7.4.16 Peak-to-Average Ratio

P/AR > 90 with a –13 dBm0 input level. On-hook and off-hook transmission paths.

7.4.17 Channel Crosstalk

With a 0-dBm0 signal between 200-3400 Hz applied to a line, other lines on the MTA <-65 dBm0 C message weighted output between 200-3400 Hz.

8 RF DOWNSTREAM

The RF downstream interface is DOCSIS 2.0 compliant:

Frequency Range	88 MHz to 860 MHz
Modulation	64-QAM or 256-QAM
Data Rate (Max.)	30,34 Mbps for 64-QAM 42,88 Mbps for 128-QAM
Bandwidth	6 MHz
RF Input Sensivity Level	-15 dBmV to +15 dBmV
Input Impedance	75 Ω

9 RF UPSTREAM

The RF upstream interface is DOCSIS 2.0 compliant:

Frequency Range	5 MHz to 42 MHz
Modulation	QPSK 8-QAM, 16-QAM, 32-QAM, 64-QAM
Data Rate (Max.)	10,30 Mbps for QPSK 15,48 Mbps for 8-QAM 20,54 Mbps for 16-QAM 25,80 Mbps for 32-QAM 30,96 Mbps for 64-QAM
Bandwidth	200 kHz to 6,4 MHz
RF Output Level	+8 dBmV to 58 dBmV for QPSK +8 dBmV to 55 dBmV for QAM
Output Impedance	75 Ω

10 REFERENCES

[1] "PacketCable Specification – Version 1.0"
Cable Television Laboratories Inc. / MCNS
Available at www.PacketCable.com

[2] "PacketCable Specification – Version 1.0 – Embedded MTA Primary Line Support Specification", PKT-SP-EMTA-PRIMARY-I01-001128
Cable Television Laboratories Inc. / MCNS
Available at www.PacketCable.com

[3] "Data-Over-Cable Service Interface Specifications – Version 2.0"
Cable Television Laboratories Inc.
Available at www.cablemodem.com