SCTE ISBE **CABLE-TEC**
EXPO '16

SEPTEMBER 26-29 **PHILADELPHIA**

Testing and turn-up of DOCSIS 3.1 services in the HFC network from a field and maintenance technician perspective

Robert J. Flask
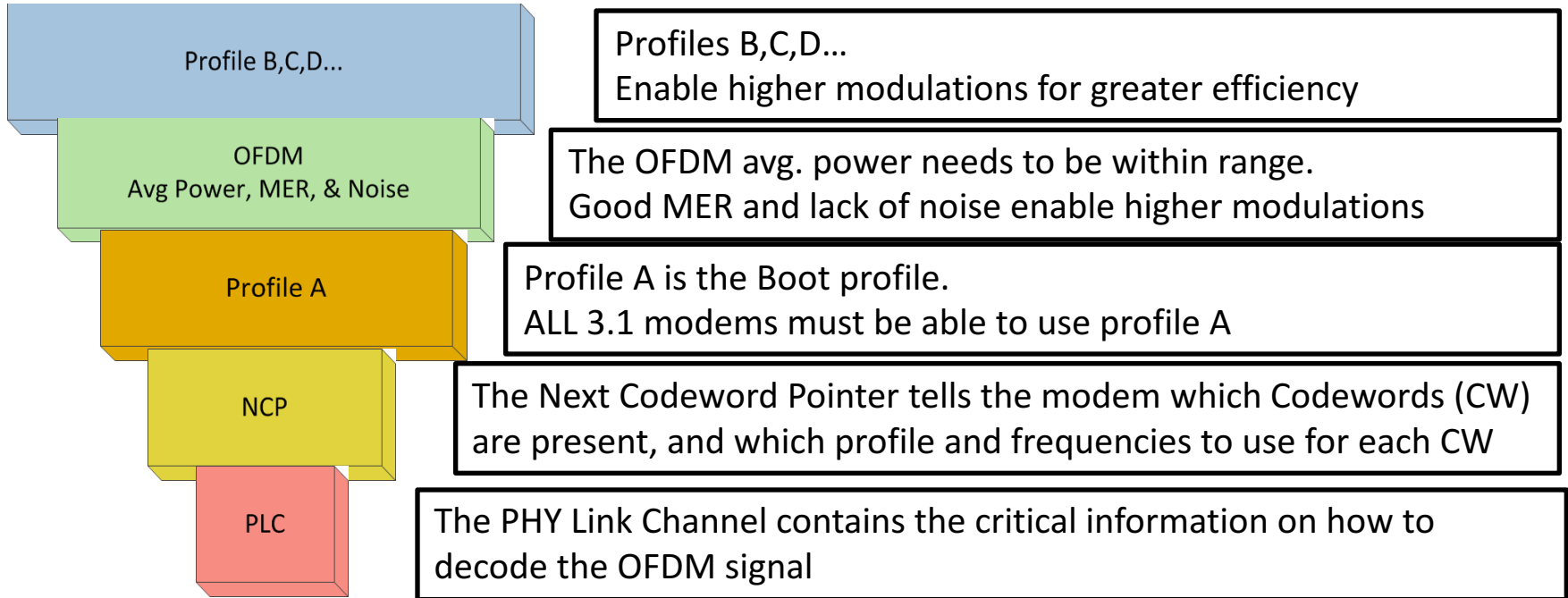
Senior Product Line Manager

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SCTE **Society of Cable Telecommunications Engineers**

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Essential Knowledge for Cable Professionals™

Agenda

- Testing the building blocks of OFDM

- Measuring OFDM power

- Troubleshooting DOCSIS 3.1- real examples

- Profile Optimization

The Building Blocks of OFDM

Block	Description
Profile B,C,D...	Profiles B,C,D... Enable higher modulations for greater efficiency
OFDM Avg Power, MER, & Noise	The OFDM avg. power needs to be within range. Good MER and lack of noise enable higher modulations
Profile A	Profile A is the Boot profile. ALL 3.1 modems must be able to use profile A
NCP	The Next Codeword Pointer tells the modem which Codewords (CW) are present, and which profile and frequencies to use for each CW
PLC	The PHY Link Channel contains the critical information on how to decode the OFDM signal

Building Block Recommended Metrics

Profile B,C,D...

OFDM
Avg Power, MER, & Noise

Profile A

NCP

PLC

Correctable CWE: variable – likely to run with high % of correctable
Uncorrectable CWE: variable – balance btwn. retries and efficiency

Avg LEVEL: >-6 dBmV
Avg MER: > 36dB
MER @ 2nd Percentile: > 35dB

ICFR < 3 dB peak to peak
MER Std Deviation: < 2dB

Uncorrectable CWE: NONE
Lock Status: Locked

If Profile A isn't locked or has Uncorrectable CWE the modem may roll back and use only SC-QAM's in 3.0 mode

Lock Status: Locked
Uncorrectable CWE: NONE

If the NCP isn't locked or has many Uncorrectable CWE the modem may not come online

Lock Status: Locked
Uncorrectable CWE: NONE

Level: > -15dBmV (6MHz)
MER: > 15dB (min)

Building Block Recommended Metrics
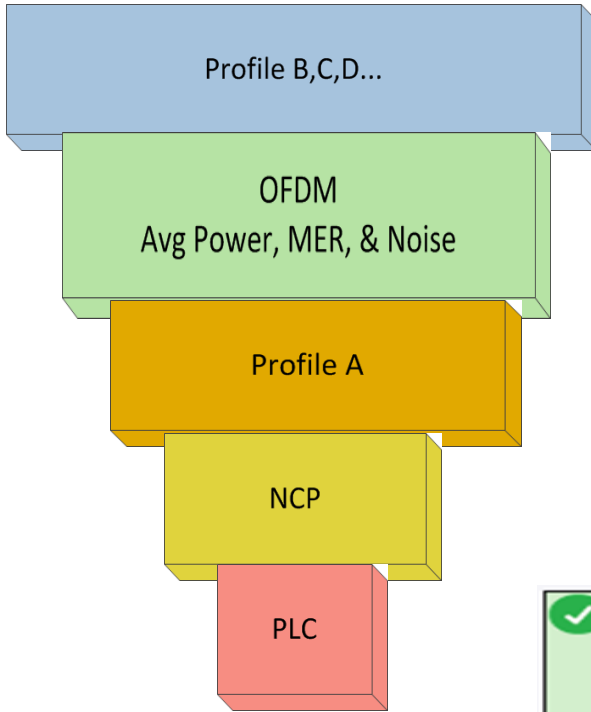
PROFILE	LOCKED	CWE (Corr)	CWE (Uncorr)
A	YES	0.0	0.0
B	YES	1.1e-2	0.0
C	YES	4.2e-1	0.0
D	YES	1.0e+0	0.0

Uncorrectable CWE — Retries

Profile B,C,D...

OFDM
Avg Power, MER, & Noise

Profile A

NCP

PLC
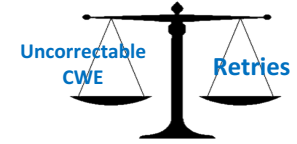
LEVEL (Avg) 8.9 dBmV

MER (Avg) 46.7 dB

MER (Std Dev) 0.7 dB

MER PCTL (2) 45.1 dB

ICFR 2.1 dB

A CWE Corr 0.0

A CWE Uncorr 0.0

NCP CWE Corr 0.0

NCP CWE Uncorr 0.0

PLC LEVEL 11.3 dBmV

PLC MER 43.9 dB

PLC CWE Corr 0.00e+00

PLC CWE Uncorr 0.00e+00

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Profile Analysis – identifying drop issues

	TAP		Ground Block		Outlet	
	Profile Locked?	Uncorrectable CWE	Profile Locked?	Uncorrectable CWE	Profile Locked	Uncorrectable CWE
Profile A	YES	NO	YES	NO	YES	NO
Profile B	YES	NO	YES	NO	NO	YES
Profile C	YES	NO	YES	YES	NO	YES
Profile D	YES	NO	NO	YES	NO	YES

Profile changes highlight problems in drop and or home wiring:

Let's talk about POWER

Average Power vs. Peak Power
Use Average for OFDM and Digital carriers

SC-QAM	DOCSIS 3.1 OFDM Carrier	DOCSIS 3.1 OFDM Carrier
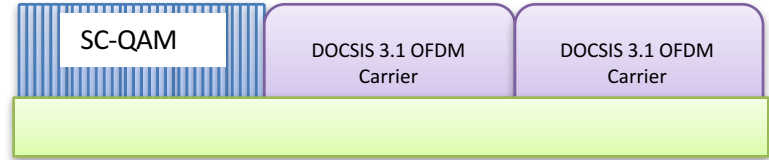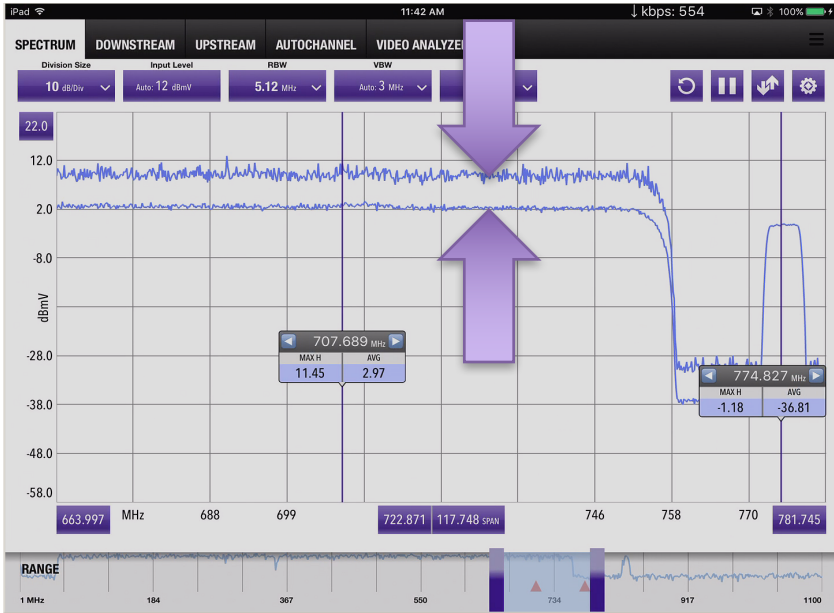
An SLM will do all the work for you

LEVEL (Avg) 10.3 dBmV	LEVEL (Max) 11.3 dBmV	LEVEL (Min) 9.9 dBmV	ICFR 2.0 dB
MER (Avg) 42.1 dB	MER (Std Dev) 1.4 dB	MER PCTL (2) 37.6 dB	Echo -41.5 dBc

Using an Analyzer

Spectrum Analyzers measure the level within the RBW window

Different RBW's have a big difference in the measured level
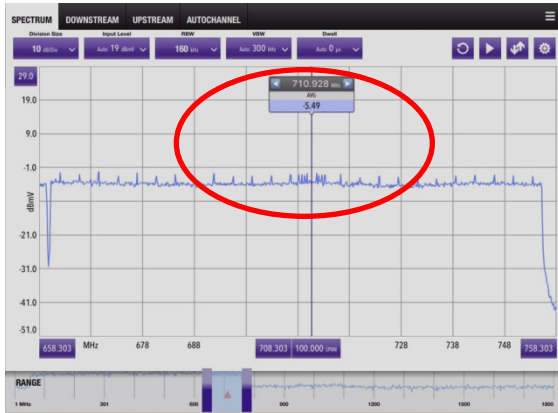
160kHz RBW
Level = -5.49dBmV
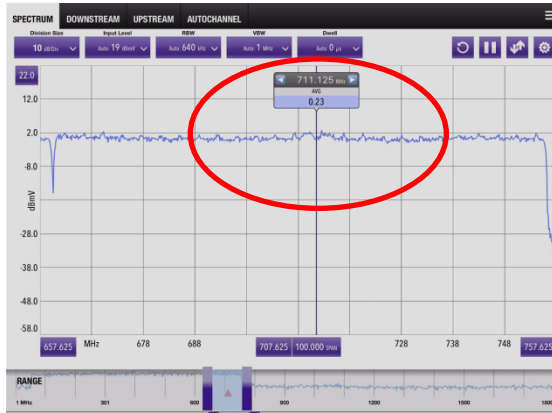
640kHz RBW
Level = 0.23 dBmV

5120kHz RBW
Level = 10.91 dBmV

- If a technician simply uses a Spectrum Analyzer and looks at the level reported by the marker without compensating for bandwidth they could be radically mis-adjusting the power.

Correcting for bandwidth
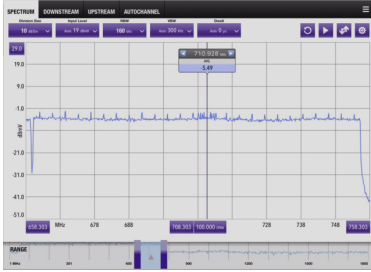
160kHz RBW
Level = -5.49dBmV
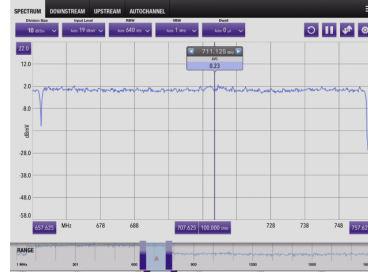
640kHz RBW
Level = 0.23 dBmV
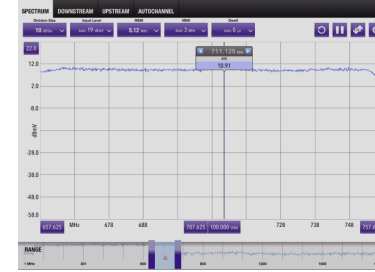
5120kHz RBW
Level = 10.91 dBmV

Remember total power?
Total Power = Power + 10*LOG (Bandwidth)
Using this to apply correction factors

Using the 5.12MHz RBW on the analyzer provides a measurement that is only 0.1dB off

= -5.49 + 10*LOG (6,000/160)
= -5.49 + 15.74
= 10.25 dBmV

= 0.23 + 10*LOG (6,000/640)
= 0.23 + 9.72
= 9.95 dBmV

= 10.91 + 10*LOG (6,000/5,120)
= 10.91+ 0.07
= 10.98 dBmV

OFDM Measurement with Spectrum Analyzer
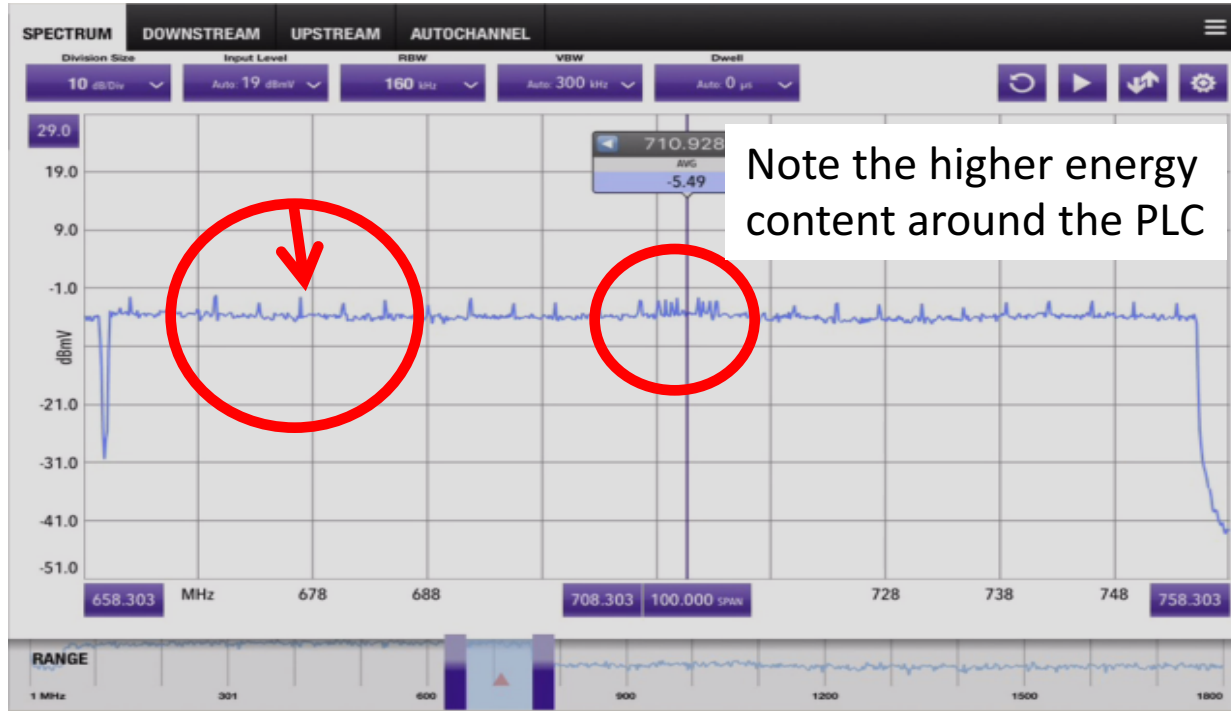
For Determining the Average Power you want to choose a marker location that is the flat/average portion and not the peaks of the pilots

Troubleshooting DOCSIS 3.1

OFDM channel 1
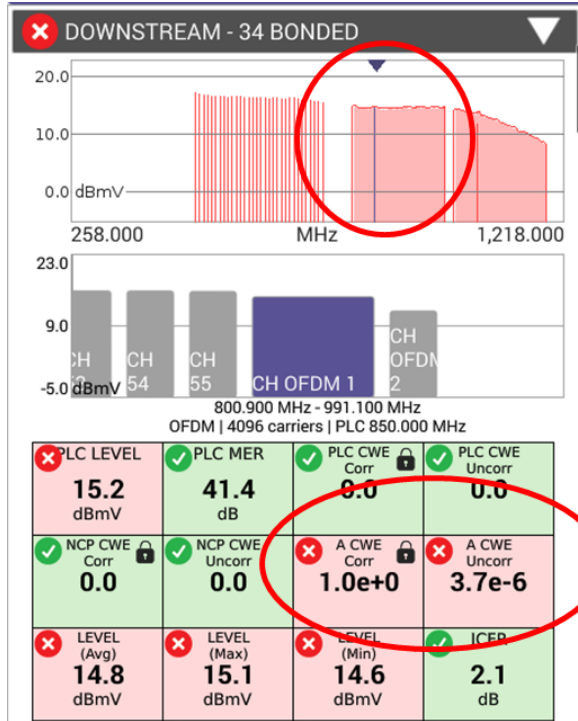
OFDM channel 2
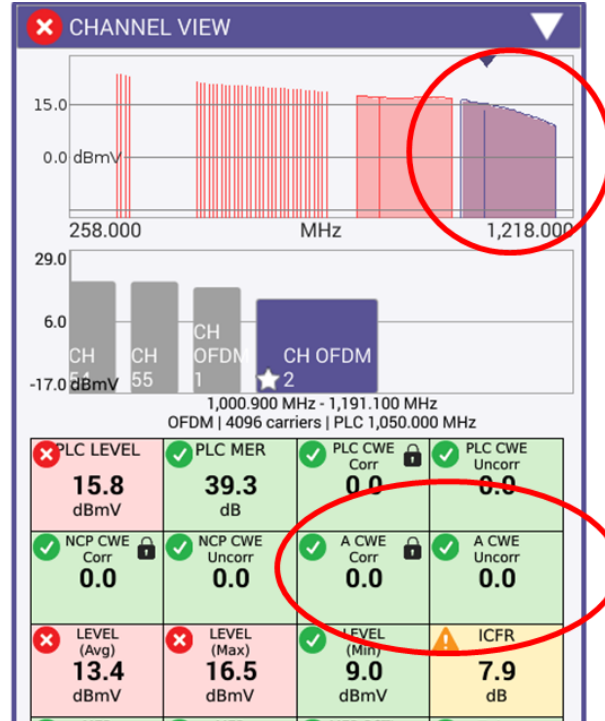
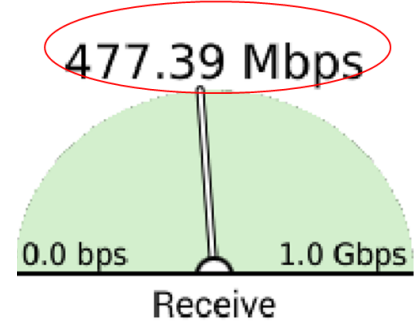# Identifying noise and MER degradation

OFDM channel 1
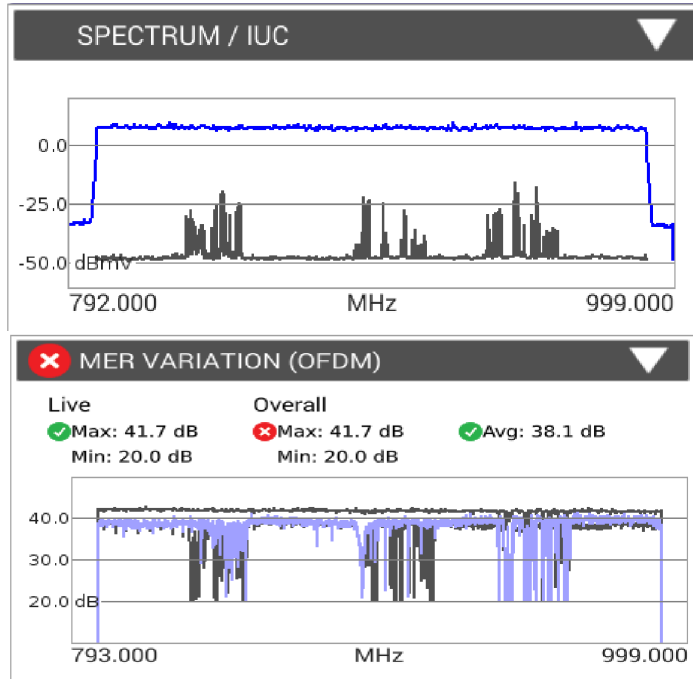
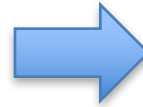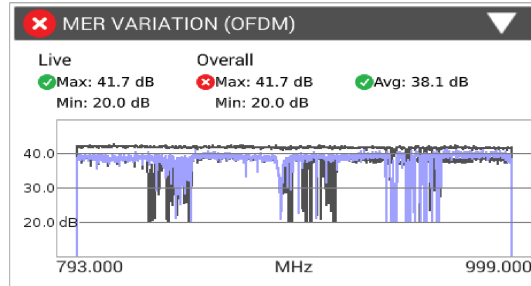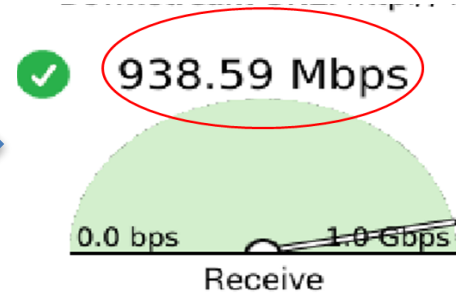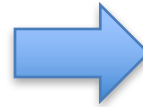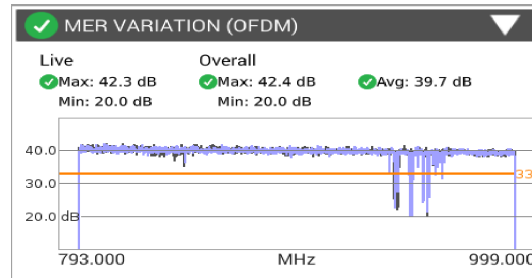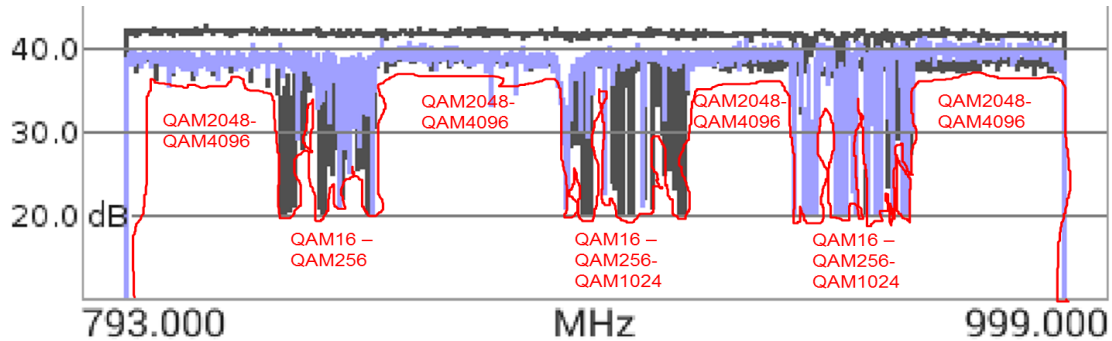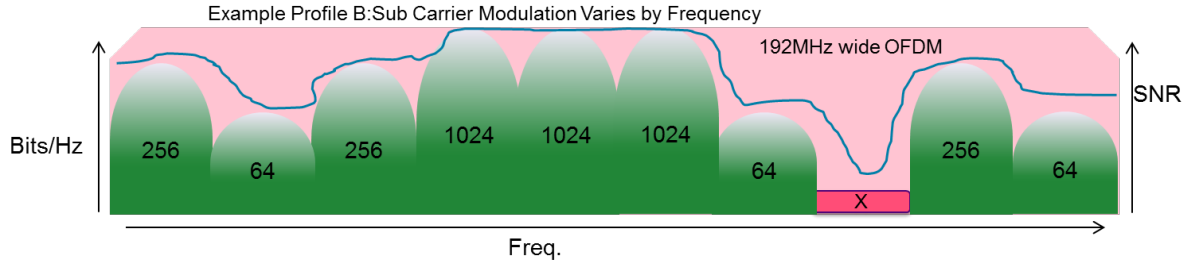OFDM channel 2
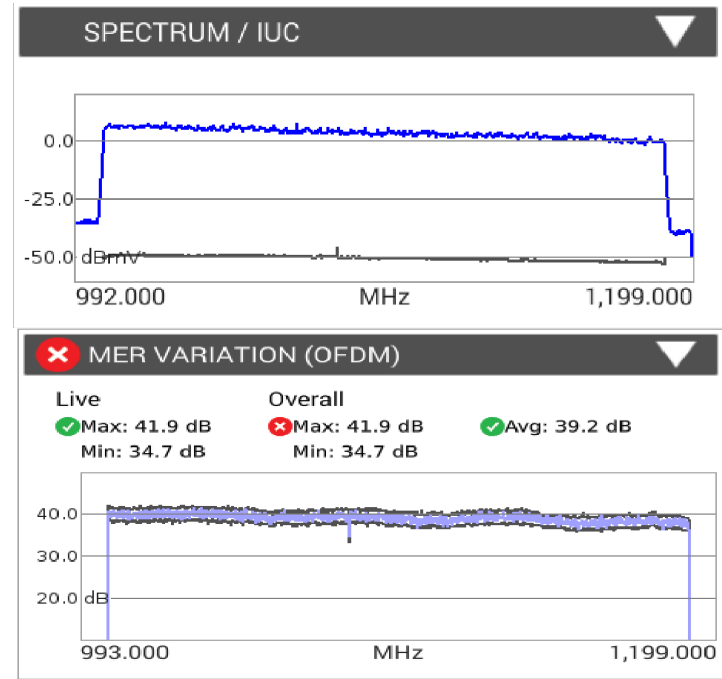
Service Level Testing

BEFORE

AFTER

Profile optimization

Example Profile B: Sub Carrier Modulation Varies by Frequency

192MHz wide OFDM

SNR

Bits/Hz

256   64   256   1024   1024   1024   64   X   256   64

Freq.

Opportunity to adjust profiles to account for plant issues

40.0
30.0
20.0 dB

793.000   MHz   999.000

QAM2048-QAM4096

QAM2048-QAM4096

QAM2048-QAM4096

QAM2048-QAM4096

QAM16 – QAM256

QAM16 – QAM256-QAM1024

QAM16 – QAM256-QAM1024

Profile Optimization

Profiles enable maximum speeds and maximize overall network capacity and throughput
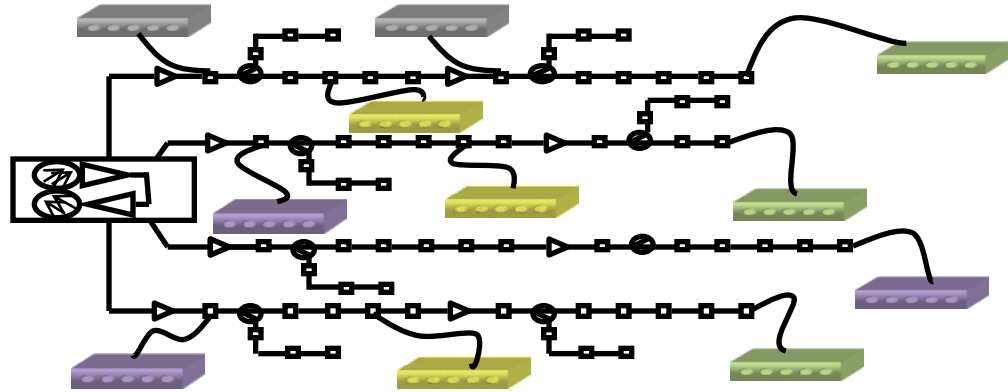
		Example Modulation mix	Approx. bits/Hz
Profile A		Mixed 64 QAM & 256 QAM	6.5
Profile B		Mixed 256 & 1024 QAM	8.0
Profile C		Mixed 1024 & 2048 QAM	9.5
Profile D		Mixed 2048 & 4096 QAM	10.1

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