Proactive Network Maintenance
R&D Wired

June 2022

CableLabs®

Upstream Priorities for Reliable Proactive Network Maintenance

A PNM Working Group Point of View

Prepared by
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1 Objective

Provide a list of priorities for calendar year 2022 to help move forward the industry in aligning vendors and MSOs to ensure enhanced reactive and proactive troubleshooting methodologies with an end goal of providing best in class services to our end users - our subscribers.

It is the expectation of the CableLabs PNM-WG that operators and vendors can use this document to prioritize development and deployment to support more reliable access services. With sufficient support from operators, reflected in their requests to vendors to support these prioritized requirements as interpreted from existing CableLabs DOCSIS® specifications, vendors will clearly know where to prioritize their CMTS functionality to enable the industry to support reliable access network services.

2 Definitions

CCAP - Converged Cable Access Platform

CMTS - cable modem termination system

Free Running - as defined in section 7.3.5.2.2 and 7.3.5.2.3 of the CM-SP-CCAP-OSSIv3.1-I17, FreeRun, which is short for Free Running, is the one of many modes of operation for UTSC. Free running is the simplest mode which causes the CCAP (or RPD) "to begin the collection of the configured Impulse Noise events. If the FreeRunDuration is set to a value greater than zero, the StartTriggerLevel is ignored and measurement of the signal power at the RF port begins when the Enable is set to true." Essentially, Free Running provides the end user with a similar experience they would have with hardware-based spectrum analyzers, in which case the upstream spectrum continues to update without intervention from the user.

Kafka Bus - is a framework implementation of a software bus using stream-processing.

MER - Modulation error ratio.

OFDMA - Orthogonal Frequency Division Multiple Access. It is a form of multi-carrier modulation.

R-MACPHY - A fiber node where both the DOCSIS MAC and DOCSIS PHY are collocated in the node.

RPD – A remote PHY device, a physical layer converter device whose functions are to convert downstream DOCSIS data, MPEG video and out-of-band (OOB) signals received from a CCAP Core over a digital fiber network.

RMD – A remote MACPHY device.

RxMER - Receive modulation error ratio. This is the MER measurement for each subcarrier in OFDM and/or OFDMA channels.

PHY – Physical Layer. Layer 1 in the Open System Interconnection (OSI) architecture; the layer that provides services to transmit bits or groups of bits over a transmission link between open systems and which entails electrical, mechanical and handshaking procedures.

SC-QAM - Single carrier quadrature amplitude modulation. These are typically 6 MHz wide QAM channels carrying video or DOCSIS data.

SNMP - Simple network management protocol.

TFTP - Trivial file transfer protocol.

UTSC – As defined in section 7.3.5 of the CM-SP-CCAP-OSSIv3.1-I17, UTSC stands for Upstream Triggered Spectrum Capture. From section 7.3.5.1 of the OSSIv3.1: "The purpose of upstream capture is to measure plant response and view the underlying noise floor, by capturing at least one OFDMA symbol during a scheduled active or quiet probe. An active probe provides the partial functionality of a network analyzer, since the input is known, and the output is captured. This permits full characterization of the linear and nonlinear response of the upstream cable plant. A quiet probe provides an opportunity to view the underlying noise and ingress while no traffic is being transmitted in the OFDMA band being measured."

vCMTS – virtual CMTS.

3 PNM Data Collection from CCAP

As a refresher, DOCSIS 3.1 introduced a new set of requirements on the CM and CCAP related to the collection and reporting of PNM data (see [PHY v3.1], Section 9, "Proactive Network Maintenance"). DOCSIS 3.1 introduced a new Bulk-Data Transfer mechanism that uses TFTP to upload PNM data to a destination TFTP server. Configuration of the PNM test execution, file storage, and TFTP destination uses SNMP as defined in [CM-OSSIv3.1] and [CCAP-OSSIv3.1]. Figure 1 below illustrates the steps and communication paths involved in collecting PNM data from a CM or CCAP device.

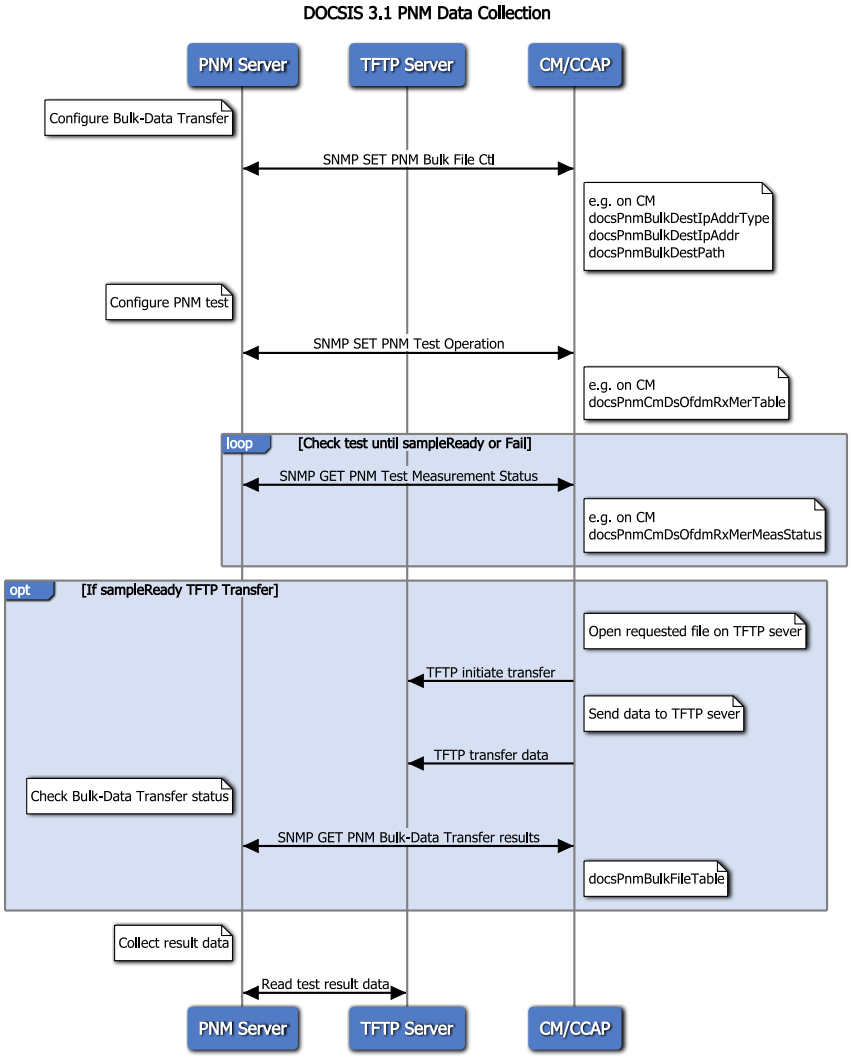

Figure 1 - Data Collection Sequence Diagram

The result of a successful PNM test and file upload is a PNM test result file that a PNM application can read and analyze. By default, each PNM test result file name contains the PNM test, a device identifier such as the CCAP identifier, and a timestamp. The PNM test file is a binary data file containing a header and a data section as defined in [CM-OSSIv3.1] and [CCAP-OSSIv3.1].

In the latest version of the CCAP-OSSIv3.1 specification the configuration table on the CCAP was changed based on the PNM-WG recommendations to better support multiple applications, but the high level mechanism of SNMP configuration request followed by TFTP upload from the CCAP remains the same.

4 Proposed 2022 Priorities

The following is a list of 2022 priorities in order. These are proposals and are subject to change if consensus within the working group is achieved to re-order the following proposal.

1. Require support for TFTP upload of data for all PNM test supported by the CCAP. This is already a MUST requirement in the OSSI specification but is not universally supported. Additionally, CCAPs should implement the latest Bulk File Transfer mechanism with support for TFTP as specified in CCAP-OSSIv3.1N-22.2232-1 or alternatively the previous CCAP Bulk Data Transfer mechanism with support for a TFTP destination per PNM test.
2. Enable support for Upstream Triggered Spectrum Capture (UTSC) across all CMTS vendors. If the CMTS (vCMTS, R-MACPHY, RPD) supports DOCSIS 3.1 or higher, then it MUST include support for UTSC.
    1. It is recommended that if a vendor does not currently support UTSC that they first implement the free-running method of UTSC (i.e., crawl before you walk), then work to implement UTSC fully as specified.
    2. It is recommended that if a vendor does not currently support UTSC that they first implement TFTP as a method for sending UTSC data to the PNM server, then enable additional methods as specified for the architecture (e.g., L2TP from the RPD).

Note that while UTSC is possible today for a number of CMTS hardware-software combinations, all known deployments require proprietary elements, and none follow the specification, so the industry generally does not have functional UTSC.

3. Enable the ability to obtain OFDMA MER (RxMER) from the CMTS in a quicker and more efficient method. The current mechanism for collecting OFDMA RxMER data is slow as the data can only be requested for a single modem at a time for any OFDMA channel. For PNM and PMA applications that need to periodically collect the data for all cable modems, this serial request for each modem is slow and problematic. The requested enhancement would be to provide a mechanism to collect these data faster for all cable modems on the CCAP. Two suggested methods would be as follows:
    1. Modify the existing definition of the docsPnmCmtsUsOfdmaRxMerCmMac to allow the use of a wildcard or null MAC address. This would indicate to the CCAP to return RxMER data for matching or all modems on the interface. The resulting uploaded measurement file would then contain a result block for each modem.
    2. Enable the CMTS to stream RxMER data over a Kafka bus.
4. Specifically for the above two items (and ultimately for all OSSI related specifications), vendors should provide clear, consistent, accurate requests and responses across platforms.
    1. This means following the specification and being able to demonstrate that as a vendor, one can demonstrate they are following the specification.
    2. Vendors MUST follow the existing OSSI specification OR provide clear documentation of deviations from the specification.

        a) Example 1: If vendor “A” configures UTSC using the majority of the UTSC specification, but deviates from the UTSC specification to require the end user to SSH into the CCAP and download the capture file, this MUST be incumbent on the vendor to produce clear and concise documentation on how and why the vendor has deviated from the specification. Further, the vendor MUST provide documentation and code examples of how to use the “new” methods they have chosen to adopt.
        b) Example 2: If vendor “B” configures UTSC using a minority of the UTSC specification or a proprietary implementation, it is required that the vendor provide a comprehensive guide on the complete usage of their UTSC/proprietary implementation along with sample code in order to expedite the

implementation. In this case, vendor "B" must produce more documentation and code because they have deviated further from the specification than vendor "A".

c) In either case of Example 1 or 2 above, both vendors MUST provide documentation and code samples which represent the areas they have deviated from the specification so that a) they can demonstrate a working UTSC analyzer at CableLabs Interop events and b) third parties (MSOs and vendors) can reproduce a working implementation of the UTSC analyzer using the vendor CCAP and/or RPD.

d) Using parameters "A", "B" and "C" and returns parameters "X", "Y" and "Z" per the OSSI specification, one would expect that when using any vendor's platform, it should be possible to configure UTSC using the same parameters "A", "B" and "C" and get the same return parameters "X", "Y" and "Z".

2. Though amplitude values would be different, the Configuration and expected output formatting should be identical and follow the OSSI specification.
3. Vendor consistency in reporting the format and units, regardless the delivery mechanism, for both UTSC and RxMER data must be consistent and well defined in the specification.

5 End notes

- UTSC is mentioned several times in PHYv3.1, but never defined - thought that was interesting.
- UTSC is never mentioned in the MULPIv3.1 - I also thought that was interesting
- UTSC is also mentioned in the CM-SP-PHY document many times, but again never defined
- Output formats fftPower, fftAmplitude, etc are mentioned in the CCAP OSSI specification but their format is not defined. For UTSC the file format describes the number of bytes occupied in the file by the various output formats, eg 4 bytes for fftPower, but the encoding of these bytes for each of the output formats is not defines. Current vendor implementations deviate in the format of these bytes, and even across different port types, integrated vs RPHY. The specifications should be updates to clearly define the required format for each and vendors should provide documentation and guidance around existing formats until compliant.

CCAP-OSSIv3.1-N-16.1536-6	8/11/2016	CCAP PNM Upstream Triggered Spectrum Capture update	Luehrs

CCAP-OSSIv3.1-N-16.1592-1	9/8/2016	Annex A updates for Upstream Spectrum Analysis feature	Hedstrom

6 References

[CCAP-OSSIv3.1]	DOCSIS Converged Cable Access Platform Operations Support System Interface Specification, CM-SP-CCAP-OSSIv3.1-I22-220216, February 16, 2022, Cable Television Laboratories, Inc.
[CM-OSSIv3.1]	DOCSIS 3.1 Cable Modem OSSI Specification, CM-SP-CM-OSSIv3.1-I20-210716, July 16, 2021, Cable Television Laboratories, Inc.
[PHYv3.1]	DOCSIS 3.1, Physical Layer Specification, CM-SP-PHYv3.1-I18-210125, January 25, 2021, Cable Television Laboratories, Inc.