

USING DOCSIS DOWNSTREAM CODEWORDS FOR A QUALITY OF
SERVICE/OUTAGE INDICATOR

INVENTORS:

THOMAS HOLTZMAN WILLIAMS

JASON W. RUPE

CableLabs[®]

Idea: PNM with Codeword Counters

CableLabs

Tom Williams Distinguished Technologist

t.williams@cablelabs.com

June 24, 2020

© CableLabs 2018. Do not share this information with anyone other than members, and vendors under NDA if applicable.

Downstream Service Monitoring Using Codeword Counters

- CMs are short on providing a history of the service they provided. e.g. cannot tell a power outage from a network outage, even when the CM is back in service
- DOCSIS™ Single Carrier (SC) downstreams have codeword counters that are 32-bit integers
 - Total codewords = unerrored + errored + corrected
 - They roll over when they hit the maximum time (2^{32} cw)
 - They can be polled more frequently than the rollover time
 - On a power outage, recycle, forced retune, counters are reset
 - DOCSIS SC has multiple bonded channels each with counter data

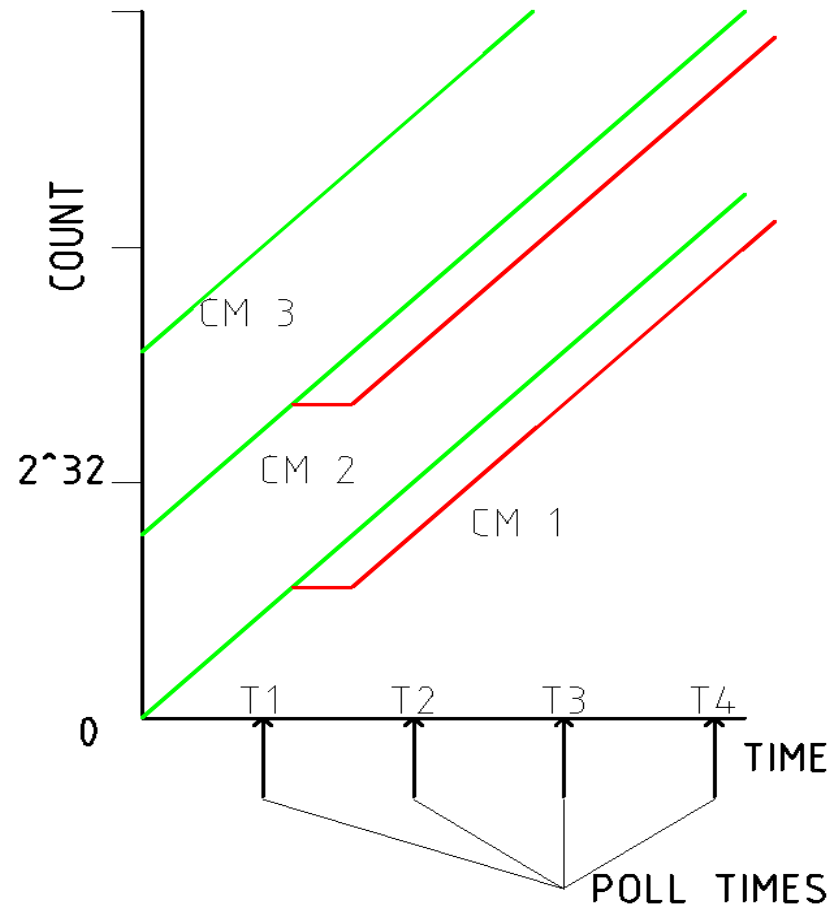
Correctable and Uncorrectable codeword MIBs

- docslf3CmtsCmUsStatusCorrecteds
OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This attribute represents the
codewords received
with correctable errors from the CM
on this upstream
channel. Discontinuities in the value
of this counter
can occur at re-initialization of the
managed system,
and at other times as indicated by
the value of
ifCounterDiscontinuityTime for the
associated upstream
channel."
REFERENCE
"RFC 2863."
 ::= { docslf3CmtsCmUsStatusEntry 8 }

- docslf3CmtsCmUsStatusUncorrectables
OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This attribute represents the
codewords received
with uncorrectable errors from the
CM on this upstream
channel. Discontinuities in the value
of this counter
can occur at re-initialization of the
managed
system, and at other times as
indicated by the value of
ifCounterDiscontinuityTime for the
associated upstream
channel."
REFERENCE
"RFC 2863."
 ::= { docslf3CmtsCmUsStatusEntry 9 }

SC Count Behavior with and without Impairment

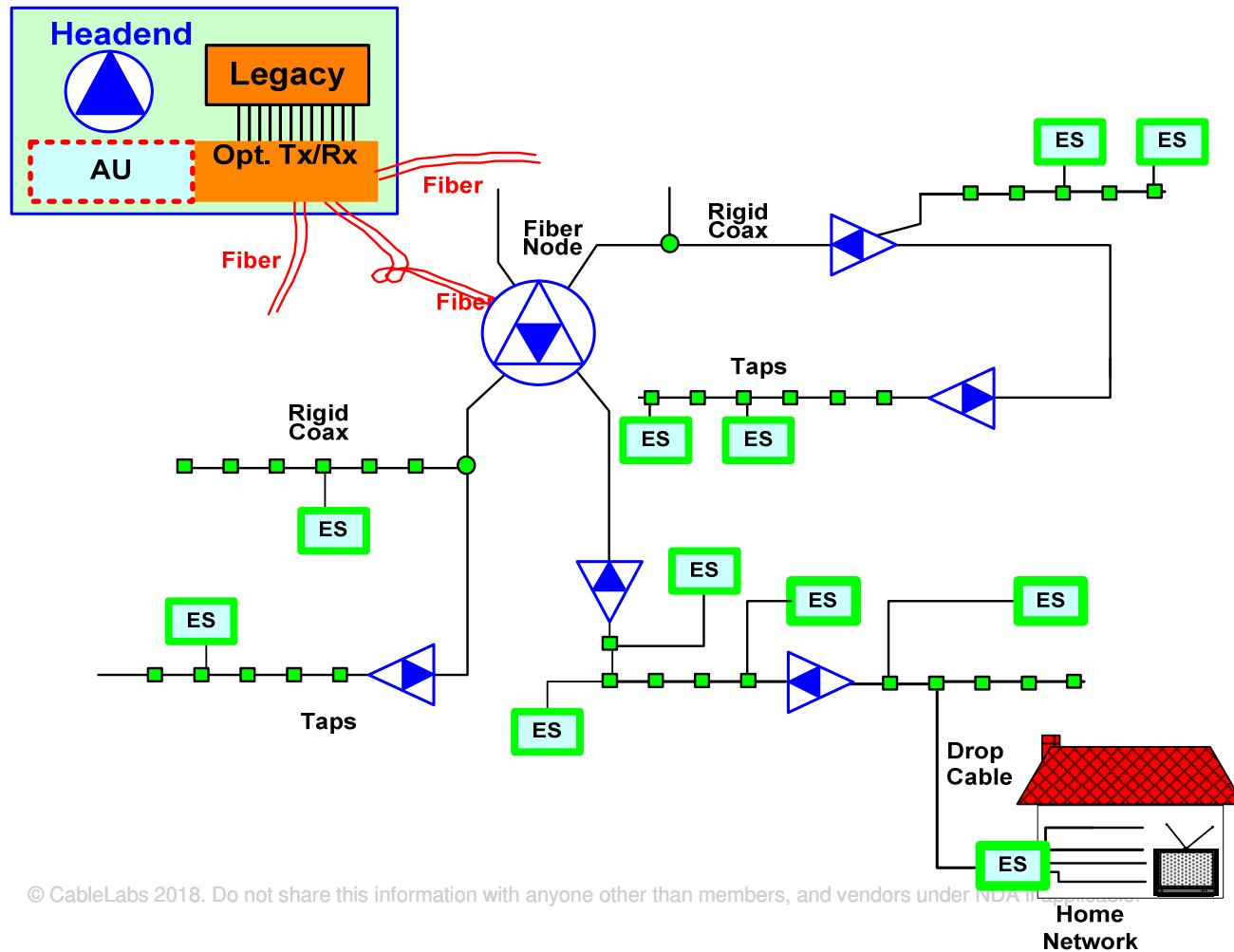
- Plot is (total) counts vs. time
- CM3 has no impairments and counts are where they are expected to be at all 3 subsequent poll times (T2, T3, T4)
- CM1 and CM2 have an outage between T1 and T2 and have a codeword shortage. Service is okay between T2 and T4
- $M = (cw2 - cw1) / (time2 - time1)$, where $cw\#$ is codeword count, M is slope, and has an expected value for excellent service



What Codeword Count Can Tell Us CableLabs®

- Who, Where, What Happened, and History
- Codeword counts make a compact data set
- Common counts tell us there was a regional power outage, and which houses were affected
- Count discontinuities reveal lousy (or dodgy) service between poll times, as a percentage
 - Correctables can indicate a problem, but no damage to service
 - Uncorrectables can indicate a problem, plus the duration
- Applications for Machine Learning (ML)
 - Cross-correlation of low codeword counts with CSR calls, disconnects
 - Overlap with LTE frequencies
 - M value vs. cascade length
- Common delta counts in a cluster reveal point (location) of failure

Homes with Common Count Deficits Locate Impairments



Applications for OFDM

- DOCSIS 3.1 and 4.0 have a PLC with associated codeword counters
 - `docslf31CmDsOfdmChanPlcTotalCodewords` M RO
 - `docslf31CmDsOfdmChanPlcUnreliableCodewords`
- Codeword counts should increment uniformly with time
- So same technique used for SC can be used for multi-carrier, at least for the robust PLC portion of the spectrum

DOCSIS 3.0 downstream carriers are 6MHz wide in the US and deliver data codewords at a constant rate. There are MIBs, listed in background, that report unerrored, uncorrectable, and correctable codewords. If those numbers are read, timestamped, and summed, a delta calculation can be made between two time intervals. If the delta total number of codewords is not as expected, an outage percentage in the delta time interval can be calculated. Note this may have occurred on a CM because of power cycling. If the uncorrectable to total codewords ratio is calculated, another predictor can be made about downstream signal quality.

Background *

docsIf3CmtsCmUsStatusUnerrored OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute represents the codewords received without error from the CM on this interface. Discontinuities in the value of this counter can occur at re-initialization of the managed system, and at other times as indicated by the value of ifCounterDiscontinuityTime for the associated upstream channel."

REFERENCE

"RFC 2863."

::= { docsIf3CmtsCmUsStatusEntry 7 }

docsIf3CmtsCmUsStatusCorrected OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute represents the codewords received with correctable errors from the CM on this upstream channel. Discontinuities in the value of this counter can occur at re-initialization of the managed system, and at other times as indicated by the value of ifCounterDiscontinuityTime for the associated upstream channel."

REFERENCE

"RFC 2863."

::= { docsIf3CmtsCmUsStatusEntry 8 }

docsIf3CmtsCmUsStatusUncorrectables OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute represents the codewords received with uncorrectable errors from the CM on this upstream channel. Discontinuities in the value of this counter can occur at re-initialization of the managed system, and at other times as indicated by the value of ifCounterDiscontinuityTime for the associated upstream channel."

REFERENCE

"RFC 2863."

::= { docsIf3CmtsCmUsStatusEntry 9 }

Abstract

The unerrored, correctable and uncorrectable DOCSIS downstream codewords are added and timestamped at two time intervals. If the total number of codewords is not as expected, a percentage of time outage can be declared. The ratio of uncorrectable to total codewords provides a second indicator of service quality.