LIVELEARNING WEBINARS™ FOR PROFESSIONALS

Proactive Network Maintenance for DOCSIS 3.1

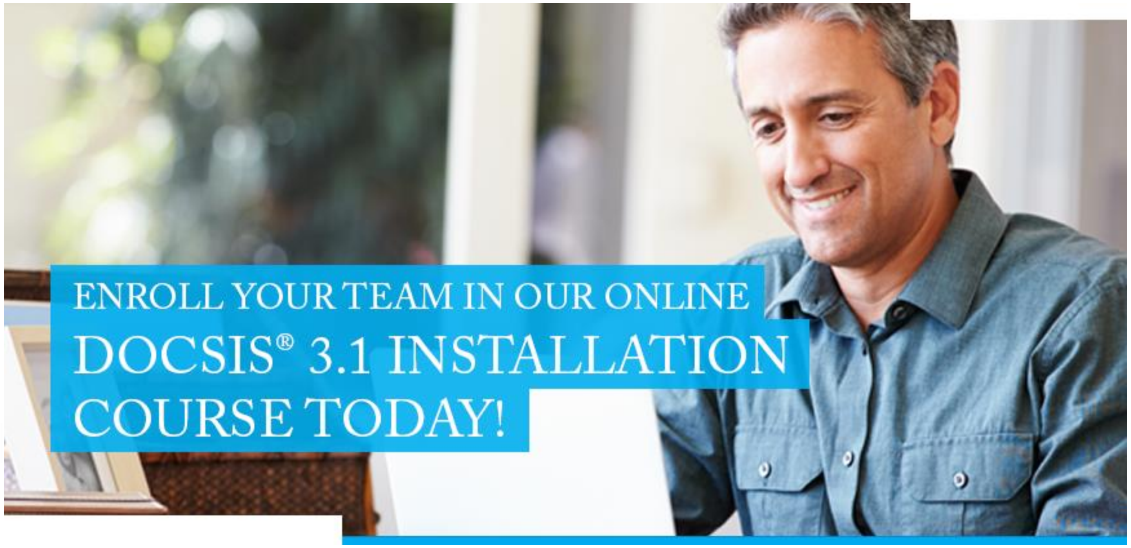
Thursday, November 30, 2017
2:00-3:00pm ET (11:00am PT)

SCTE • ISBE in partnership with BTR BROADBAND TECHNOLOGY REPORT

Today's Webinar is sponsored by:

WSE

VeEX The Verification Experts



Our industry-leading online DOCSIS 3.1 installation course is designed to give your broadband installation professionals a better understanding of the operational implications of DOCSIS 3.1, as well as procedures for installation and methods used for troubleshooting.

FOR MORE INFORMATION OR TO REGISTER:
SCTE.ORG/DOCSIS

PROACTIVE NETWORK MAINTENANCE

The proactive network maintenance (PNM) course prepares broadband professionals to better understand the elements and implementations of the multiple tools and techniques inside of the PNM tool kit.

This course teaches participants what proactivity truly is and how it applies to their everyday jobs. It also details: different PNM technologies such as pre-equalization and how it addresses plant problems, how it works within DOCSIS® and how it can be used to identify and locate plant problems.

FOR MORE INFO & TO REGISTER GO TO:

https://www.scte.org/SCTE/Events/Event_Display.aspx?EventKey=PNM0000000

Today's Speakers

Randy Harmon

Director of Operations

White Sands Engineering

Jason Rupe

Principal Architect for Proactive Network Maintenance

CableLabs

Brady Volpe

Founder and CEO

The Volpe Firm and Nimble This

Nitish Khullar

Product Manager, HFC Monitoring Platform

VeEX

Our first speaker:

Randy Harmon

- Director of Operations, White Sands Engineering
  - Started the company in his garage
  - Now WSE is the largest manufacturer of custom coaxial cable, fiber assemblies and connectivity products in the United States.

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Assemblies RF Requirements

COMPLETED ASSEMBLIES SHALL BE 100% TESTED TO MEET THE FOLLOWING RF RETURN LOSS AND INSERTION LOSS PARAMETERS (5 MHz - 1.2 GHz):

RETURN LOSS <-23dB MAX PEAK.

INSERTION LOSS (5-1002MHz) <1.3db.

INSERTION LOSS (1002MHz-1.2GHz) <1.45db.

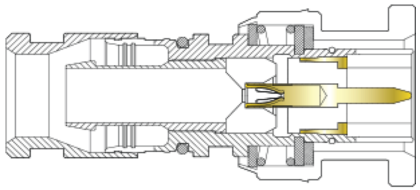
RF performance for DOCSIS 3.1

Ensuring consistent RF performance within a systems.

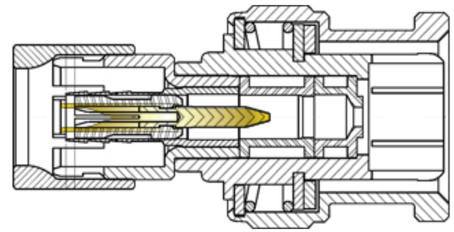
1. Optimize all the mating positions:
   a. Coax center conductor to the connector pin
   b. Connector pin to the mating connector pin

2. Pin height on male pins and contact position on female pins is critical to ensure the entire cable/connector system performance is optimal as a complete system.

Fixed Pin vs. Sliding Pin

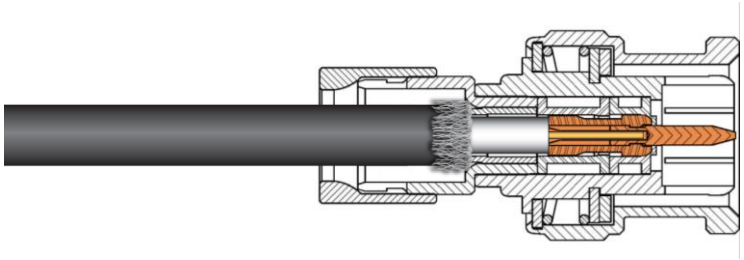


vs.



Blind Entry
(Fixed Pin)

Non-Blind Entry
(Sliding Pin)



RF conductivity performance for DOCSIS 3.1

Any part where the pins heights/depths could vary in the final product opens itself up to reduced performance if not controlled correctly.

This includes the female receptacle mating interface.

Adjustments to the waveguide (tuning) within the bodies of the connectors can only achieve maximized RF performance if all mating positions are correct and consistent.

Our second speaker:

Jason Rupe

Principal Architect for Proactive Network Maintenance, CableLabs

- Wide range of experience, from teaching to research
- Includes work at communications service providers
- Active in IEEE and IIE

LIVELEARNING WEBINARS™ FOR PROFESSIONALS

DOCSIS® 3.1 Proactive Network Maintenance

Thursday, November 30, 2017
Jason Rupe, Ph.D., Principal Architect
CableLabs
j.rupe@cablelabs.com

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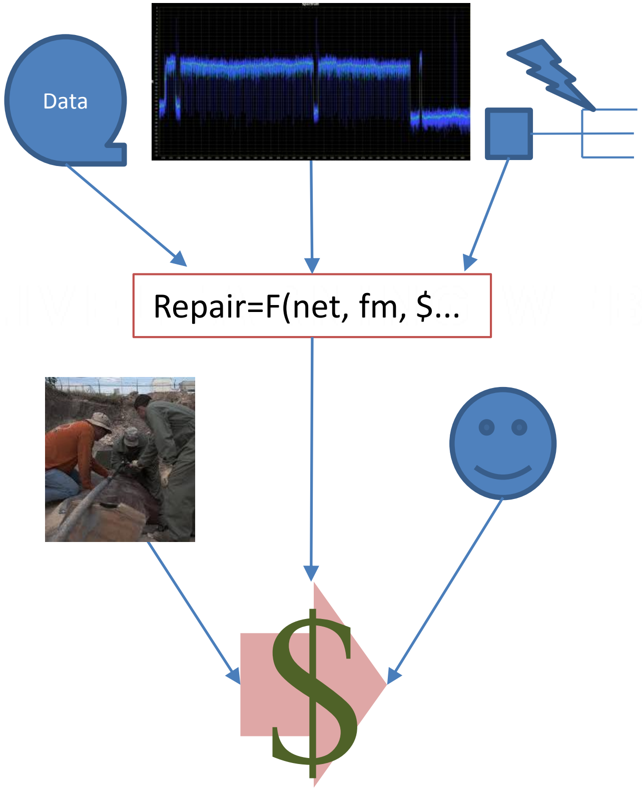
Elements of a D3.1 PNM Program



- Accurate assessment of network failure modes which lead to service calls.
- Baseline view of impairments on the network that relate to the failure modes.
- Models that predict the impairments' transitions to failures and service calls.
- Technologies that help you cheaply and accurately find and remove those impairments.
- Leadership to join and keep it all together.

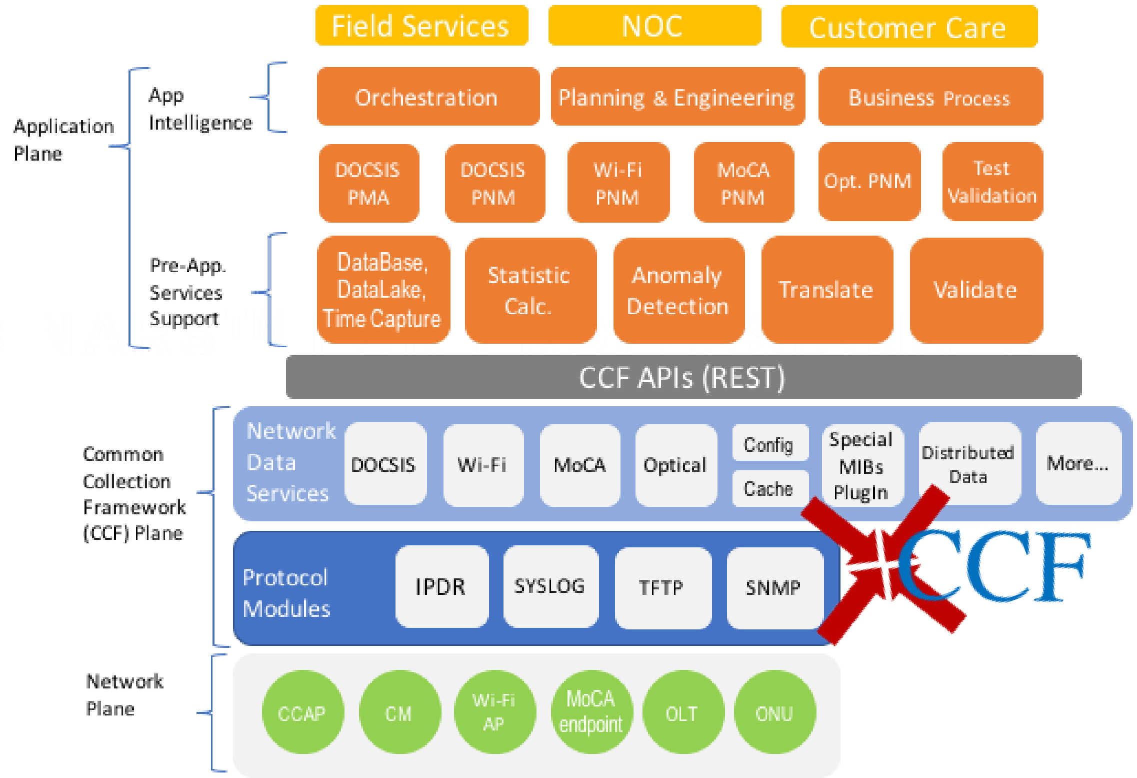
Reference Stack

Multiple layers within the application layer:

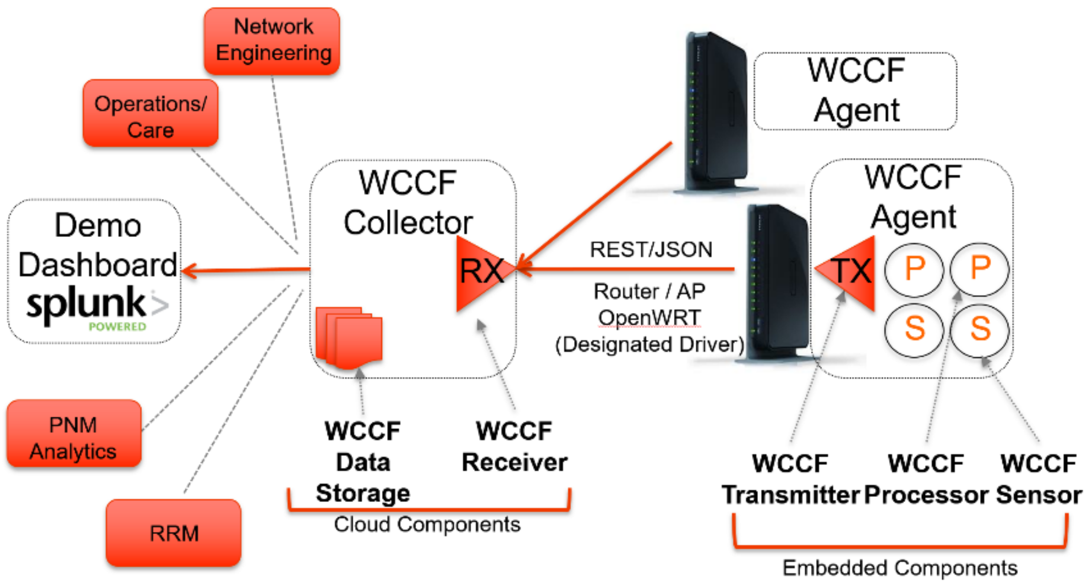
- Application services for shared functionality,
- Decoupled elements for efficiency and effectiveness.

Packaging around existing XCCF for resiliency and ease of implementation.

Decoupled XCCF elements for wide and free use.



Wi-Fi PNM


Network Engineering
Operations/ Care
Demo Dashboard
splunk
POWERED
PNM Analytics
RRM
WCCF Collector
RX
WCCF Data Storage
WCCF Receiver
Cloud Components
WCCF Agent
REST/JSON
Router / AP
OpenWRT
(Designated Driver)
WCCF Agent
TX
P
P
S
S
WCCF Transmitter
WCCF Processor
WCCF Sensor
Embedded Components

Proactive Maintenance Decisions

$$\$_{repair} * Pr(\text{eventual failure}) > \$_{\text{proactive maintenance}}$$

- When the expected future cost of a possible reactive maintenance is greater than the cost of a proactive truck roll, proactive maintenance saves money.
- But how do you know a network condition will lead to eventual failure? And if it will, then when?
- What is the real cost of a repair, when we consider urgency, overtime, customer goodwill, multiple customers being impacted, and other complex factors?
- What is the real cost of a proactive repair if I can cluster work and plan it for optimal cost?

$$E(\#\ \text{Failures}) > \$_{\text{proactive maintenance}} / \$_{repair}$$

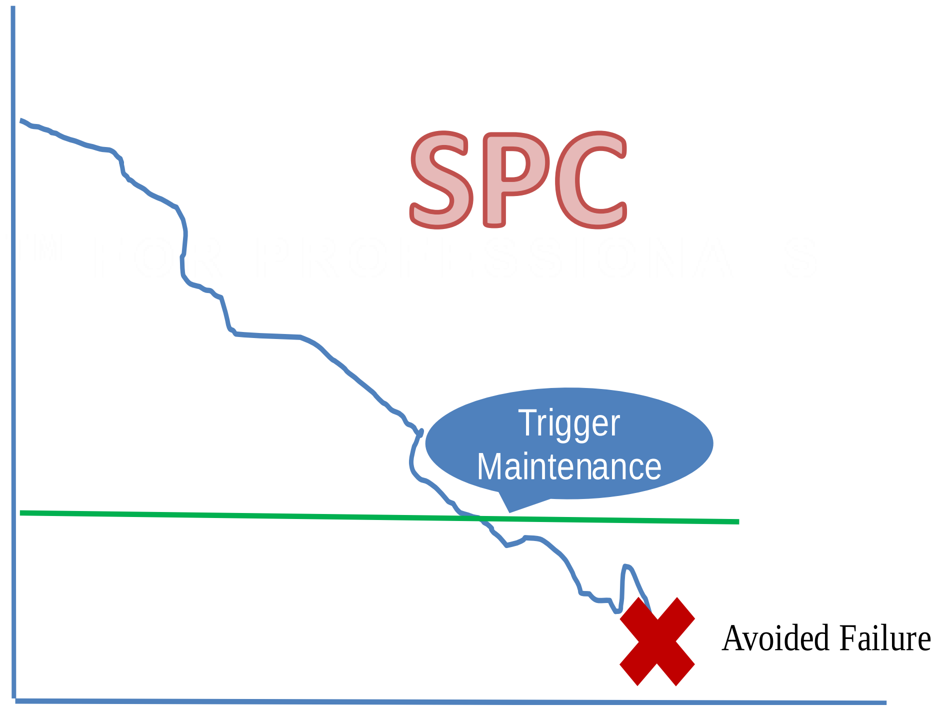
Decisions, decisions…

Do you have enough information to know:

- ✓ That you have an impairment
- ✓ Where the impairment is
- ✓ How likely it is to turn into a problem (repair call, capacity issue, quality reduction)
- ✓ How long you have to address it proactively

Analysis reduces these sources of uncertainty.

- But how much certainty is required in your case?



Developing PNM

Bridge the gap between problem and solution.
Make PNM cheaper, easier, faster, and safer to implement.
Connect the disconnected elements so they can function together.

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More information

- DOCSIS® 3.1 Common Collection Framework (DCCF) Architecture Technical Report:
  CM-TR-DCCF-PNM-V01-171010
- Wi-Fi PNM Common Collection Framework Technical Report:
  WR-TR-PNM-WCCF-V01-171010
- PNM Series: The Business Case for a Common Collection Framework

CableLabs®

Thank you!

Our third speaker:

Brady Volpe

Founder and CEO, The Volpe Firm and Nimble This

- The Volpe Firm is a technical telecommunications company
- Nimble This is a PNM company
- Has 25+ years of broadband cable and telecommunications industry experience

Our fourth speaker:

Nitish Khullar

Product Manager, HFC Monitoring Platform, VeEX Inc.

- Joined VeEX in 2013
- Formerly at Sunrise Telecom

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PNM Before DOCSIS 3.1

Pre-Equalization

- Detect upstream impairments
- Localize groups of modems for common impairments
- Detect in-home impairments
- Detect intermittent modems

Upstream spectrum analysis using CMTS

Downstream spectrum analysis using CM

Nevertheless – We are doing great things with PNM Pre-D3.1

PNM D3.1 Downstream

- ✓ Post-Eq in DS
- ✓ DS Spectrum Analyzer
- ✓ Network Analyzer
- ✓ Vector Signal Analyzer
- ✓ Noise Power Ratio (NPR) Measurement
- ✓ Loads of histograms and statistics

PNM D3.1 Upstream

- ✓ Pre-Eq in US – 40x ↑ accuracy
- ✓ US Spectrum Analyzer
- ✓ Network Analyzer
- ✓ Vector Signal Analyzer
- ✓ Noise Power Ratio (NPR) Measurement
- ✓ Loads of histograms and statistics
- ✓ Impulse Noise Statistics

Plus Data Transfer via TFTP !

D3.1 Communications - **Modem Setup Occurs via SNMP**

Test modes from DOCS-PNM-MIB

- dsSpectrumAnalyzer(2)
- dsOfdmSymbolCapture(3)
- dsOfdmChanEstCoef(4)
- dsConstellationDisp(5)
- dsOfdmRxMERPerSubCar(6)
- dsOfdmCodewordErrorRate(7)
- dsHistogram(8)
- usPreEqualizerCoef(9)

- EX: snmpset -v2c -c private 10.1.4.10 dsOfdmRxMERPerSubCar.79 i 1

D3.1 Communications – Data Retrieval Occurs via TFTP

Trivial File Transfer Protocol – TFTP

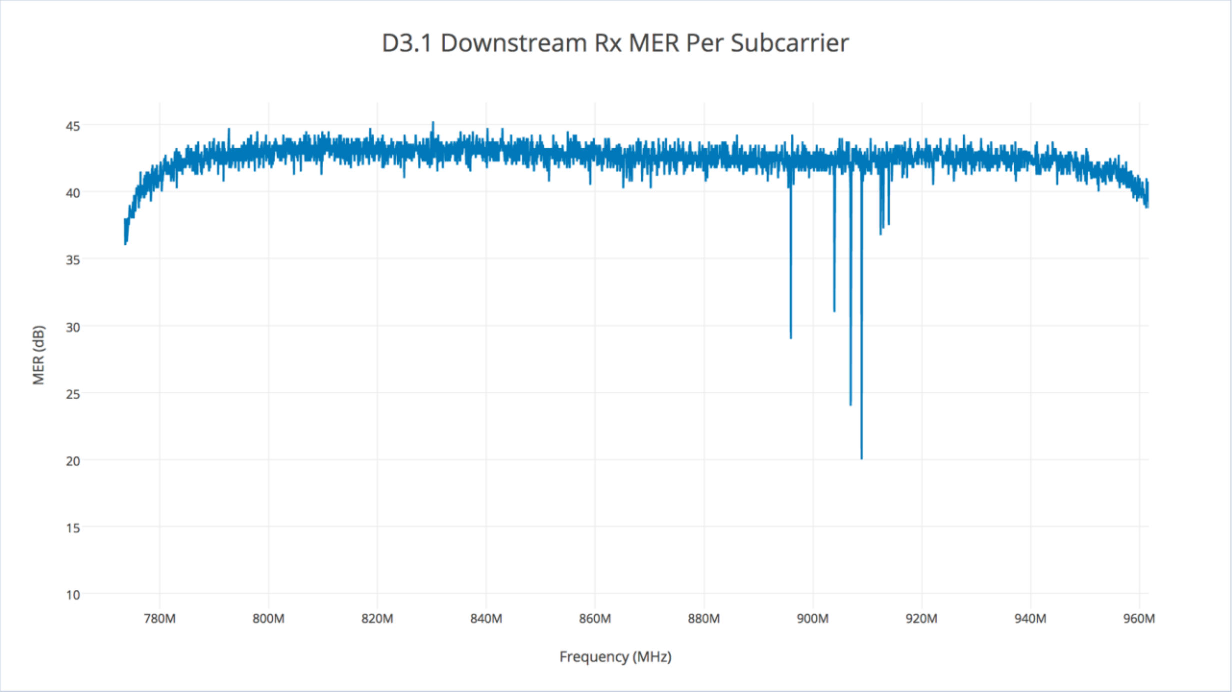
- Much faster and efficient than SNMP
- Data can be returned automatically or upon request
- Data must be processed to be viewed

TFTP File Format Example for RxMER per Subcarrier

Element	Size	Hex	Decimal
FileType	4 Bytes	504E4D04	1347308804
CaptureTime	4 Bytes	587CBEFB	1484570363
DS Channel ID	1 Byte	9F	159
CM Mac Address	6 Bytes	503955845BFA	503955845BFA
Subcarrier Zero Freq in Hz	4 Bytes	2E1C3300	773600000
First Active Subcarrier Index	2 Bytes	00A6	166
Subcarrier Spacing in kHz	1 Byte	32	50
Length in Bytes of Rx MER Data	4 Bytes	00001000	4096

D3.1 RxMER per Subcarrier Example (4069 Bytes)

Raw Data: 504E4D04 587CBEFB 9F503955 845BFA2E 1C330000 A6320000 1000FFFF 98909295 94989491 95959596 9898969B 999C9A9B 9A9A9898 989A9C99 9B9D999D …



DOCSIS 3.1 OFDM Subcarrier Analysis in the Filed and Headend

- Analyze the Subcarrier QAMs contained in the OFDM channel
- Check the Power Level of the OFDM Signal in 6 MHz “Chunks”
- Analyze the MER of each individual Subcarrier
- Analyze the Noise under the OFDM Signal

DOCSIS 3.1 OFDM Subcarrier Analysis Field Meters

Power Scan

MER Scan

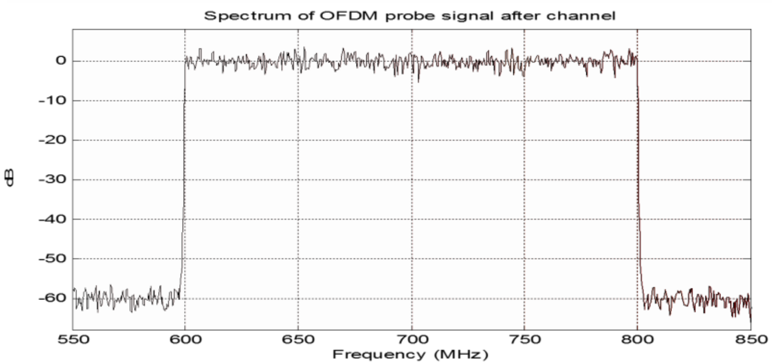
MER & Noise

Noise Floor Scan

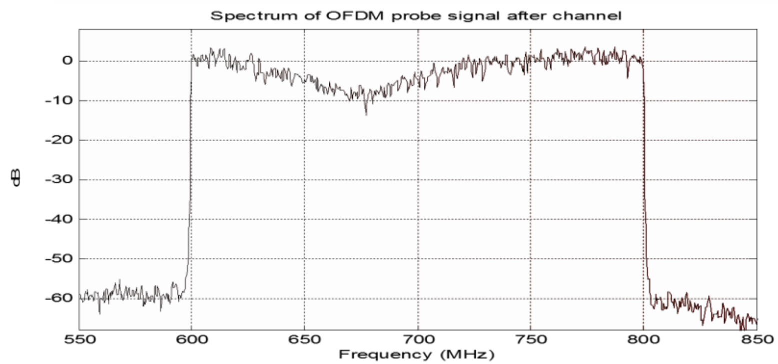
D3.1 PNM DS Symbol Capture

- With known input and output samples, channel can be completely characterized
- Compression, laser clipping, group delay, ingress under carriers, …

Ordinary OFDM symbol is captured by CMTS at input to cable plant



The same received symbol is captured by CM after cable plant

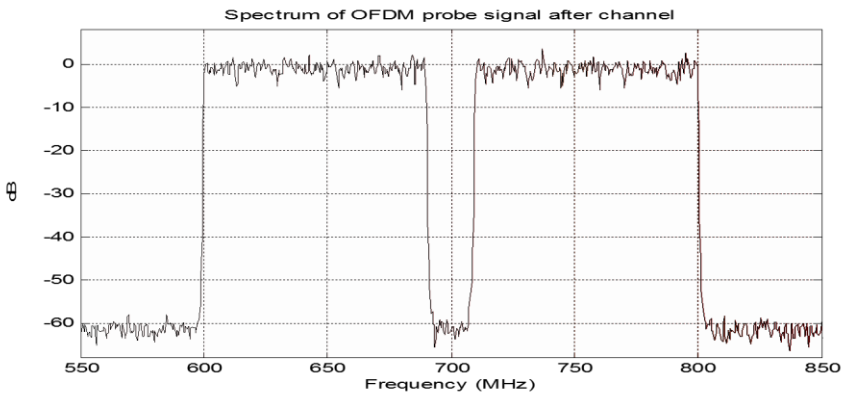


Source: Broadcom

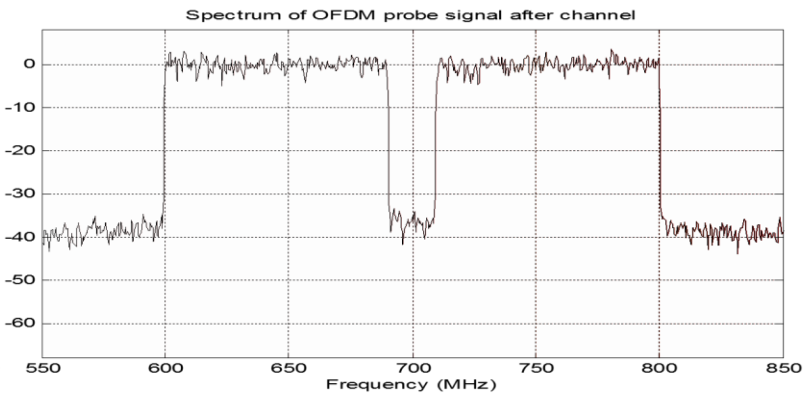
D3.1 PNM Noise Power Ratio

- NPR tests in production HFC plants!
- Notches out impaired subcarriers to see impairments under them

Notch spectrum after passing through clean plant



Notch showing 10 MHz wide LTE Interference at -35 dBc



Source: Broadcom

Summary

- PNM is amazingly powerful TODAY!
- DOCSIS 3.1 has added many exciting features
  - Network Analyzer, VSA, NPR, etc.
  - Still waiting for most features to be supported by vendors
  - ETA on support should be by mid-2018, phased-in
- We know PNM changes plant maintenance today
- With D3.1 PNM we expect even more OPEX and CAPEX savings to be realized

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The Volpe Firm

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It’s Time for Questions

Please submit questions using the Question Tool on your screen.

More Questions?

You can contact our speakers at:

Randy Harmon: rharmon@tvcinc.com

Jason Rupe: J.Rupe@cablelabs.com

Brady Volpe: brady.volpe@volpefirm.com

Nitish Khullar: nkhullar@veexinc.com

Next Month's Webinar

Exploring Cable Mobility

Date: December 11, 2017

Register at: www.scte.org/LiveLearning

The digital disruption has transformed the economy and created the perfect storm for MSOs to offer more than Wi-Fi, emerging as formidable wireless players. This webinar will explore key factors that MSOs should consider and outlines viable strategies for successfully entering the mobile game. Sponsored by Amdocs.

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Thank You!

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