CELEBRATING 10 YEARS

2006 -2016 10th ANNIVERSARY

VeEX The Verification Experts

DOCSIS 3.1/OFDM

Getting Acquainted
Testing/Troubleshooting

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Today's Speaker

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- 5 Years Telecom/MSO/ISP/WSP/NEM Field Engineering

Technical Session Overview

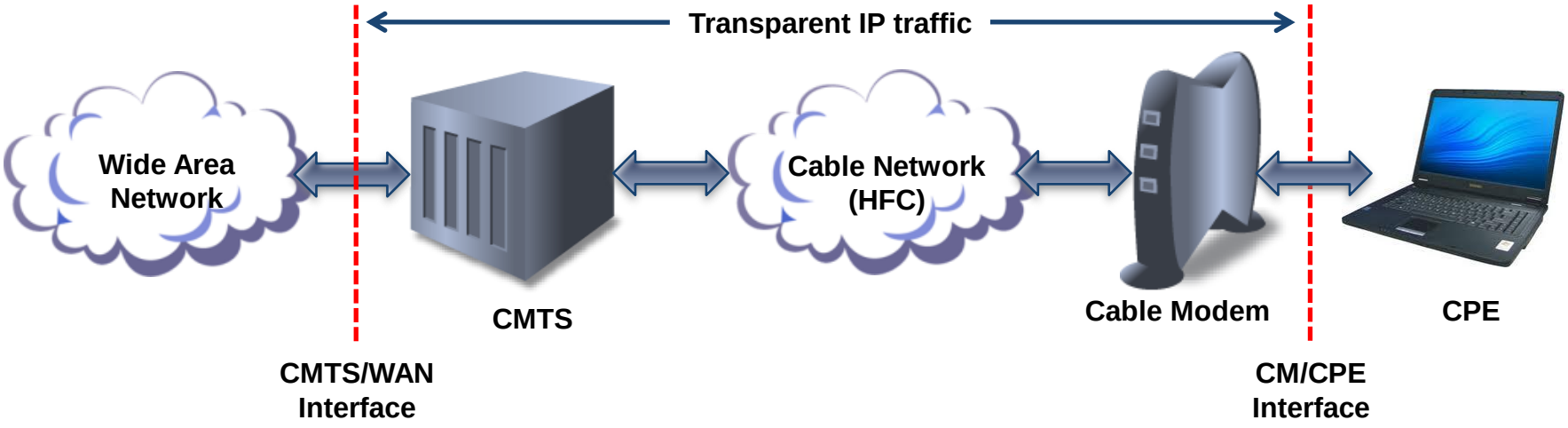
- ✓ DOCSIS 3.0 Review
- ✓DOCSIS 3.1 Introduction
- ✓ DOCSIS 3.1 Basics
- ✓ Using the Tools
- ✓Digging In

DOCSIS Today

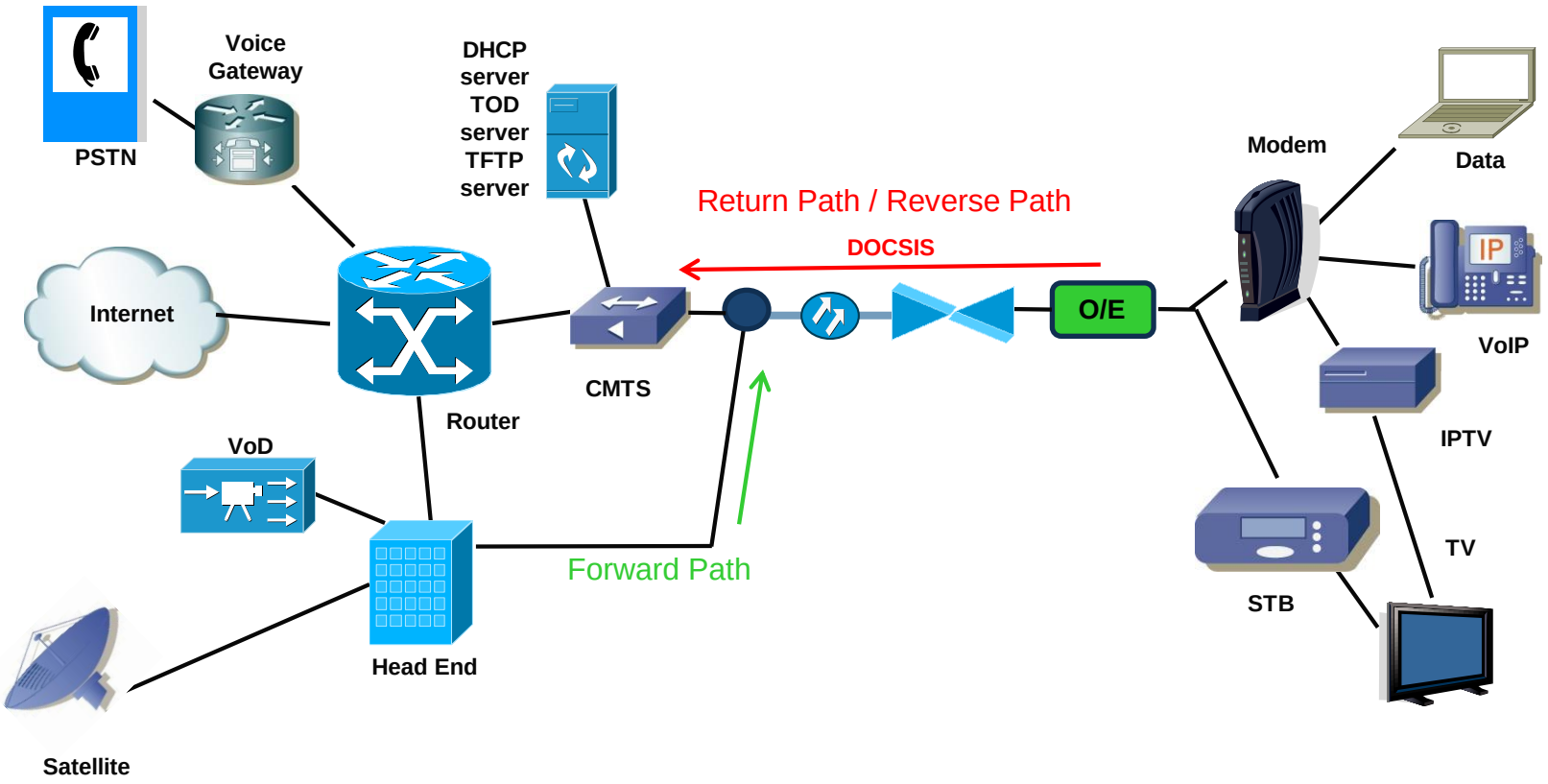
DOCSIS

An Overview/Same as always…

- DOCSIS system
  - Enables transparent bi-directional Internet Protocol (IP) traffic, between the cable system headend and customer location
- DOCSIS specification
  - Defines PHY & MAC layer protocols for communication & Ethernet frame transport between CMTS & CM
- DOCSIS network comprises:
  - Cable Modem Termination System (CMTS) located at the headend
  - Cable Network - an all-coaxial or hybrid-fiber/coax (HFC) cable network
  - Cable Modem (CM) located at the Customer Premise



CATV HFC Network



HDTV, HSD, SDV, VoIP, Broadband revenue generating services are made possible **by Digital Cable Services.**

DOCSIS 3.0

Services driving Channel Bonding

- **High bandwidth residential data and content**
  - Video and photo uploads
  - Proliferation of social networking sites and applications (Gaming)
- **IP "Video over DOCSIS" (VDOC)**
  - High definition Video to multiple devices
  - PCs, hybrid STBs, portable devices
  - High bandwidth Internet streaming (OTT)
- **High Bandwidth Video conferencing**
  - Cisco TelePresence
- **Commercial service**
  - High bandwidth symmetrical data services (2/4/6/8/10Mb)
  - Bonded E1/T1 circuit emulation (23-46 calls)
  - High bandwidth Ethernet / L2VPN services

DOCSIS 3.0

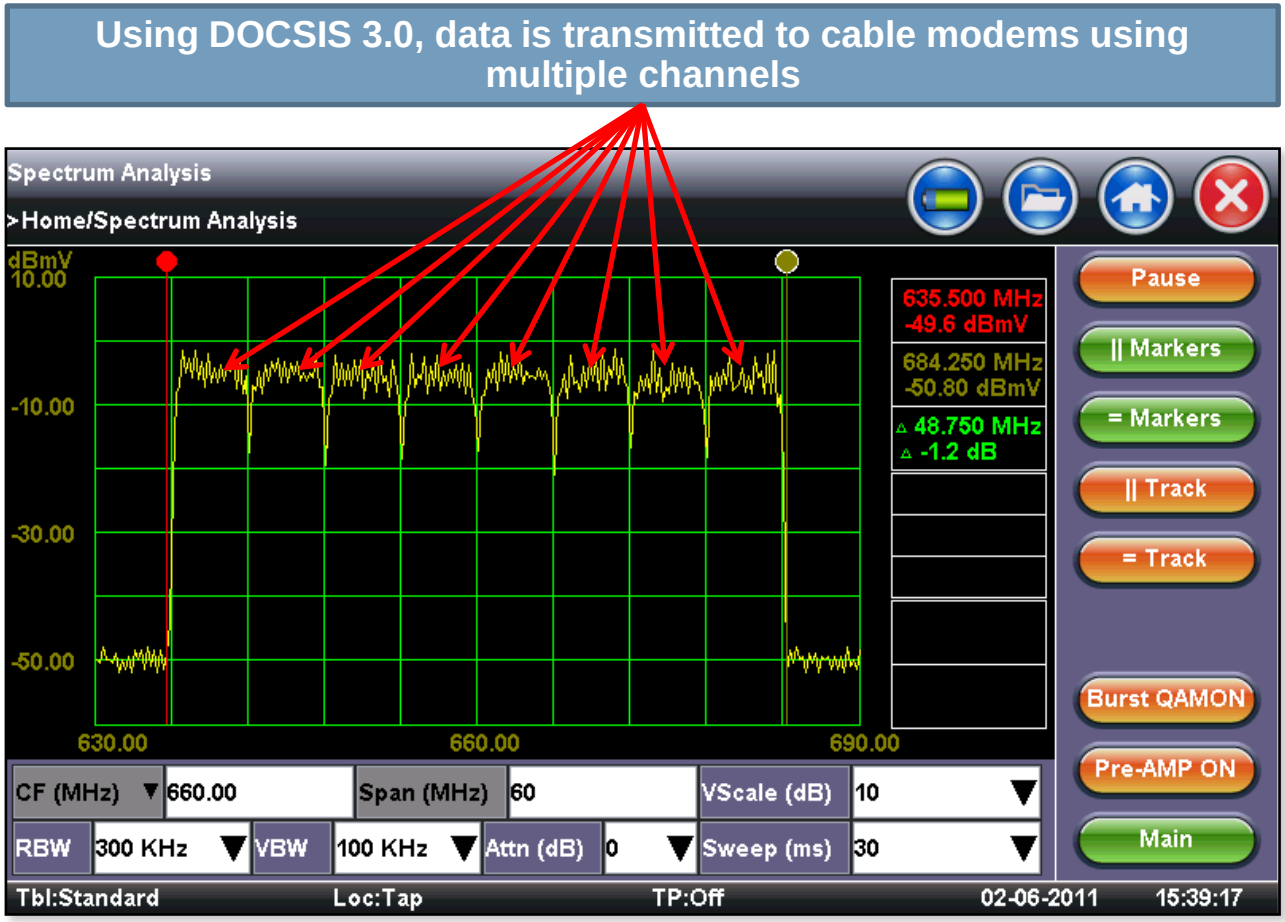
Major Feature Overview

Increased DS bandwidth	• Bonded Downstream Channels • 56Mbps (RAW) each, 448Mbps Total
Increased US bandwidth	• Bonded Upstream Channels • 27Mbps (RAW) each, 122Mbps Total
IPv6	• IPV6 allows for $3.4x10^{38}$ IP addresses • IP addresses are lengthened from 32 bits to 128 bits
Backwards compatibility	• Existing DOCSIS 1.0, 1.1 and 2.0 systems • Scalable deployment with easy subscriber migration
IP Multicast	• IPTV-type applications • Efficient “switched-video-like” bandwidth usage
Commercial	• E1 & T1 circuit emulation
Network Security	• Early Authentication and Encryption (EAE) and AES 128bit encryption which is more robust and secure

DOCSIS 3.0

DS Channel Bonding

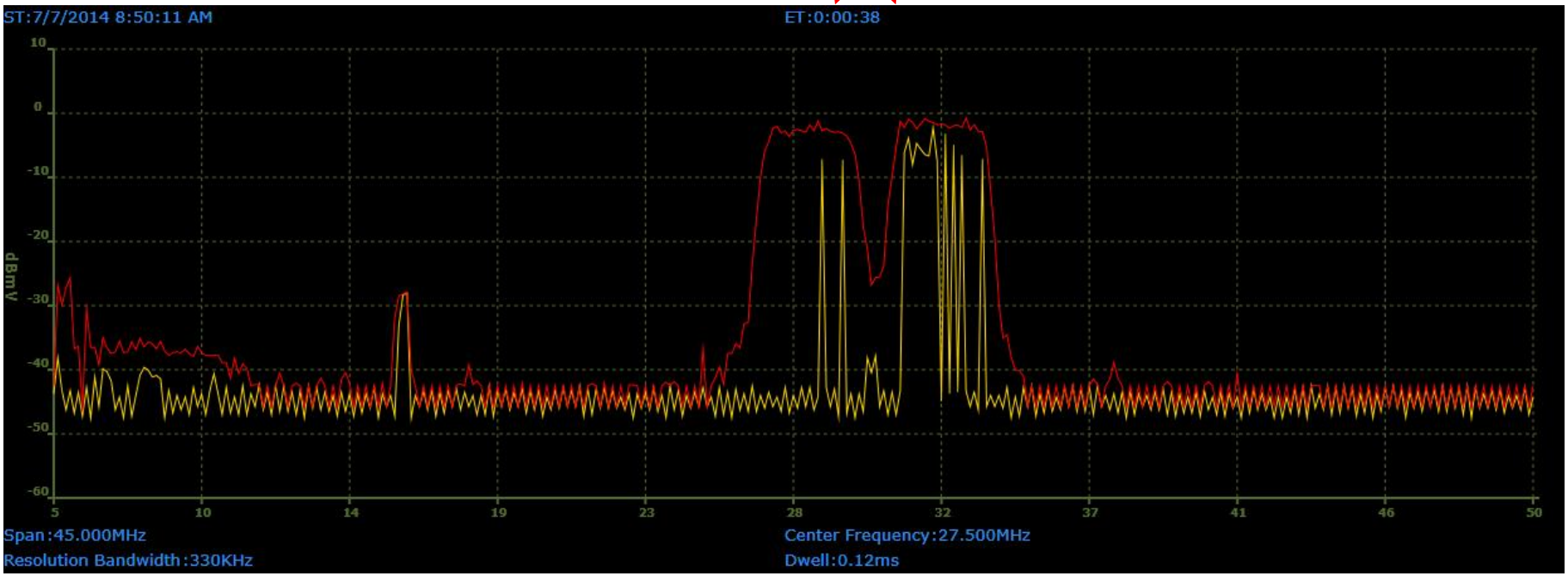
- Channel bonding basically means data is transmitted to/from Cable Modems using multiple individual RF channels instead of a single channel (Much Larger Pipe)



DOCSIS 3.0

Upstream Bonding

Using DOCSIS 3.0, upstream data is transmitted using multiple channels



DOCSIS 3.0 Downstream
Where are we today?

8x4 Bonding	300MB
16x4 Bonding	600MB
24x4 Bonding	**900MB****
32x8 Bonding	**1GB****

All fine but **customer** and **competitors** pushing for more!

DOCSIS 3.1 Introduction

What is DOCSIS 3.1?

- **Goals**
  - Achieve 10+ Gbps in the DS
  - Achive 1+ Gbps in the US
  - Backward compatibility with D3.0/D2.0/D1.1
  - Better Spectral Efficiency
- **Technology**
  - **OFDM, OFDMA, LDPC** (Low Density Parity Check)
  - New DS and US Spectrum
  - Re-use of the D3.0 MAC Concepts
- D3.1 offers Throughput and Services equivalent to FTTH but much more cost-effectively

Capacity

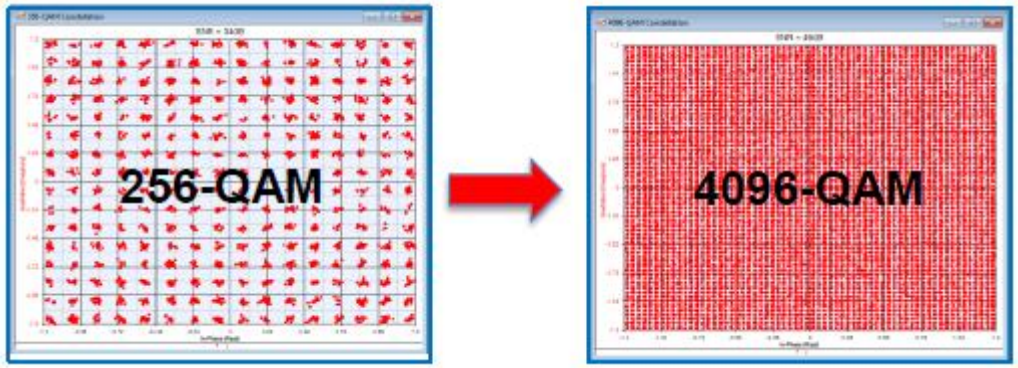
		Current	Stage 1	Stage 2	Stage 3
Downstream	Spectrum	54 to 1002 MHz	108 to 1002 MHz	258 to 1274 MHz *With Amp Upgrade*	500 to 1794 MHz *With Tap Upgrade*
	Modulation	QAM-256	QAM-256	QAM- 256,1024 and higher	QAM-256,1024 and higher
	Channels	8	24	3000	7000
	Throughput	300 Mbps	1 Gbps	7 Gbps	10+ Gbps
Upstream	Spectrum	5 to 42 / 65 MHz	5 to 85 MHz	5 to 204 MHz	5 to 400 MHz
	Modulation	QAM-64	QAM-64	QAM-256 and higher	QAM-1024 and higher
	Channels	4	12	32	60
	Throughput	100 Mbps	650 Mbps	1.5 Gbps	2+ Gbps

Why DOCSIS 3.1?

- Traffic growth is driven by demand and competition (FiOS, U-Verse, G.Fast, other FTTH)
- The DOCSIS 3.1 spec will greatly increase the bandwidth performance of the HFC plant using OFDM PHY & LDPC FEC
- 10+ Gbps Downstream & 1+ Gbps Upstream will permit DOCSIS to satisfy subscriber BW needs well in to the future (Is it all hype)?
- Additional Business Services (EoD, EPL)
- DOCSIS scales very well.
  - Efficient spectrum utilization
  - Node splits
  - Adding BW (DS & US)
    - Mid-split/High-Split architecture
    - DOCSIS Enhancements (higher modulations, new PHY/FEC, etc.)

More Capacity needed

- Higher orders of modulation (HOM)



- Elimination/ Reduction of RF guard band

- Greater capacity achieved primarily through LDPC (HOM in clean channel) and OFDM (elimination of guard bands and HOM in impaired channels)
- Close to 2X improvements over DOCSIS 3.0

DOCSIS 3.1 Delivers More Throughput

- DOCSIS 3.1 delivers more throughput in existing spectrum
  - 750MHz, 860MHz and higher plant
  - Capitalizes on the new LDPC FEC & OFDM PHY technologies
  - Permits higher modulation orders (QAM 1024, 4096 & etc.)
  - Eliminates 6MHz & 8MHz channelization (N.A & Europe can unify)
  - Upstream operation up to at least 200MHz
  - Downstream operation to at least 1.2GHz
  - Will use bit-loading to adjust to the HFC plant

DOCSIS 3.1 Basics

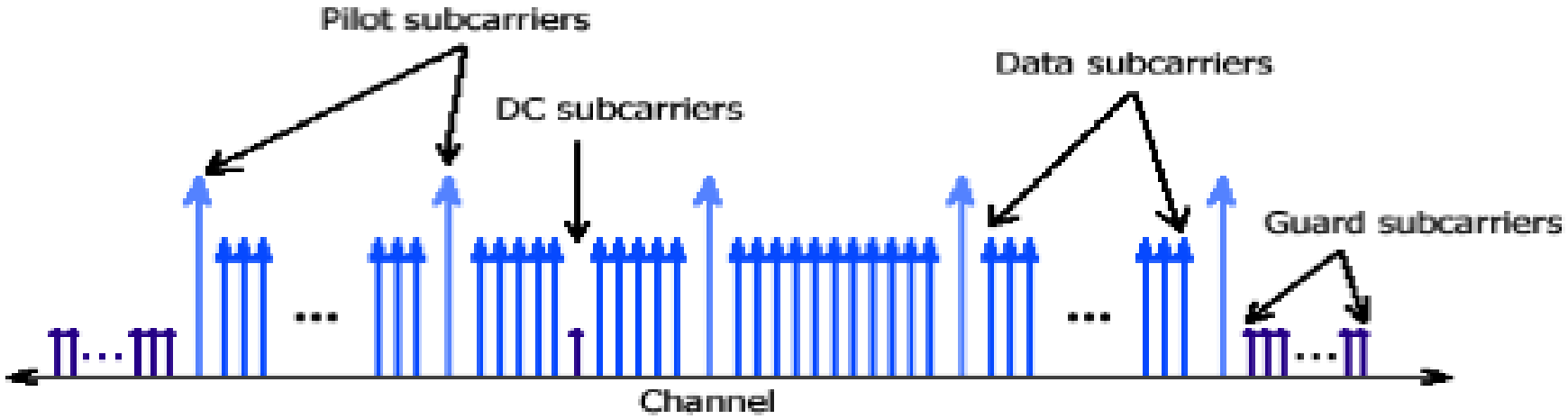
Example of Spectrum Options

- Downstream Spectrum Options
  - 1. Initially use 750/862/1002 MHz Plants (> 6 Gbps)
  - 2. Next up to 1.2 GHz with amp upgrade (> 7Gbps +)
  - 3. Long-term to 1.7 GHz with tap upgrade (> 10Gbps +)

Upstream Spectrum Options

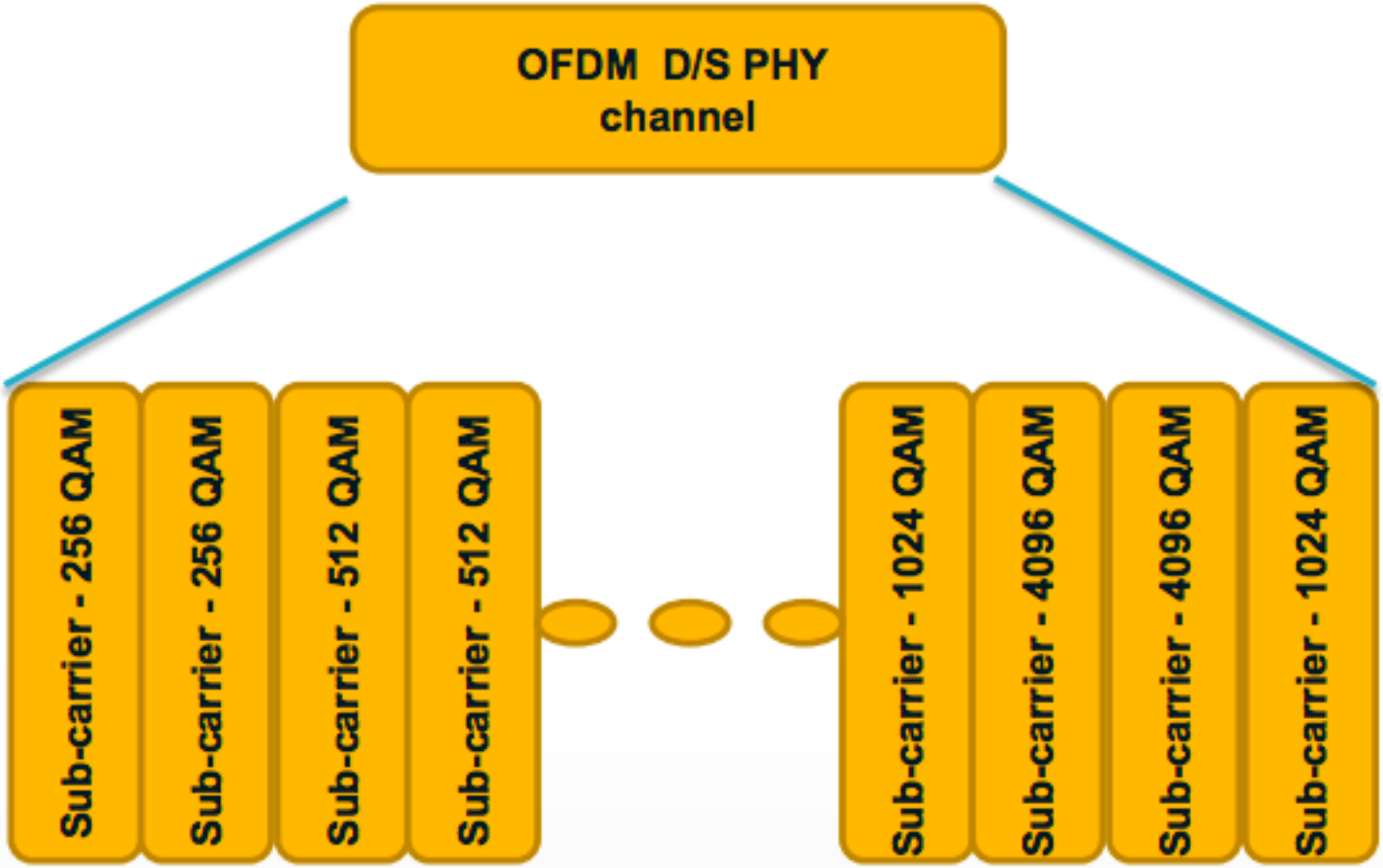
- 1. Use the current sub-split 42/65 MHz (> 200 Mbps)
- 2. mid-split 85 MHz (> 400 Mbps)
- 3. high-split 230 MHz (> 1Gbps)

OFDM



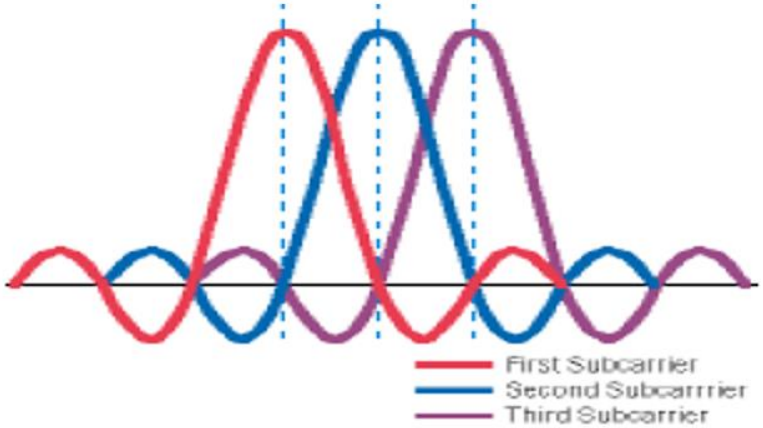
- **Orthogonal Frequency Division Multiplexing** = large collection of very narrow QAM sub-carriers
- Sub-carriers are grouped into OFDM blocks which are processed by FFT

No wasted Capacity



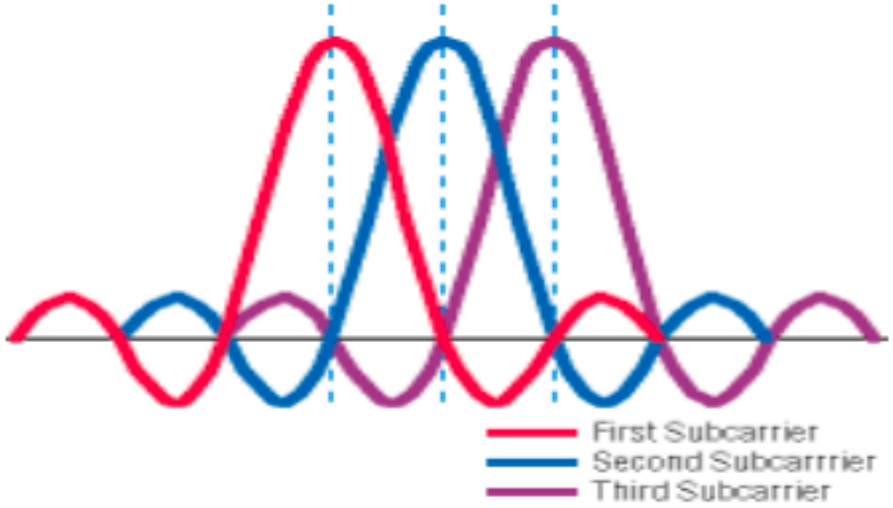
OFDM

- DOCSIS 3.1 uses a new Channel Scheme: **O**rthogonal **F**requency **D**ivision **M**ultiplexing
- OFDM is a transmission technique that consists of multiplexing **many** individual **subcarriers** with precise frequency spacing.
  - For DOCSIS 3.1, these Subcarriers are QAM modulated.
- Orthogonality – The Takeaway!
  - enables Subcarriers to be closely spaced together (actually overlap), without interfering with each other
- Proven and Robust.
  - OFDM is already used in other major transmission technologies including Wireless LAN, LTE, and DSL

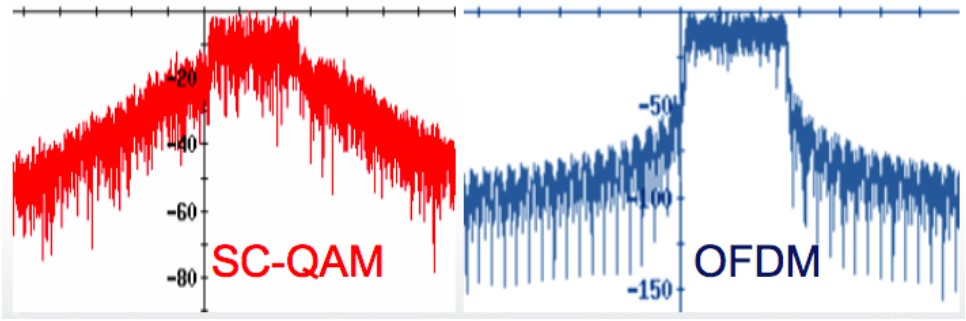


OFDM Concept

- OFDM sub-carriers can be packed tightly without interfering with each other

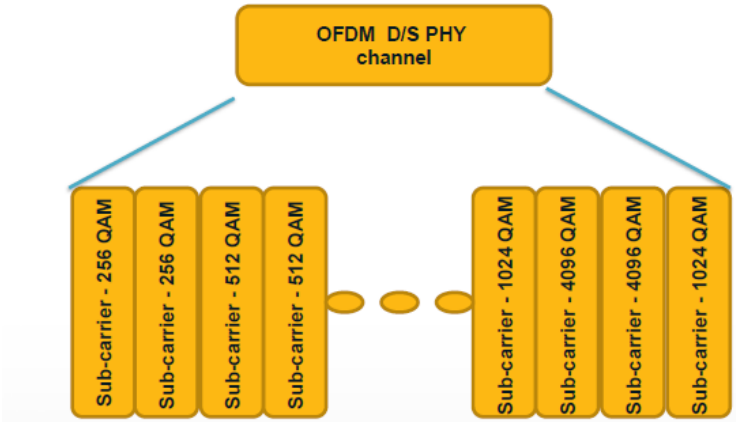


- OFDM sub-carriers fall off faster at the band edges



Multiple OFDM Subcarriers

- The **OFDM** Phy Channel can be from 24 to 192 MHz wide, consisting of multiplexed subcarriers
- **Subcarriers** can be either 25 kHz or 50 kHz wide
- For one 192 MHz OFDM Channel:
  - Up to 7680 25 kHz wide subcarriers
  - Up to 3840 50 kHz wide subcarriers



- Much more spectrum control. Subcarriers can be On or Off depending on:
  - Spectrum availability
    - Enables co-existence with legacy services.
  - Plant conditions
    - Deal with noise disturbers, such as LTE interference, on an individual subcarrier basis, only turning off affected carriers.
  - Far superior to D3.0, with 6 or 8 MHz wide carriers, which do not have such flexibilities.

LDPC
Forward Error Correction

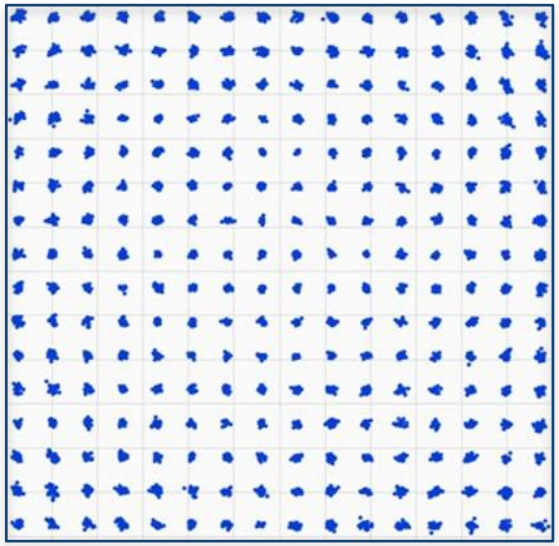
- DOCSIS 3.1 uses a new error correcting code called **L**ow **D**ensity **P**arity **C**heck
- **Advanced** Forward Error Correction technology which provides performance that is close to Shannon Theoretical Limit for channel capacity: trying to get every useful bit.
  - Invented in 1960; High computational complexity. It has only recently been implemented in a practical (cost effective) way.
- Both frequency and time interleaving are used to provide more robustness against narrowband interferers and burst noise.
- Far superior error correction capabilities than Reed-Solomon
  - Provides a 2 Bit gain from Reed Solomon FEC
  - Results in higher MER readings

TAKEAWAY….

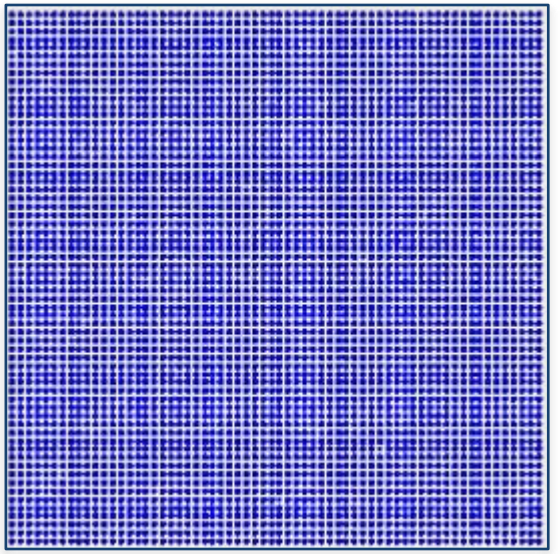
Current DOCSIS 3.0 networks that support QAM-256 can support QAM-1024 with DOCSIS 3.1

Higher Order QAM Modulation
With Dynamic Adaptation

QAM-256



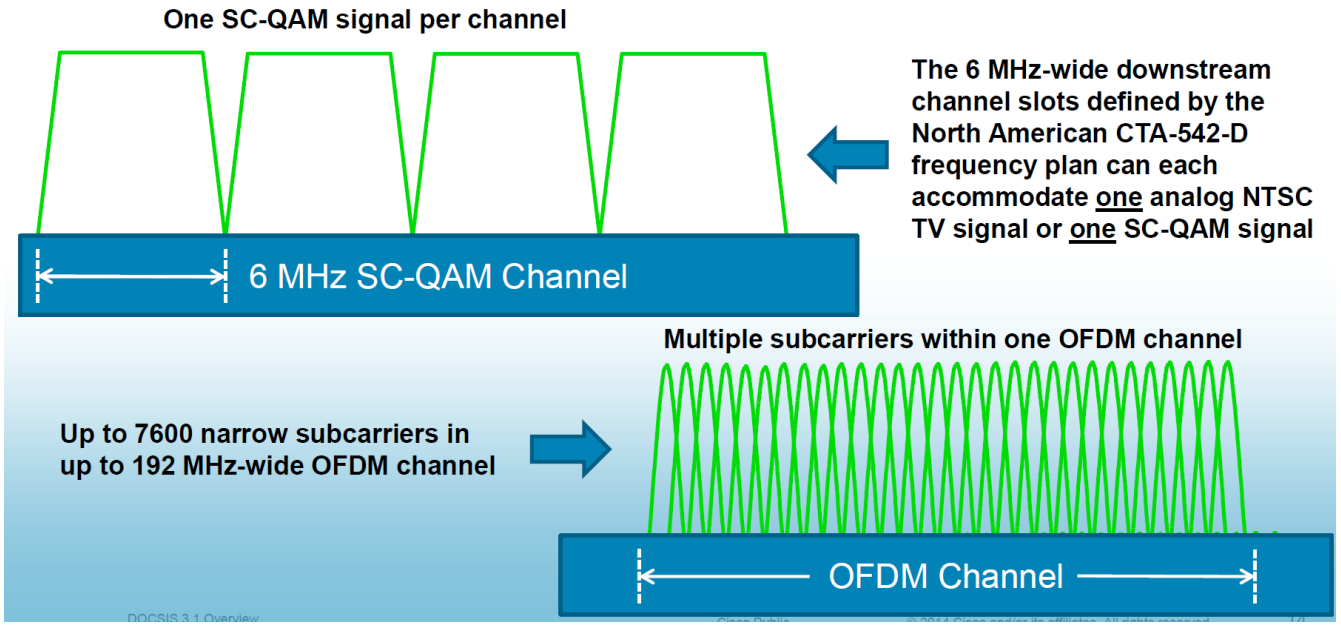
QAM-4096



- **<u>The combination of OFDM and LDPC</u>** allows for **<u>higher modulation orders</u>**: QAM-1024, QAM-2048, and QAM 4096.
- D3.1 supports multiple modulation profiles: a mix of base Modulation and higher Modulation profiles
- Different profiles can be used depending on customer line quality. Higher quality lines can utilize Higher Modulation Profiles.
- Dynamic adaptation to line conditions. For an impairment that occurs – the affected OFDM subcarrier can downshift to a lower order modulation to help ensure robust, error free transmission

OFDM-Channel Width

OFDM versus SC-QAM

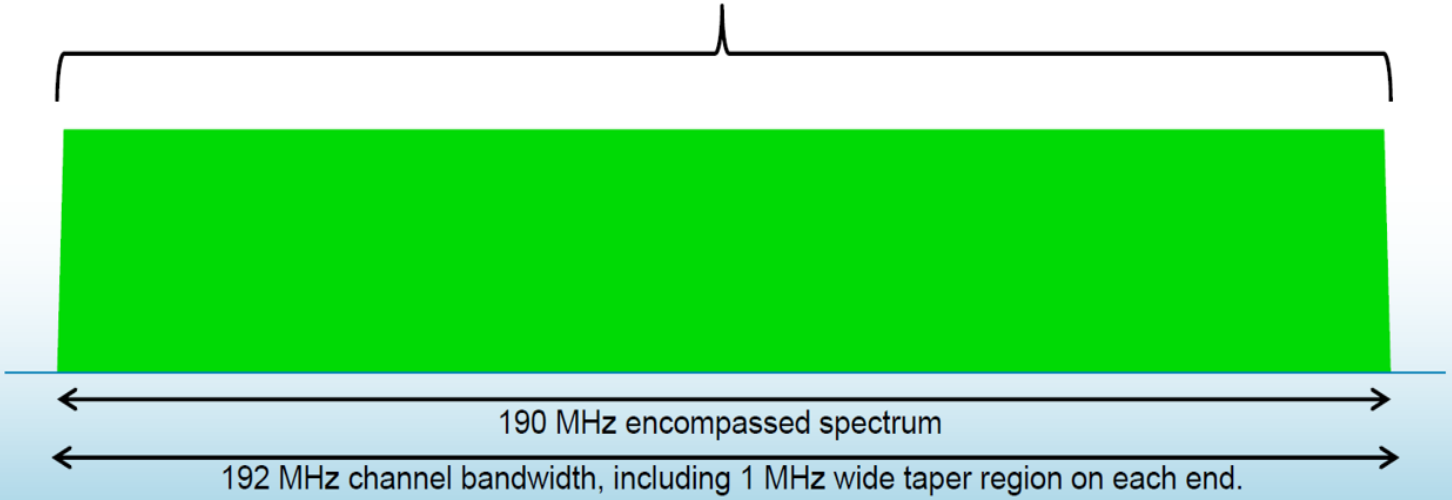


- With OFDM, the concept of a 6 MHz or 8 MHz channel is no longer necessary.
- DOCSIS 3.1 OFDM channel bandwidth is flexible

  DOCSIS 3.1 supports downstream OFDM modulated spectrum from a minimum of 22 MHz to a maximum of 190 MHz, which will occupy at least 24 MHz and 192 MHz, respectively, including a portion of the OFDM band-edge spectral skirts

The Anatomy of an OFDM Channel

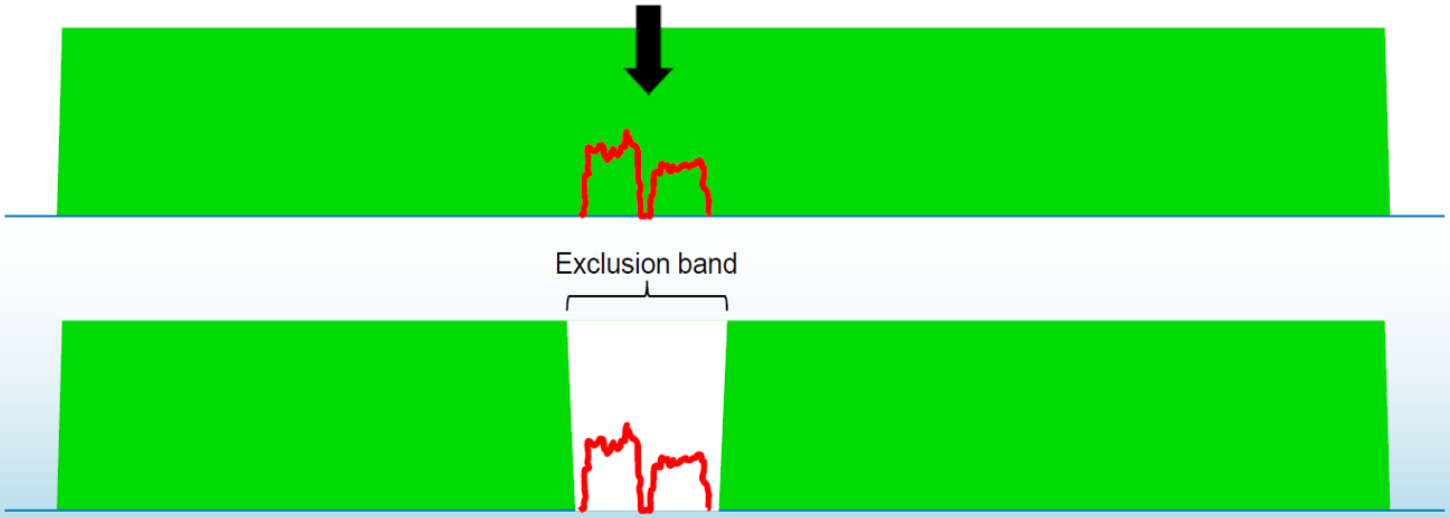
25 kHz subcarrier spacing: 7600 subcarriers (called “8K FFT”)
50 kHz subcarrier spacing: 3800 subcarriers (called “4K FFT”)



Since the taper regions in this example total 2 MHz out of 192 MHz, the equivalent excess bandwidth or “alpha” is (2/192) x 100 ≈ 1%, compared to 12% for DOCSIS 3.0 and earlier 256-QAM SC-QAM.

OFDM- Exclusion Bands

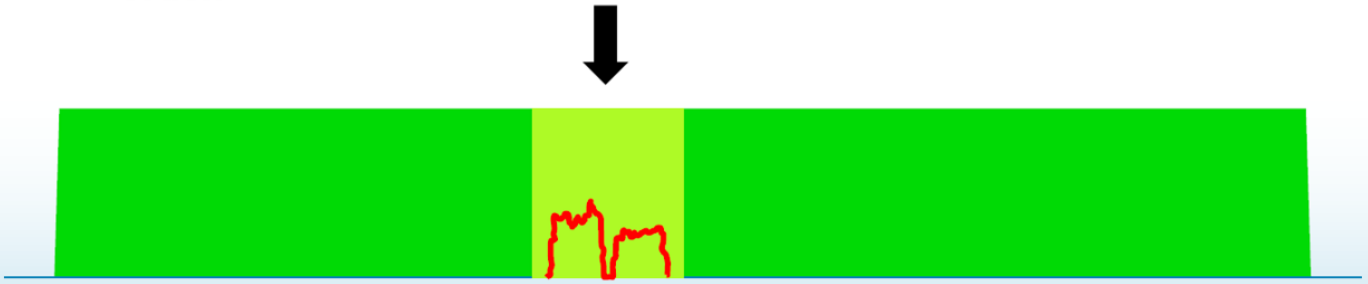
Exclusion bands may be created within an OFDM channel for problems such as strong in-channel ingress (e.g., LTE interference).



An exclusion band is a set of contiguous subcarriers within the OFDM channel bandwidth that are set to zero-value by the transmitter to avoid interference or to accommodate co-existing transmissions such as legacy SC-QAM signals.

OFDM- Variable Bit Loading

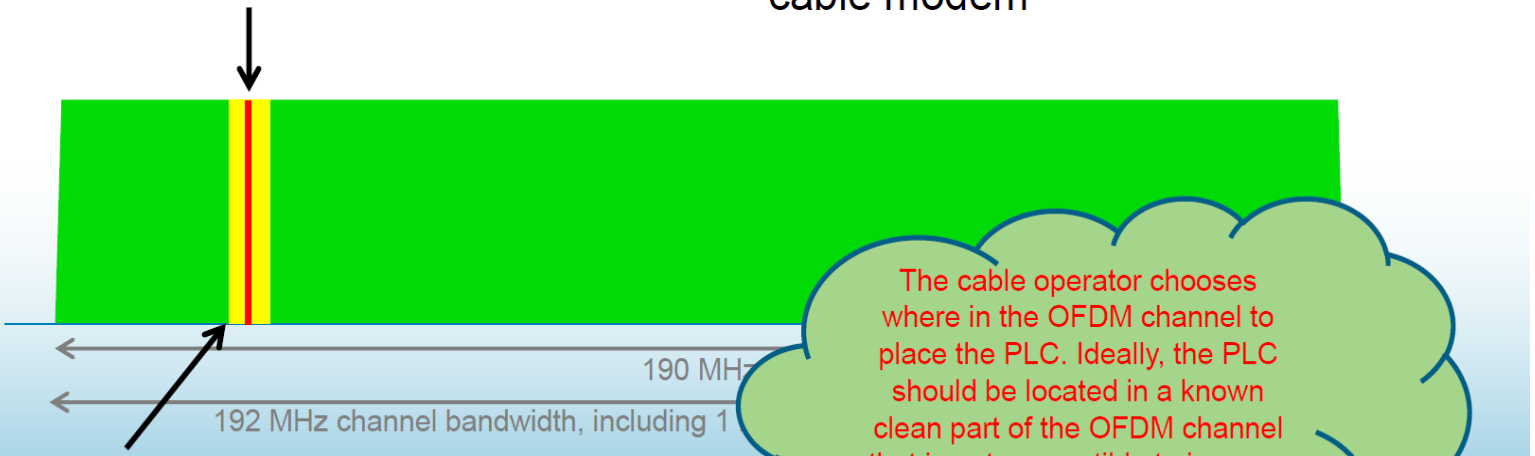
As an alternative to an exclusion band in that part of an OFDM channel experiencing interference, the bit loading may be changed to allow continued carriage of data, but using a more robust lower modulation order.



Anatomy of a downstream OFDM channel

400 kHz bandwidth PHY link channel (PLC), shown here in red, is centered within a 6 MHz contiguous portion of the OFDM channel (yellow) that has no exclusions.

The PLC conveys physical layer parameters from the CMTS to the cable modem

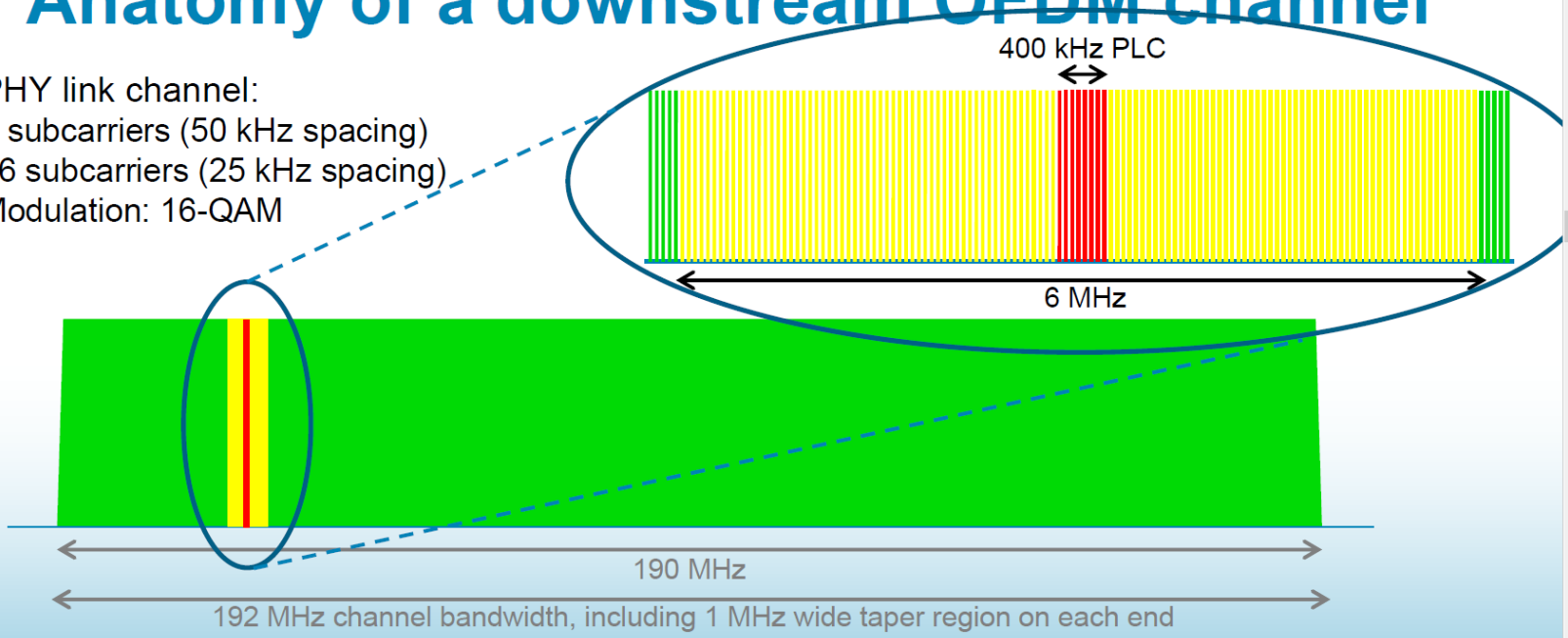


The lowest frequency subcarrier that bounds the 6 MHz portion of the OFDM channel in which the PLC is located is centered on a 1 MHz grid.

The cable operator chooses where in the OFDM channel to place the PLC. Ideally, the PLC should be located in a known clean part of the OFDM channel that is not susceptible to ingress, direct pickup, and other types of interference.

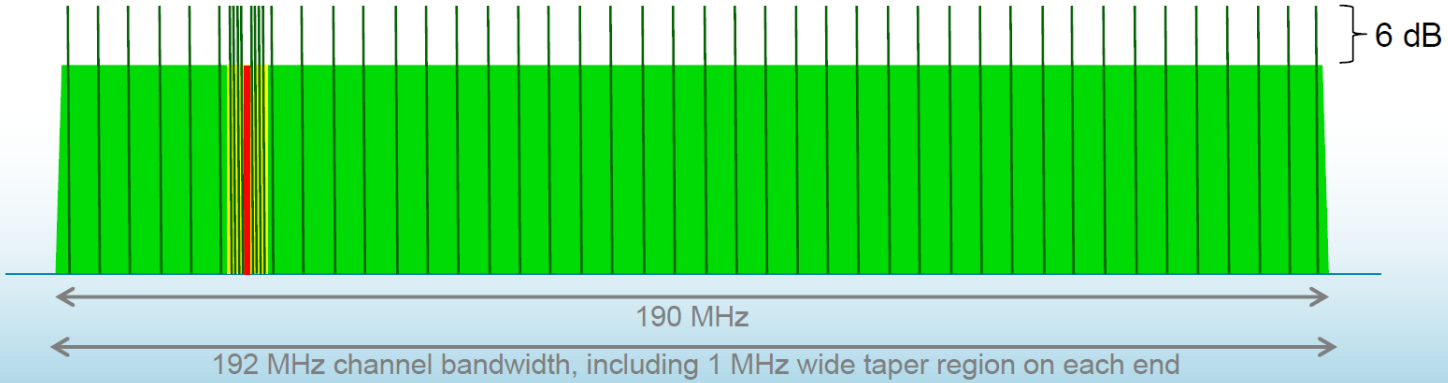
Anatomy of a downstream OFDM channel

PHY link channel:
8 subcarriers (50 kHz spacing)
16 subcarriers (25 kHz spacing)
Modulation: 16-QAM



Anatomy of a downstream OFDM channel

Subcarriers called continuous pilots are more or less evenly distributed throughout the OFDM channel, and are boosted 6 dB relative to other subcarriers. There can be anywhere from 16 to 128 continuous pilots in an OFDM channel, including 8 in the PLC band (next slide).

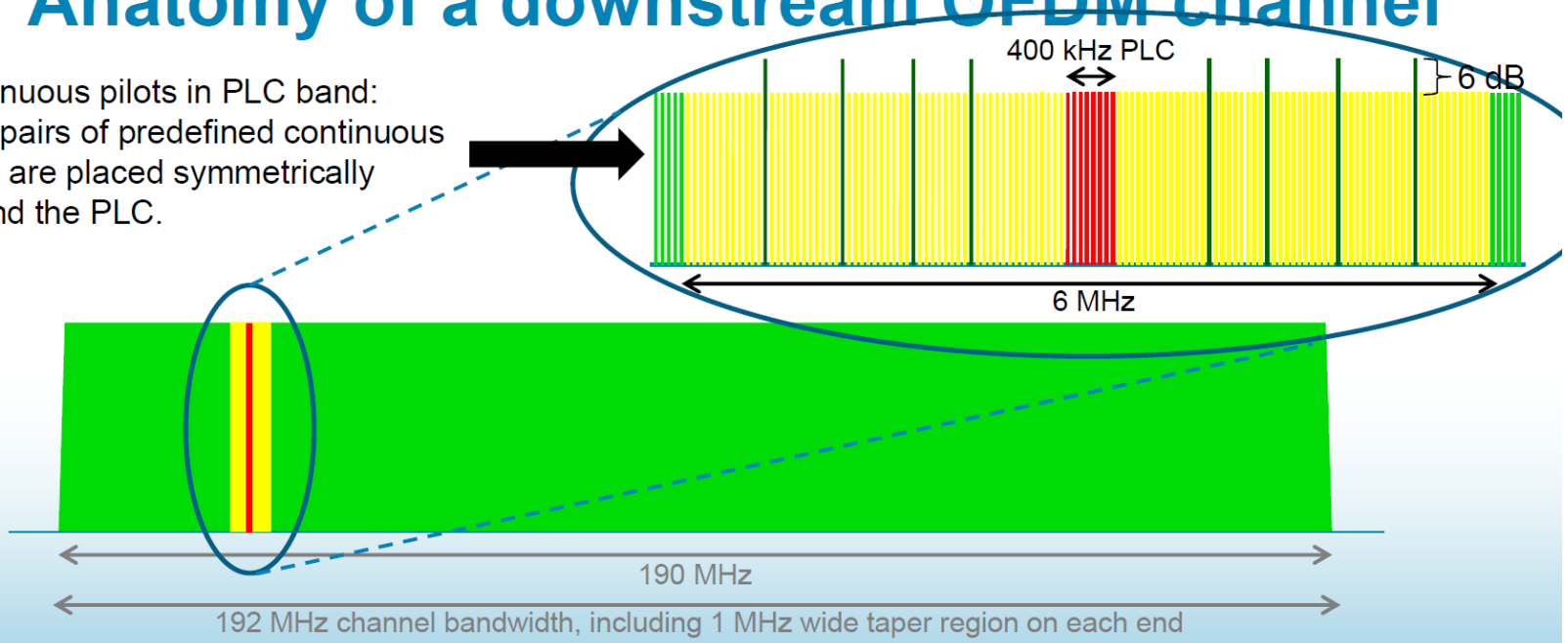


Continuous pilots occur at the same frequency in every OFDM symbol, and are used for frequency and phase tracking. Continuous pilots do not carry data (they are BPSK modulated with a pseudo-random sequence, though).

OFDM-PLC
Add the Pilots

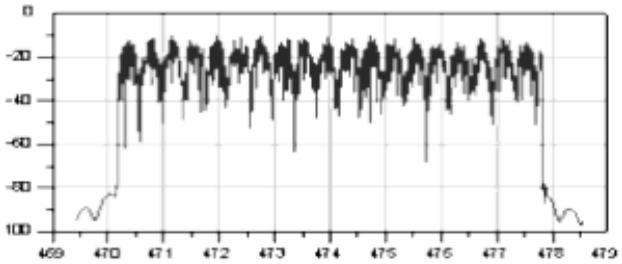
Anatomy of a downstream OFDM channel

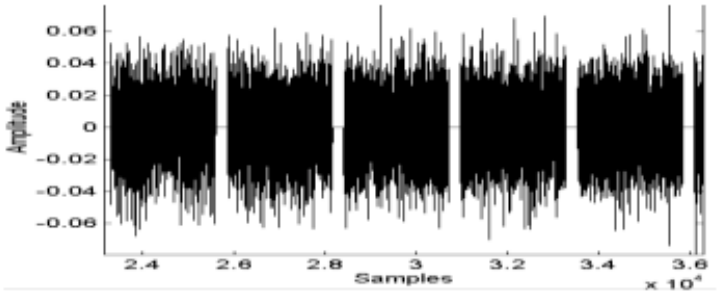
Continuous pilots in PLC band:
Four pairs of predefined continuous pilots are placed symmetrically around the PLC.



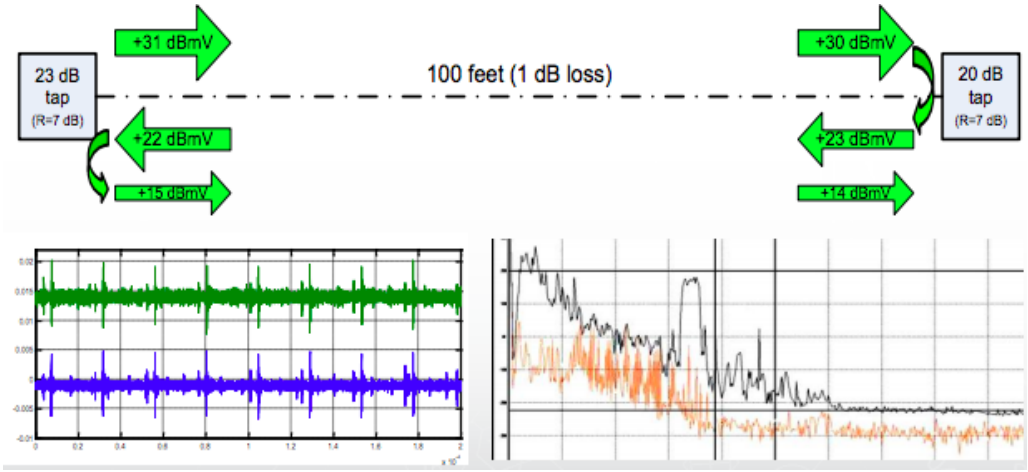
OFDM Secret Weapon

- Narrow Sub-carriers means long symbols

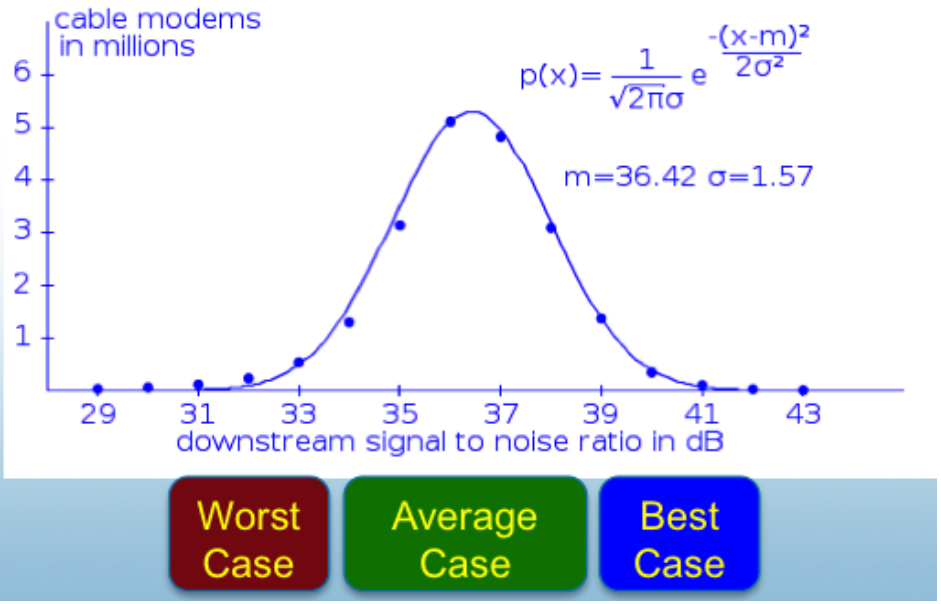




- Benefits are easy mitigation of
  - Micro-reflections
  - Ingress, Impulse and Burst Noise



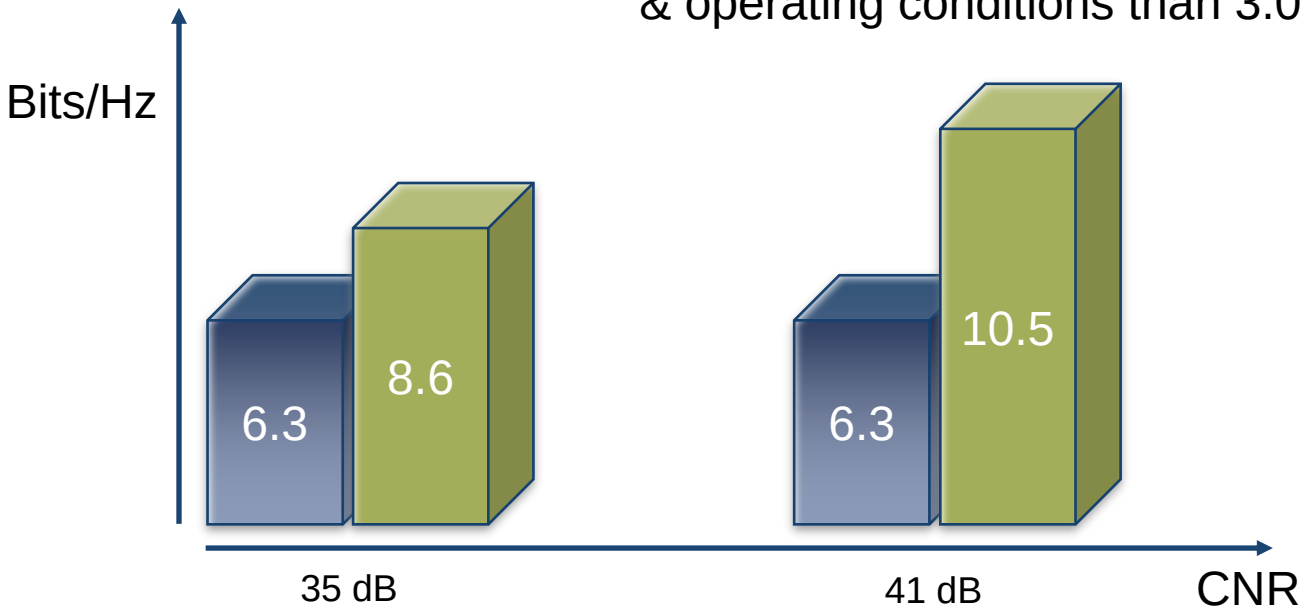
Downstream Profiles QAM4K Anyone?



- HFC Plant has at least 8 dB variation in CNR across plant
- Multiple profiles allow operators to leverage SNR variation to improve system capacity
- Example with 4 profiles
  - A. Worst (mostly QAM256)
  - B. Average (mostly QAM1024)
  - C. Better (mostly QAM2048)
  - D. Best (mostly QAM4096)

OFDM - More for less

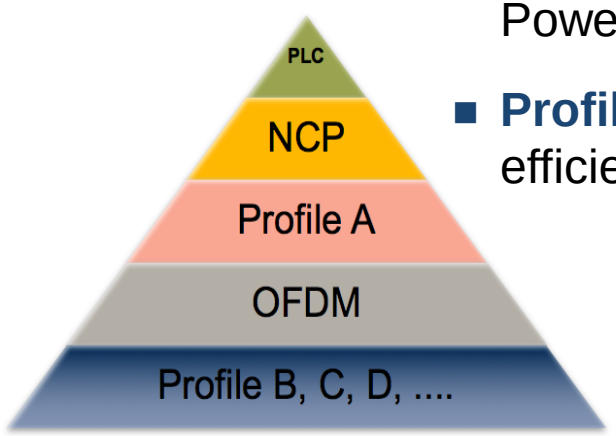
- OFDM/3.1 gives more Bits/Hz at the same CNR & operating conditions than 3.0

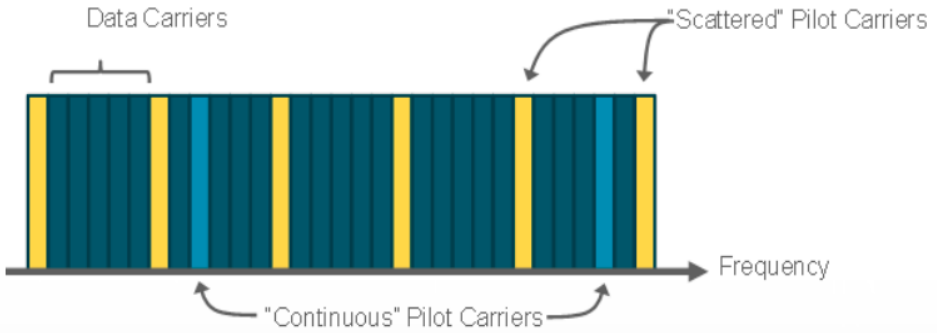


35%	Efficiency gain 3.1 vs. 3.0
6.3	Max Bits/Hz on 3.0
10.5	Max Bits/Hz on 3.1 w/ QAM 4096
8.5	Typical Bits/Hz on 3.1 w/mixed QAM (256~4096)

Building Blocks in Details

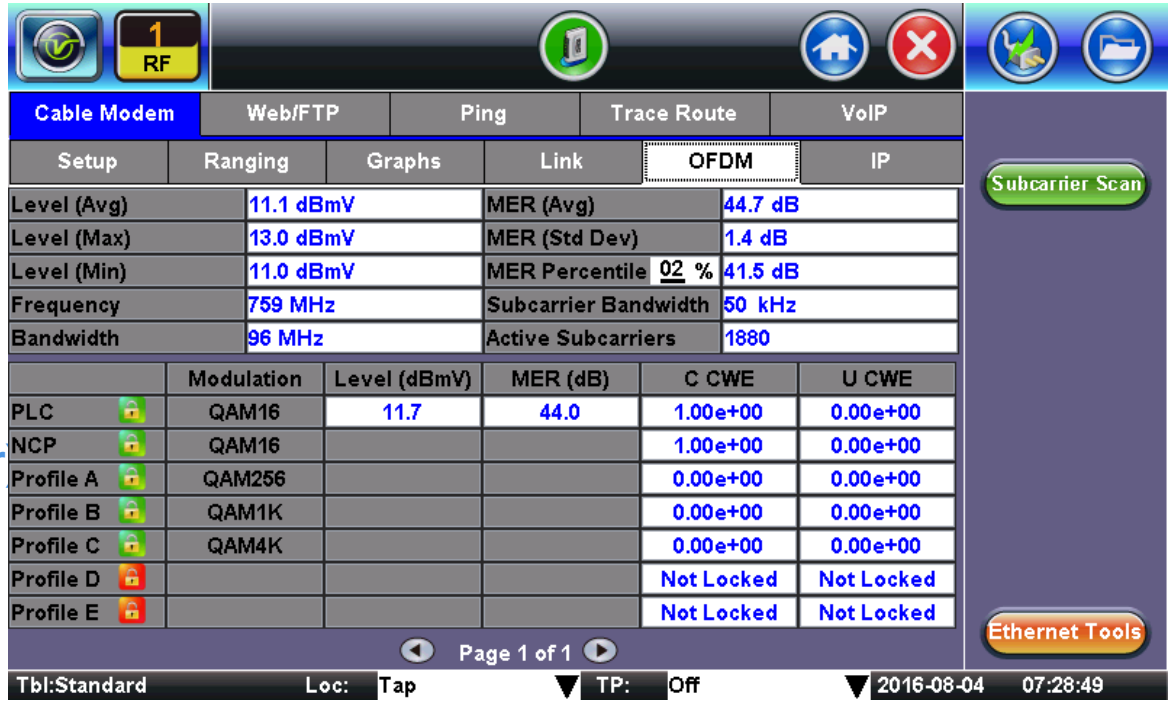
- **PLC:** (Physical Link Channel) all necessary information to decode and use the OFDM Signal – your passport
- **NCP:** (Next Codeword Pointer) provides the modems with which Code Words (CW) are present and on each profile which CW to use
- **Profile A**: used for Boot Profile - **No profile A no 3.1**. All 3.1 modems will use Profile A. Many times is QAM256
- **OFDM**: Information about the overall OFDM channel Avg Power, MER, and Noise
- **Profiles B, C and D**: Provide higher modulations for greater efficiency





OFDM Measurements

- **OFDM Overall**
  - Level, MER stats
- **PLC (Physical Link Channel)**
  - Level, MER, CWE and UCWE
- **NCP (Next Codeword Pointer)**
  - Level, MER, CWE, and UCWE
- **Profiles A, B, C, D**
  - MER, CWE, and UCWE



Test 1: PLC (PHY Link Channel)

	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00

- **PLC needs to be locked**
- U CWE (Uncorrectable CWE): 0
- SNR > 44 dB (QAM16 OFDM)
- Level > 19 dBmV (Where, at the node/AMP?) Down to about -6dBm
- C CWE (Correctable CWE): Should be 0 but as long as they are corrected, it is okay (We currently display 100% corrected) << This is a known issue with the Broadcom chipset.

Test 2: NCP (Next Codeword Pointer)

NCP

	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00
NCP	QAM16			1.00e+00	0.00e+00

- NCP needs to be locked
- U CWE (Uncorrectable CWE): 0
- C CWE (Correctable CWE): Should be 0 but as long as they are corrected, it is okay. **Not OK really, there is something causing this!**

Test 3: Profile A

Profile A

	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00
NCP	QAM16			1.00e+00	0.00e+00
Profile A	QAM256			0.00e+00	0.00e+00

- **Profile A needs to be locked**
- U CWE (Uncorrectable CWE): 0
- C CWE (Correctable CWE): Should be 0 but as long as they are corrected, it is okay
- IMPORTANT: If Profile A has not achieved locked or gets UCWE, modems will roll back to 3.0 > Look for Profile A performances if modem only locks in DOCSIS 3.0 mode

Test 4: OFDM Overall

OFDM

Setup	Ranging	Graphs	Link	OFDM	IP

Level (Avg)	11.1 dBmV	MER (Avg)	44.7 dB
Level (Max)	13.0 dBmV	MER (Std Dev)	1.4 dB
Level (Min)	11.0 dBmV	MER Percentile 02 %	41.5 dB
Frequency	759 MHz	Subcarrier Bandwidth	50 kHz
Bandwidth	96 MHz	Active Subcarriers	1880

- Desireable Average Level 11.1 dBmV
- Frequency – 759 MHz
- Very Good MER Average > 44.7
- MER Standard Deviation 1.4 dB
- MER @ 2nd Percentile > 40 dB
- Bandwidth – 96 MHz
- Active Subcarriers - 1880

Modulation	Min MER
QAM4096	41 dB
QAM2048	37 dB
QAM1024	34 dB
QAM256	27 dB
QAM16	15 dB

Test 5: Profiles B, C, D

Profile B, C, D, ...

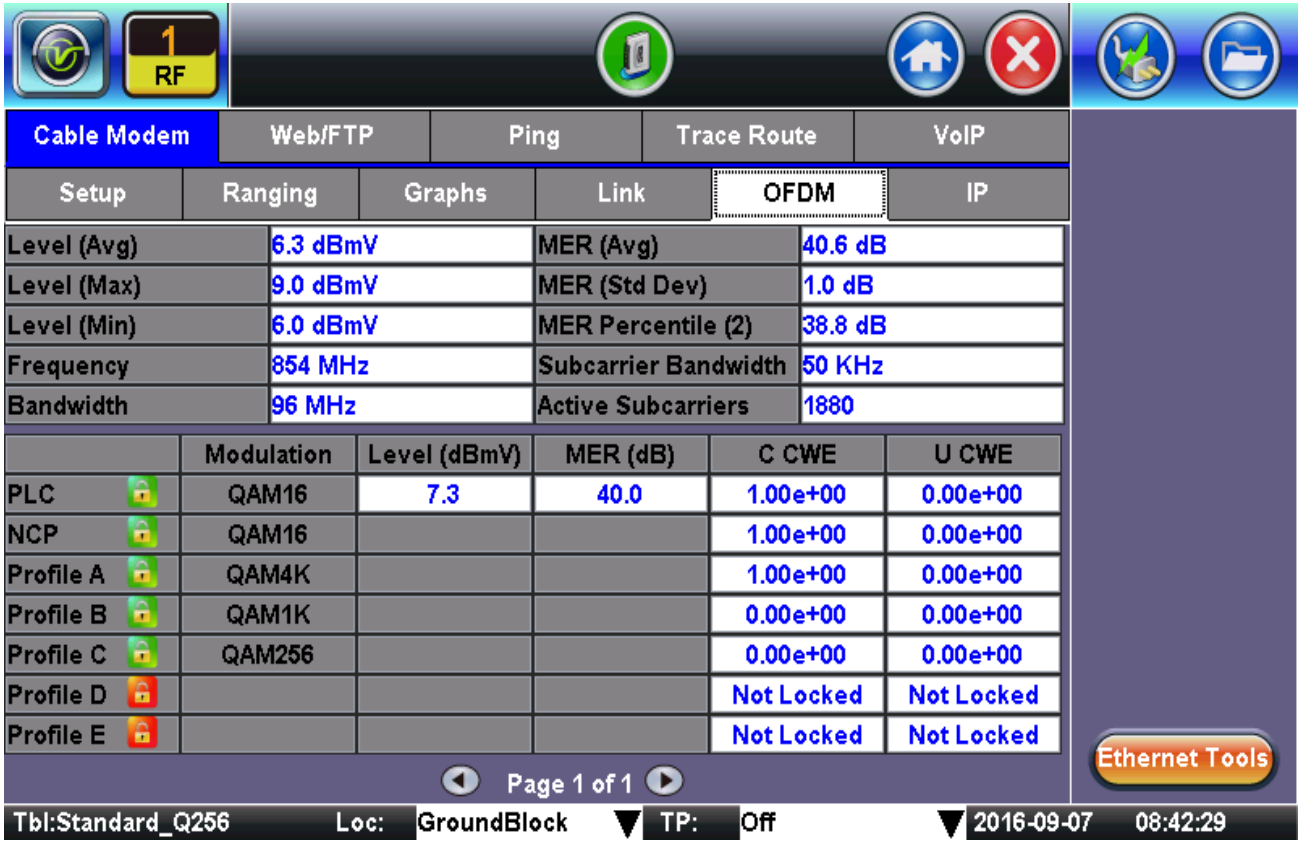
	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00
NCP	QAM16			1.00e+00	0.00e+00
Profile A	QAM256			0.00e+00	0.00e+00
Profile B	QAM1K			0.00e+00	0.00e+00
Profile C	QAM4K			0.00e+00	0.00e+00
Profile D				Not Locked	Not Locked
Profile E				Not Locked	Not Locked

- Profile needs to be locked
- U CWE (Uncorrectable CWE) and CWE (Correctable CWE): varies
- SNR see table per profile

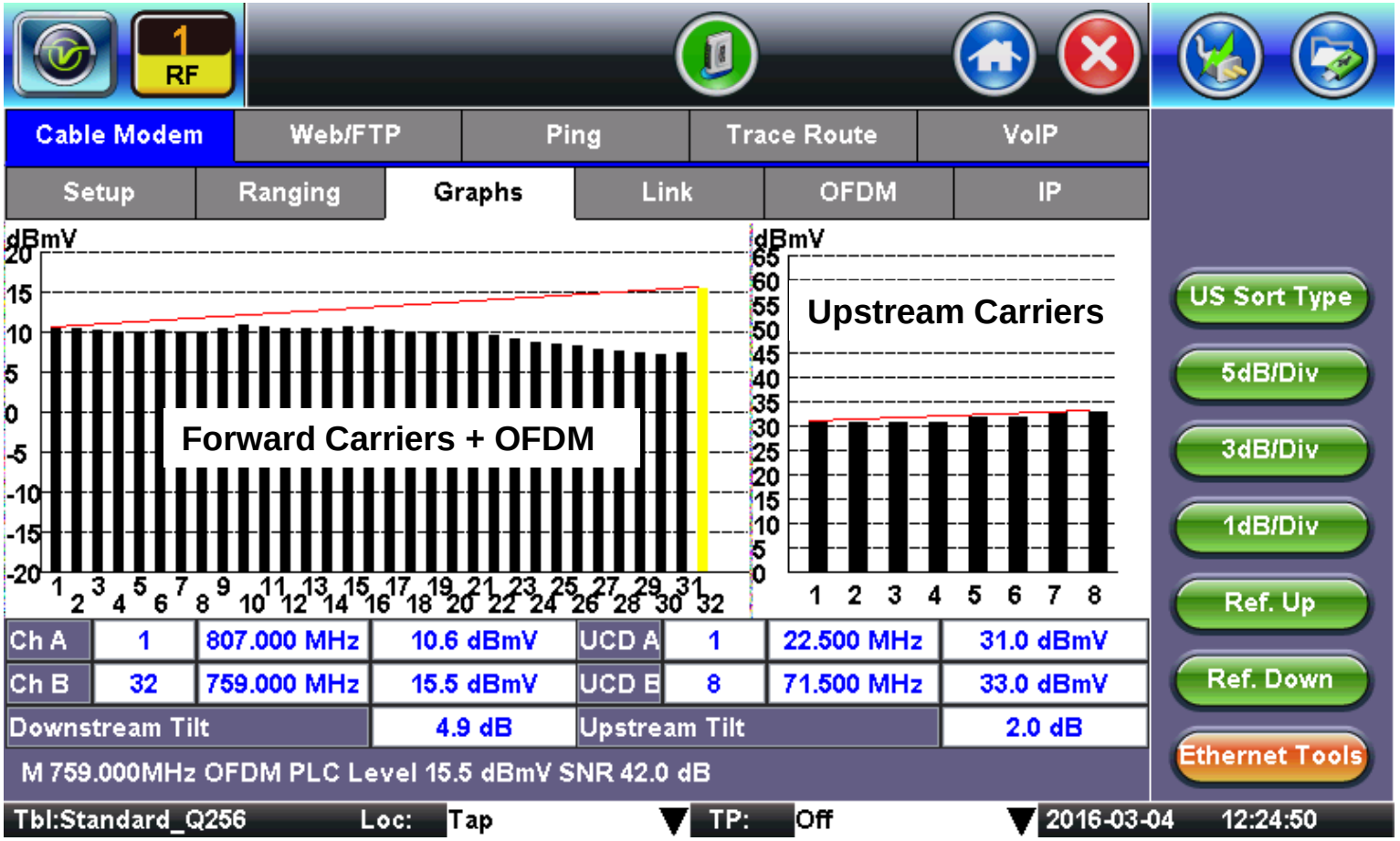
Modulation	Min SNR
QAM4096	41 dB
QAM2048	37 dB
QAM1024	34 dB
QAM256	27 dB
QAM16	15 dB

Service Level Testing
Connection Summaries

- Lock onto primary
- Verify Bonding of SC QAM and OFDM on the Forward
- Verify Bonding on the Return
- Verify Average Power
- Verify Upstream TX



Service Level Testing
Balance of Carriers

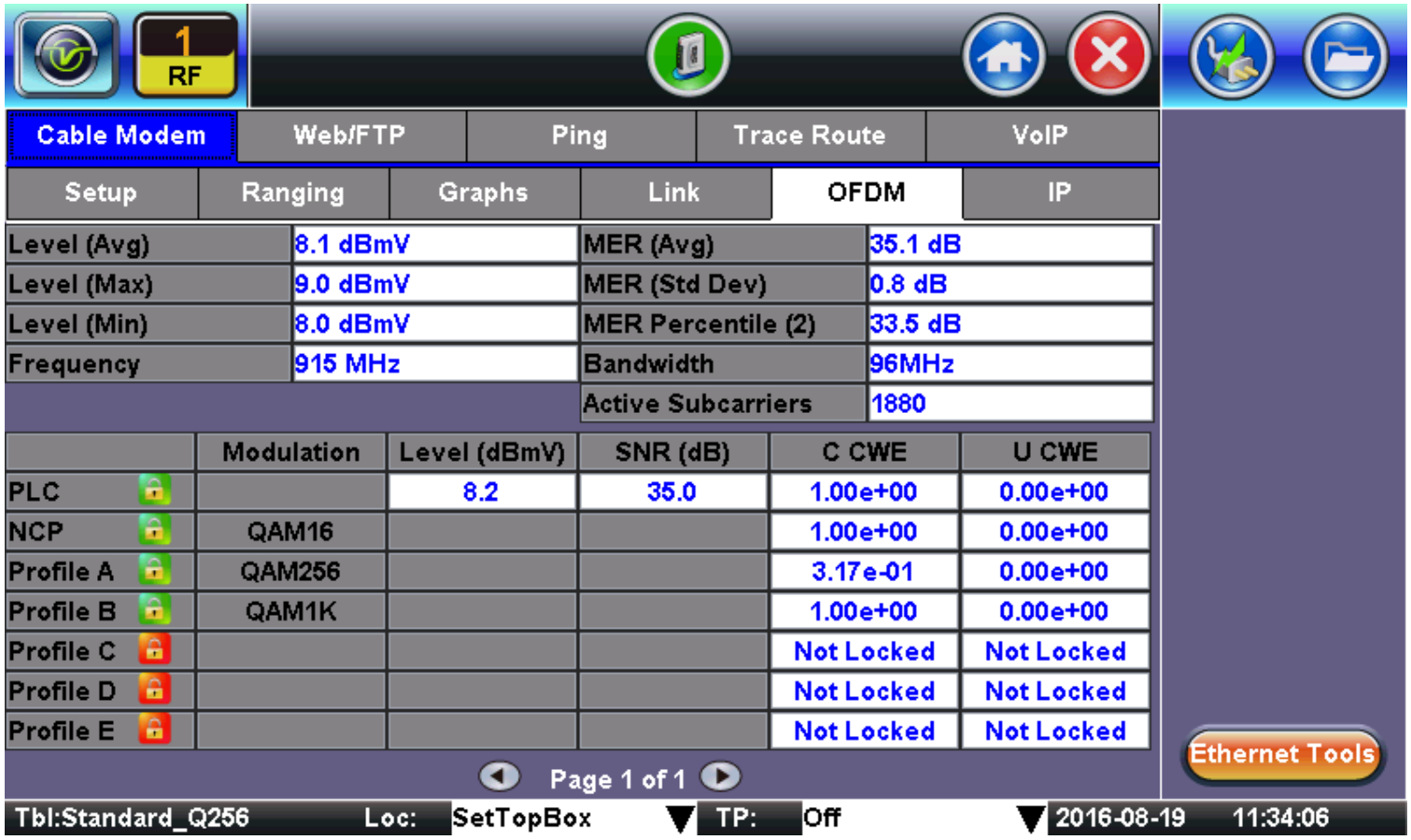


- Verify Forward & Transmit Balance
- “Tilt” for DOCSIS Carriers

Service Level Testing

- Check bonded channels for any errors

Service Level Testing



- Perform OFDM verification

Summary

Review the OFDM Basic configuration and measurements

PLC (Physical Link Channel) – Level, Lock & U CWE

	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00

NCP (Next Codeword Pointer) – Lock, U CWE

	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00
NCP	QAM16			1.00e+00	0.00e+00

Profile A – Lock, U CWE

	Modulation	Level (dBmV)	MER (dB)	C CWE	U CWE
PLC	QAM16	11.7	44.0	1.00e+00	0.00e+00
NCP	QAM16			1.00e+00	0.00e+00
Profile A	QAM256			0.00e+00	0.00e+00
Profile B	QAM1K			0.00e+00	0.00e+00
Profile C	QAM4K			0.00e+00	0.00e+00

Summary

Review the OFDM Basic configuration and measurements

OFDM overall parameters

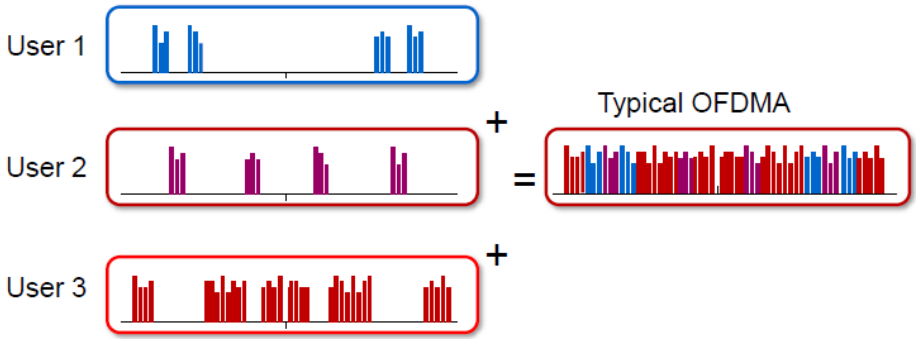
- Average 6MHz Power Level
- Average MER
- MER Standard Deviation
- MER 2 Percentile

Setup	Ranging	Graphs	Link	OFDM	IP
Level (Avg)	11.1 dBmV		MER (Avg)	44.7 dB	
Level (Max)	13.0 dBmV		MER (Std Dev)	1.4 dB	
Level (Min)	11.0 dBmV		MER Percentile 02 %	41.5 dB	
Frequency	759 MHz		Subcarrier Bandwidth	50 kHz	
Bandwidth	96 MHz		Active Subcarriers	1880	

What About the Return?
Future but getting near…

- DOCSIS 3.1. Replaces ATDMA with OFDMA
- **O**rthogonal **F**requency **D**ivision **M**ultiple **A**ccess
- Both time and frequency methods are used to support multi-user transmission and for backwards compatibility with D3.0 US Channel Bonding
- More efficient US Bandwidth
- Flexibility: can shut on/off OFDMA subcarriers to adapt legacy US channels with D3.1 US

From Keysite PPT:



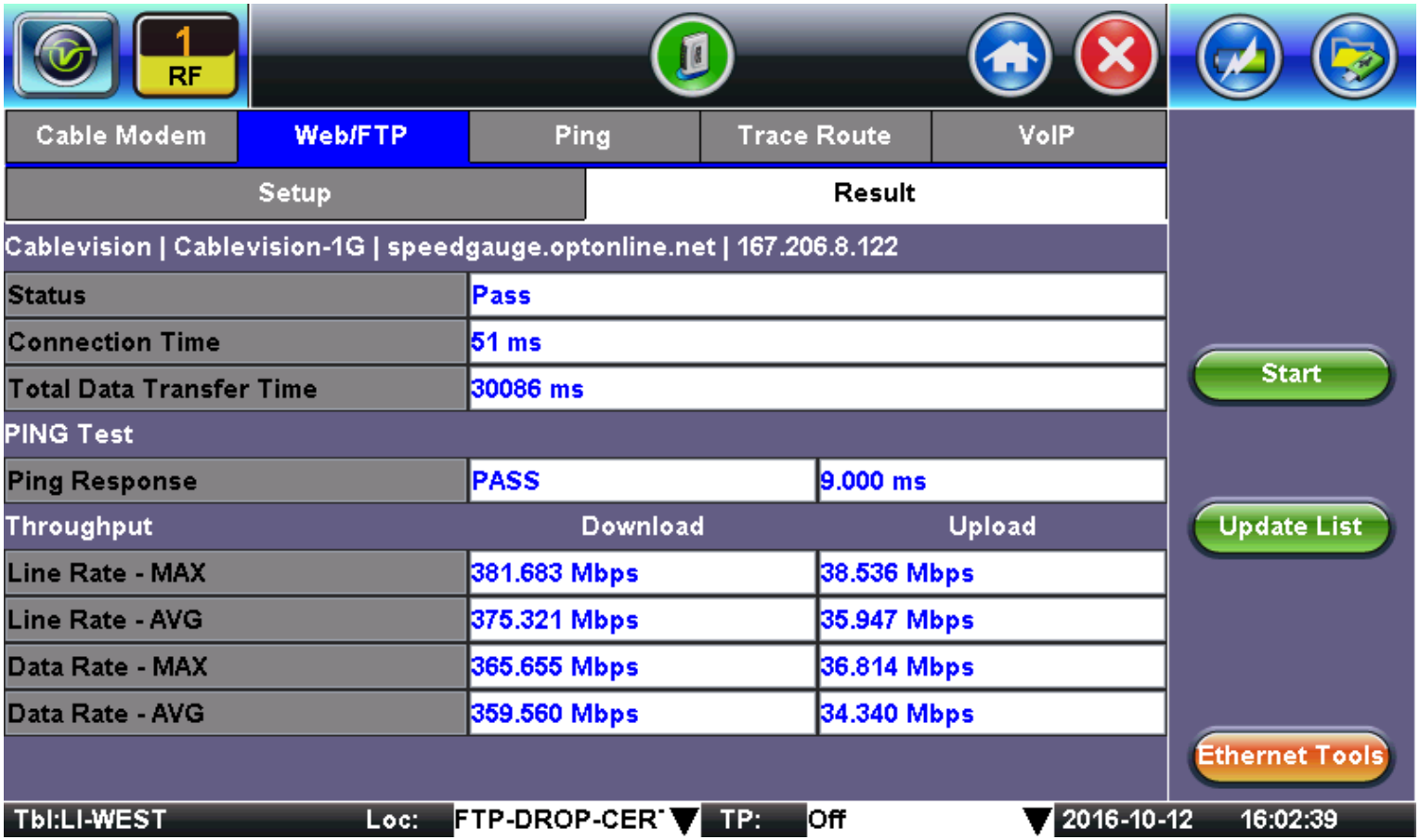
- DOCSIS 3.1 is going from time domain symbols to frequency domain symbols (ATDMA > OFDMA)
  - Read section 9 of the DOCSIS 3.1 PHY specification for PNM details

Services Testing/Verification

IP Functions
PING

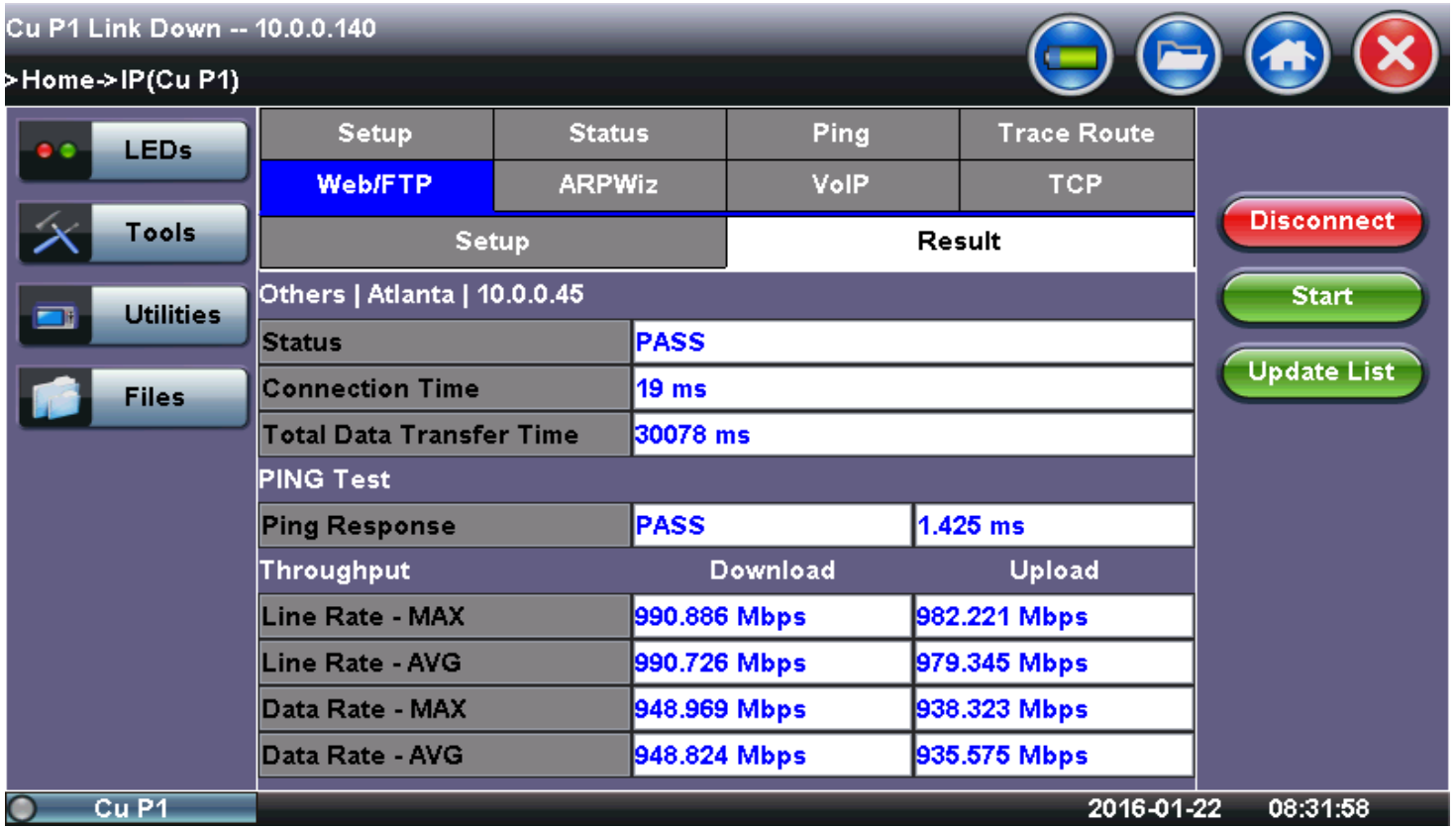
- PING for connectivity/Latency to CMTS, Internal IP or Public IP

IP Functions
Cable Modem VeTEST (Speedtest)



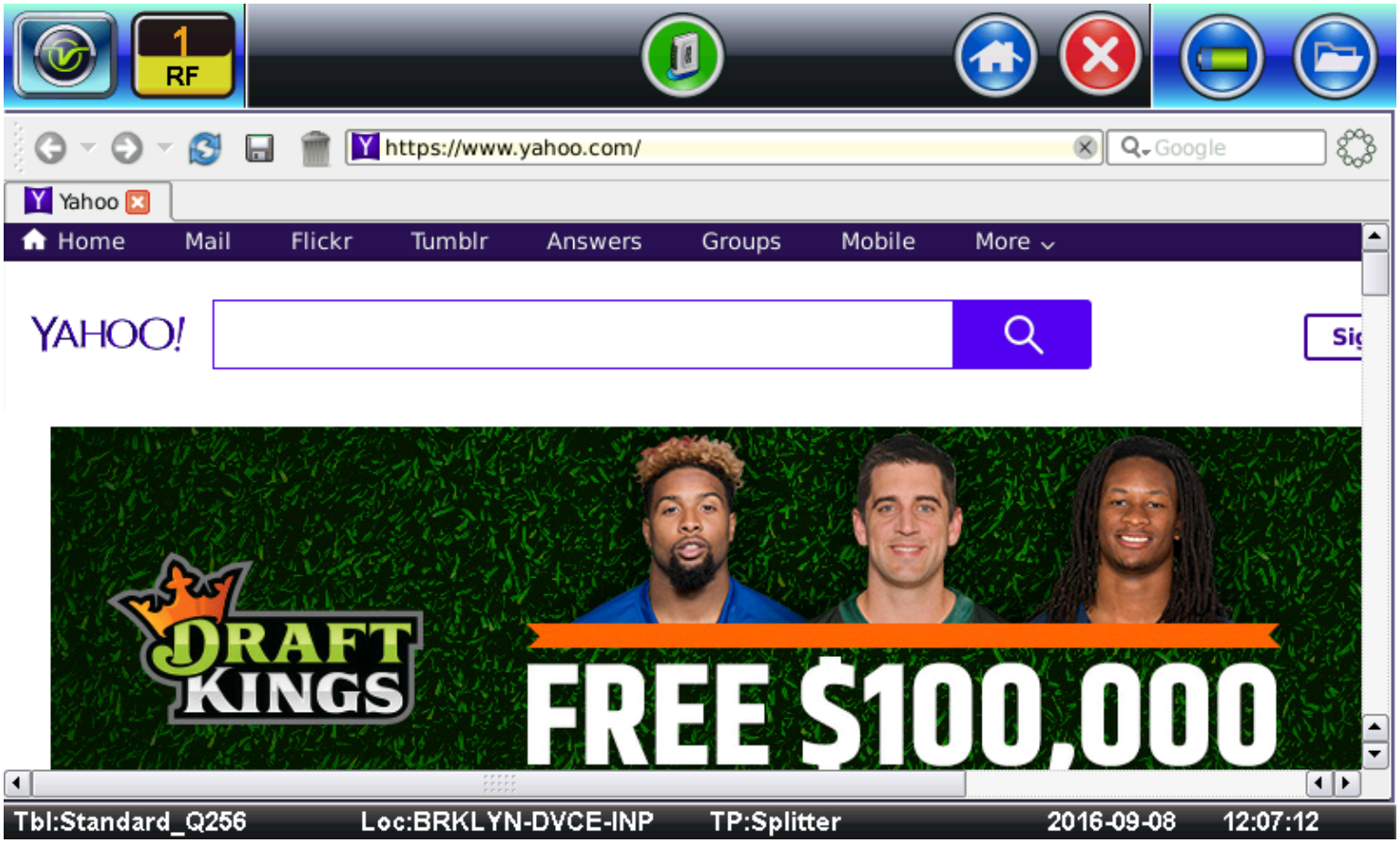
- Throughput testing on RF
- On or Off Net

IP Functions
Ethernet/CPE VeTEST



- Throughput testing both on Ethernet Port
- On or Off Net

Web Browser


1
RF
https://www.yahoo.com/
Google
Yahoo
Home
Mail
Flickr
Tumblr
Answers
Groups
Mobile
More
YAHOO!
DRAFT KINGS
FREE $100,000
Tbl:Standard_Q256
Loc:BRKLYN-DVCE-INP
TP:Splitter
2016-09-08
12:07:12

Trouble?
Sub Carrier Scans

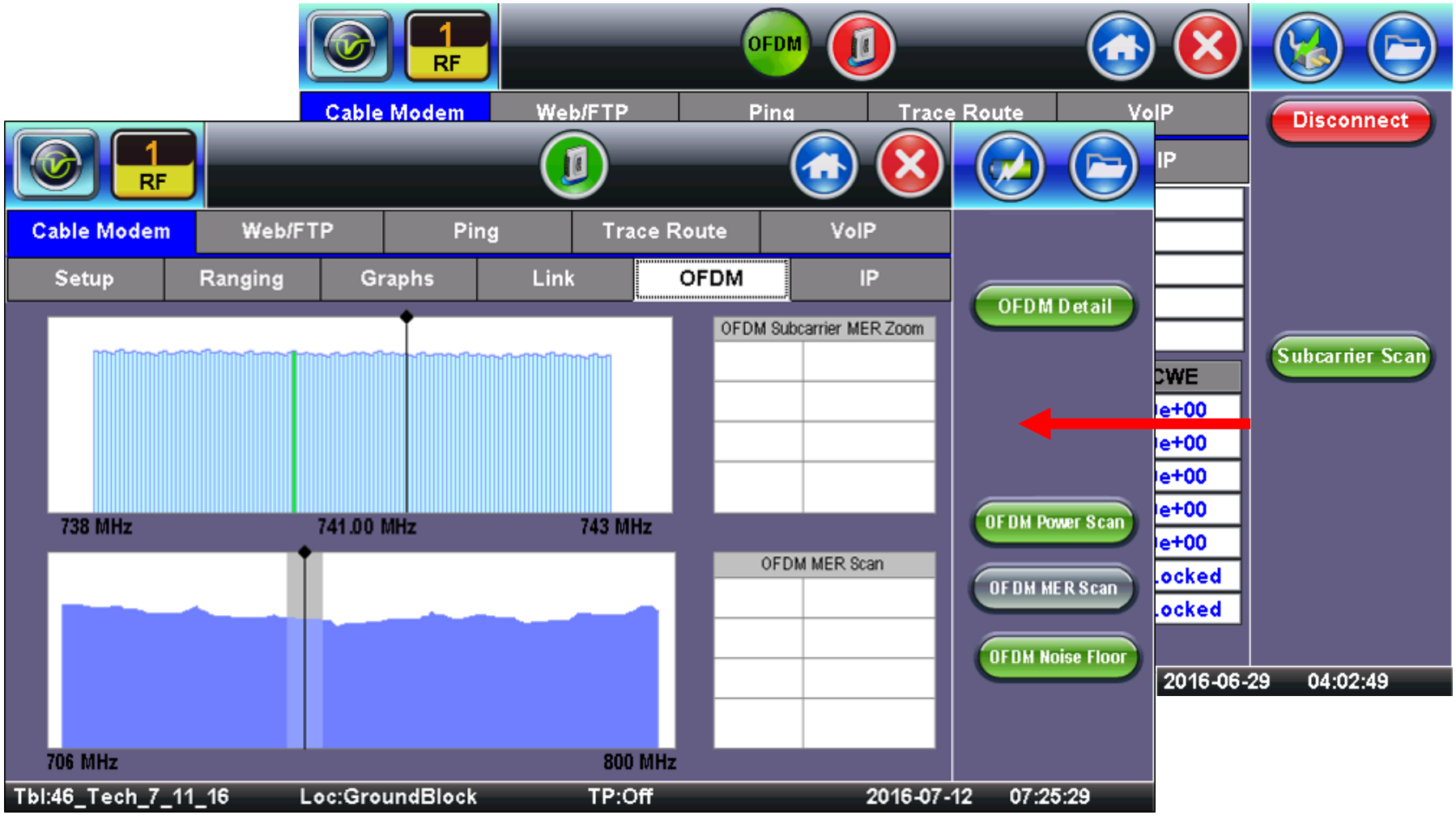
What Happens if your 3.1 service is not performing?

OFDM Sub-carrier Scan
OFDM 6 MHz Power

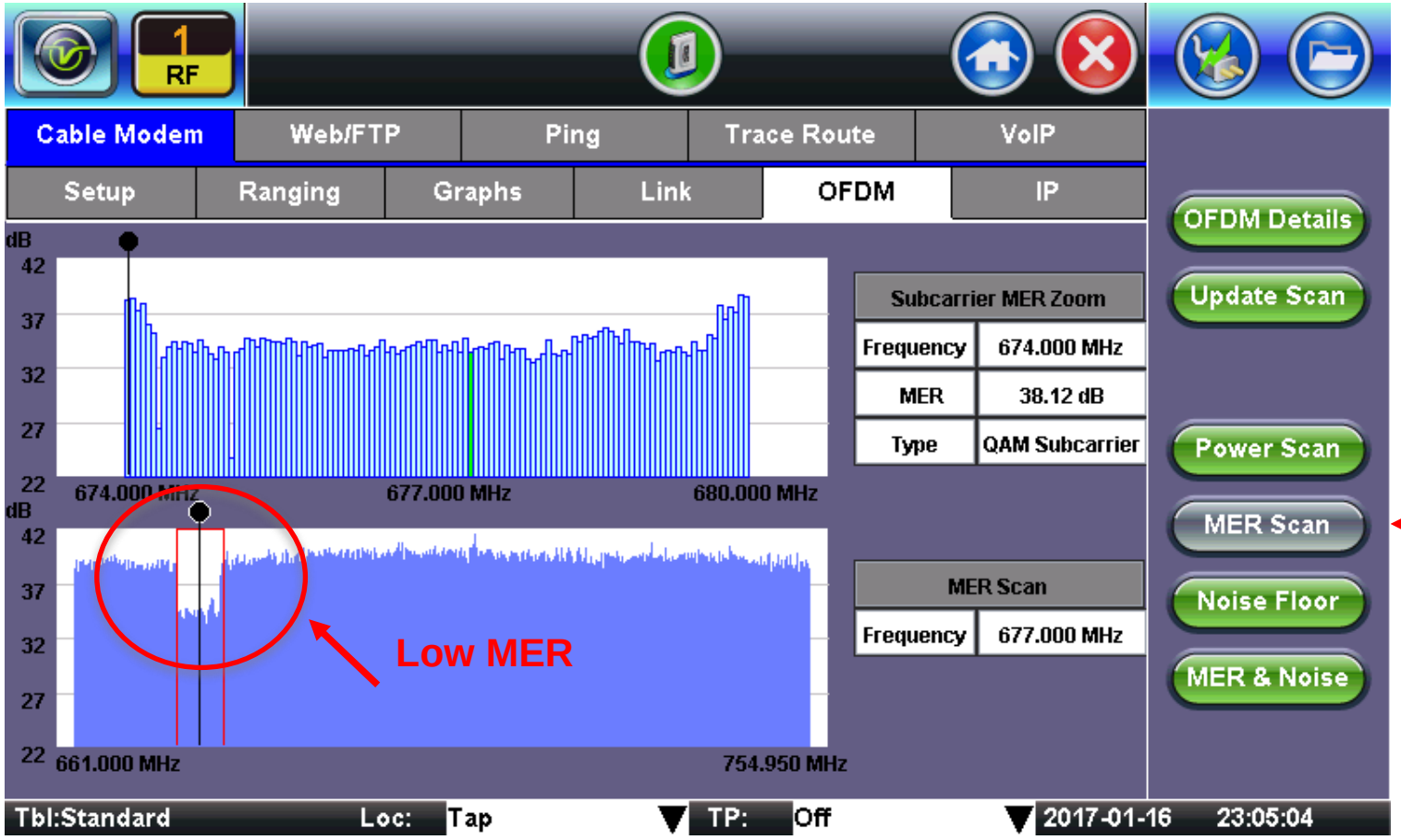
Good Example

OFDM Sub-carrier Scan
OFDM 6 MHz Power

OFDM Sub-carrier Scan
MER Scan

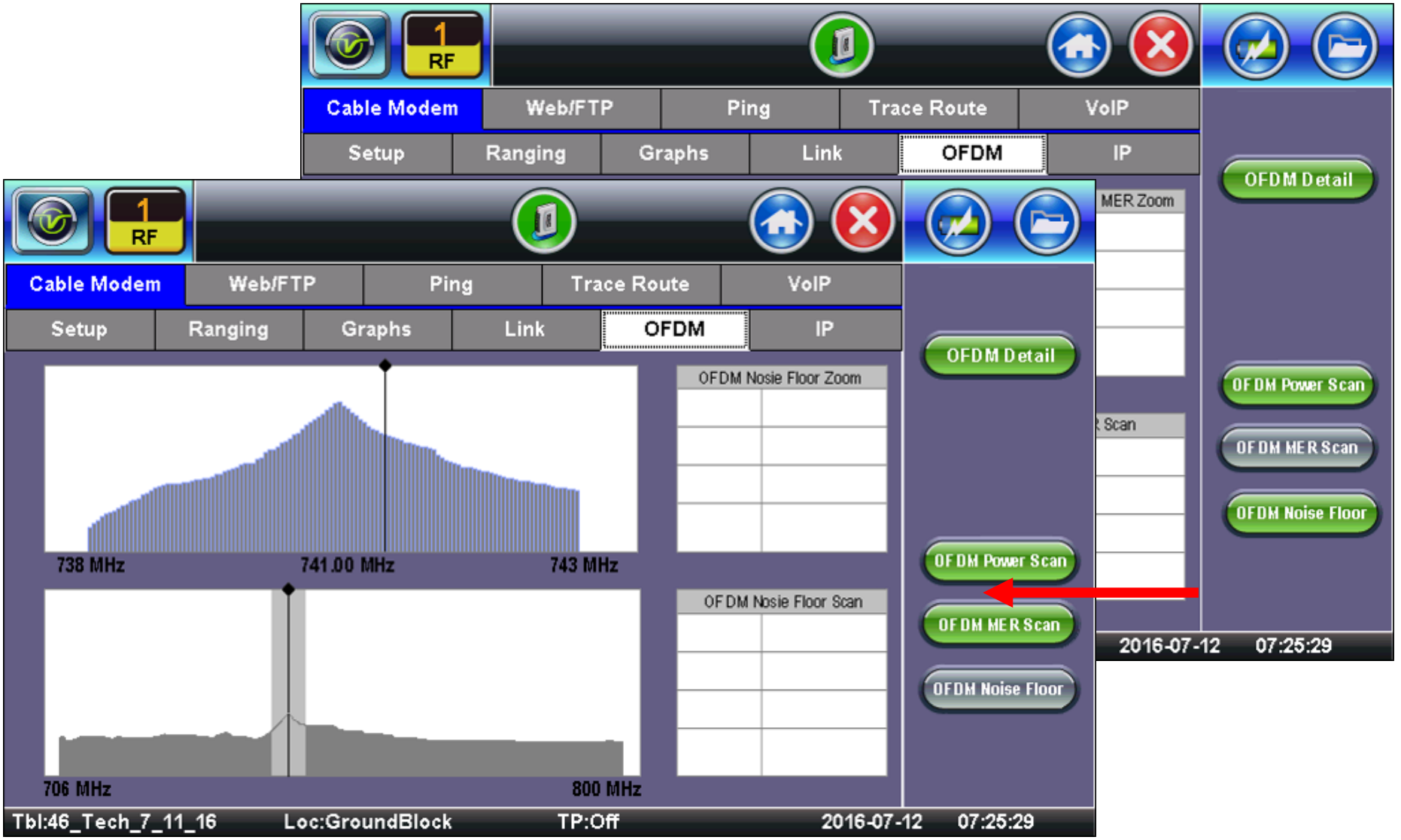


OFDM Sub-carrier Scan
MER Scan

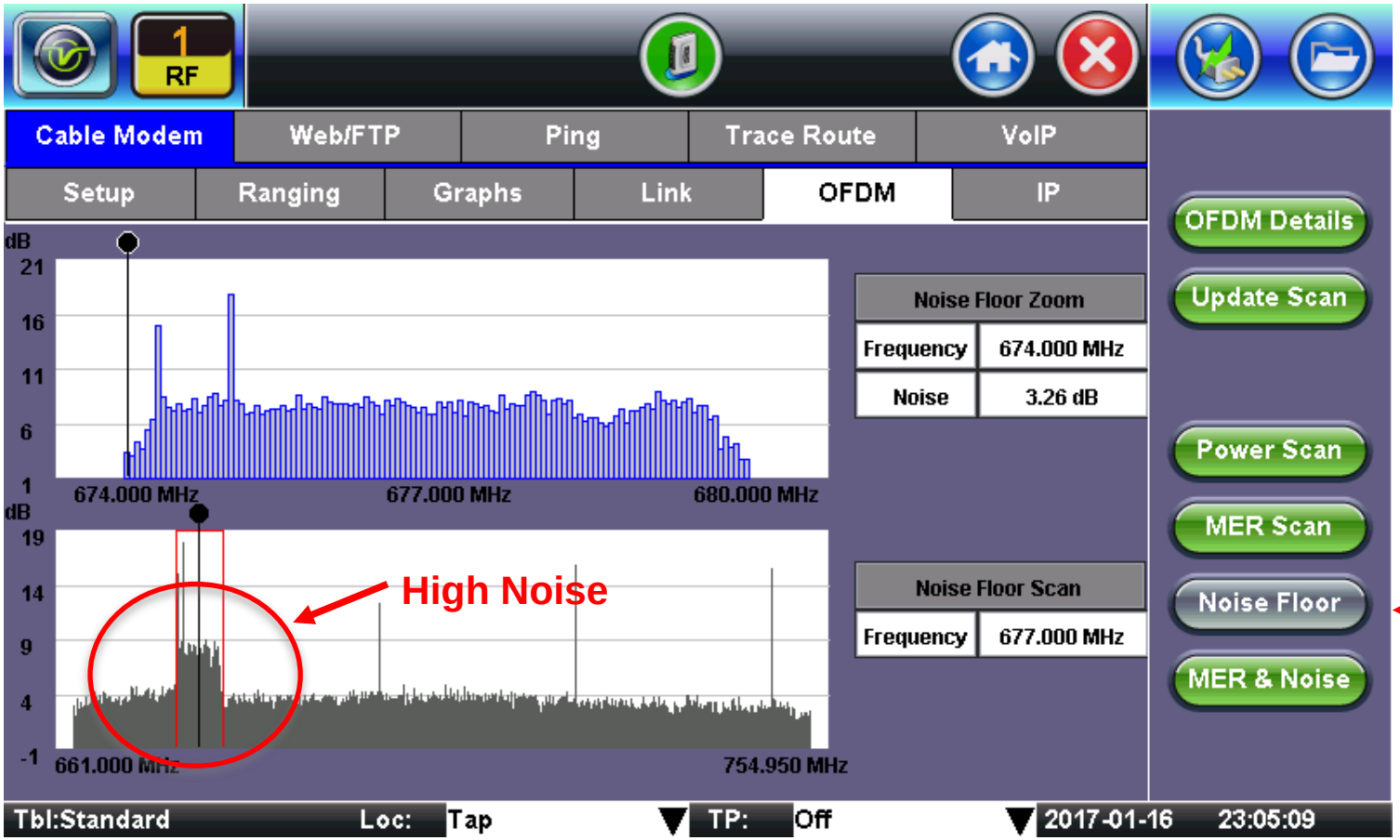


Actual Customer Site

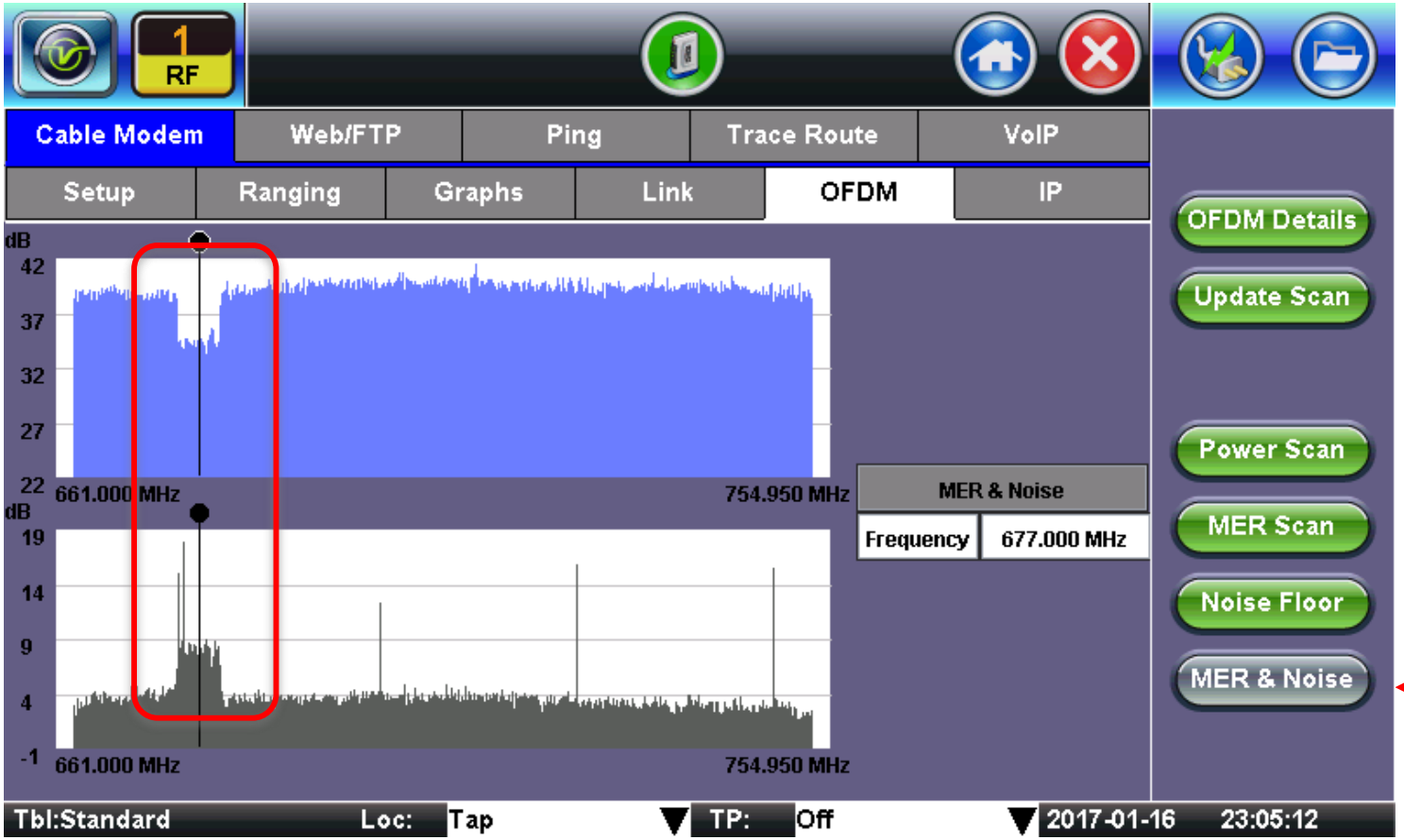
OFDM Sub-carrier Scan
OFDM Noise Floor



OFDM Sub-carrier Scan
OFDM Noise Floor

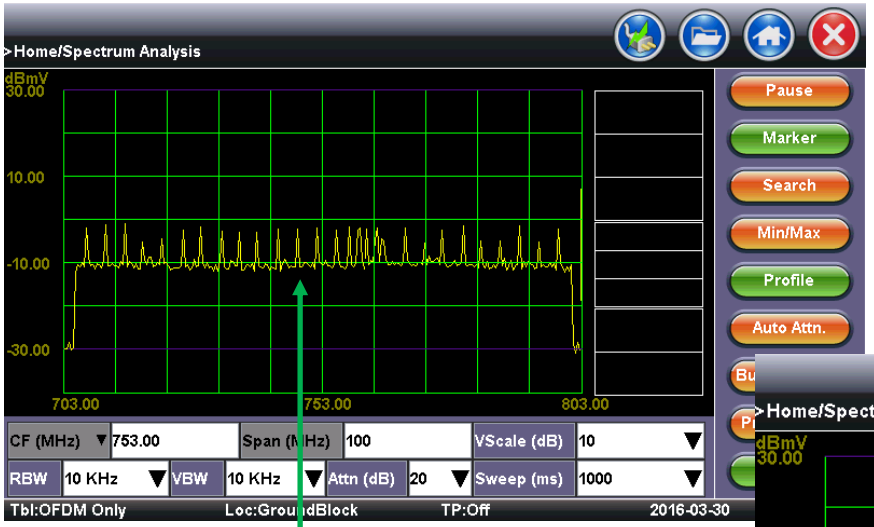


OFDM Sub-carrier Scan
OFDM MER & Noise



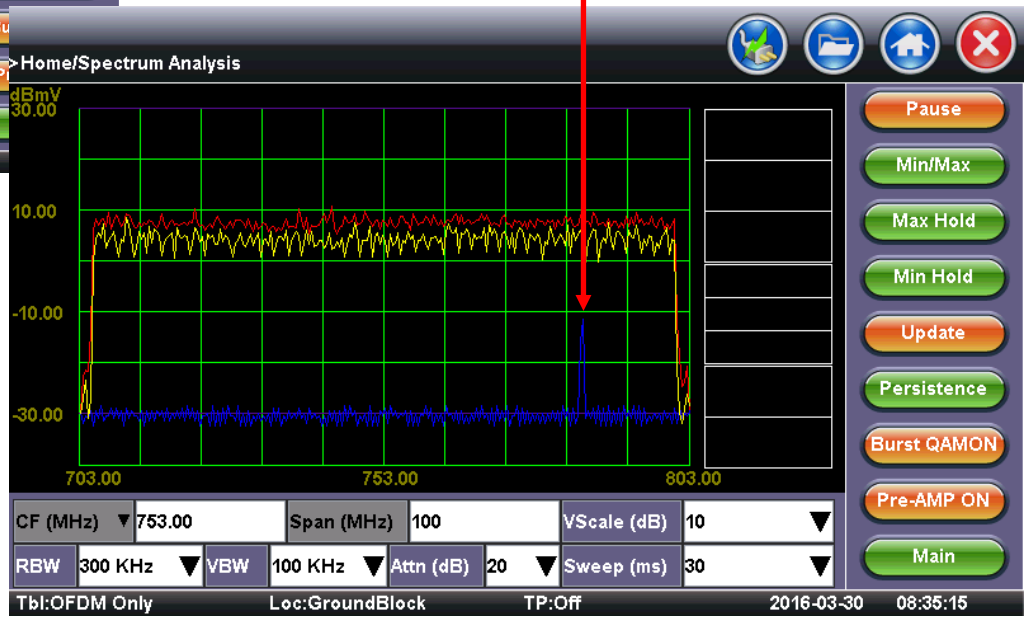
In this case Low MER was caused by High Noise
(Not Always)

Using Spectrum to find Noise under OFDM



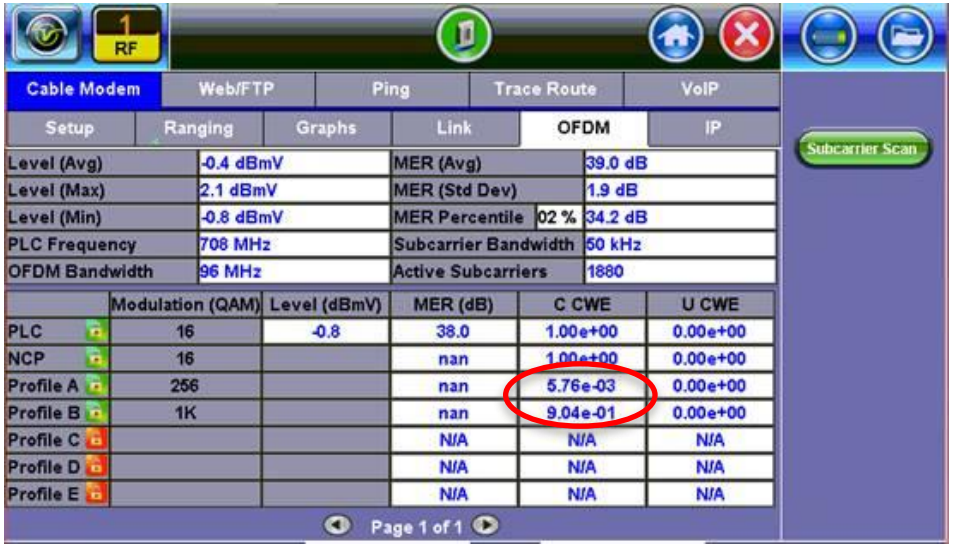
OFDM 96 MHz
Running clean

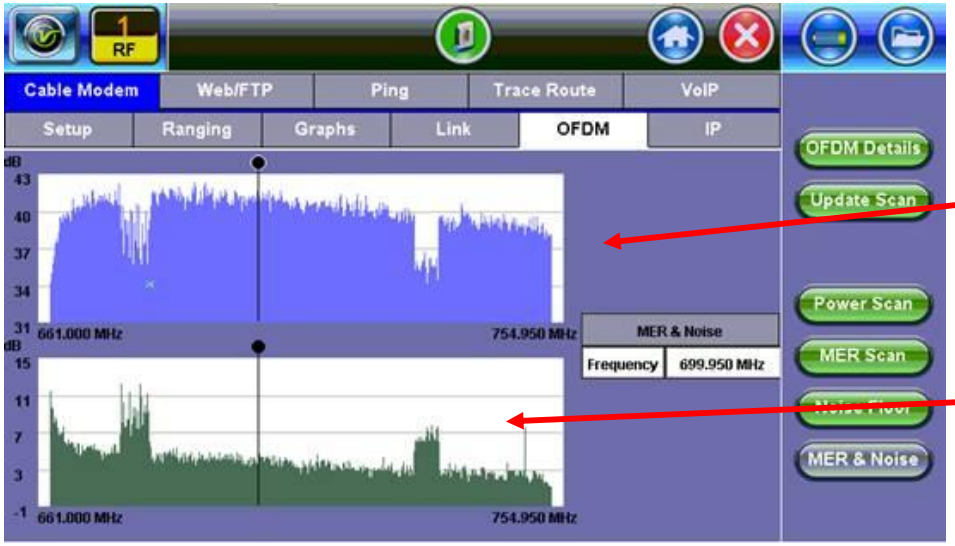
Noise Detected @ NCP
Could cause modems to switch to 3.0



Interesting Use Cases- A growing list!

DOCSIS 3.1
Using the Sub-Carrier Scan in the Plant





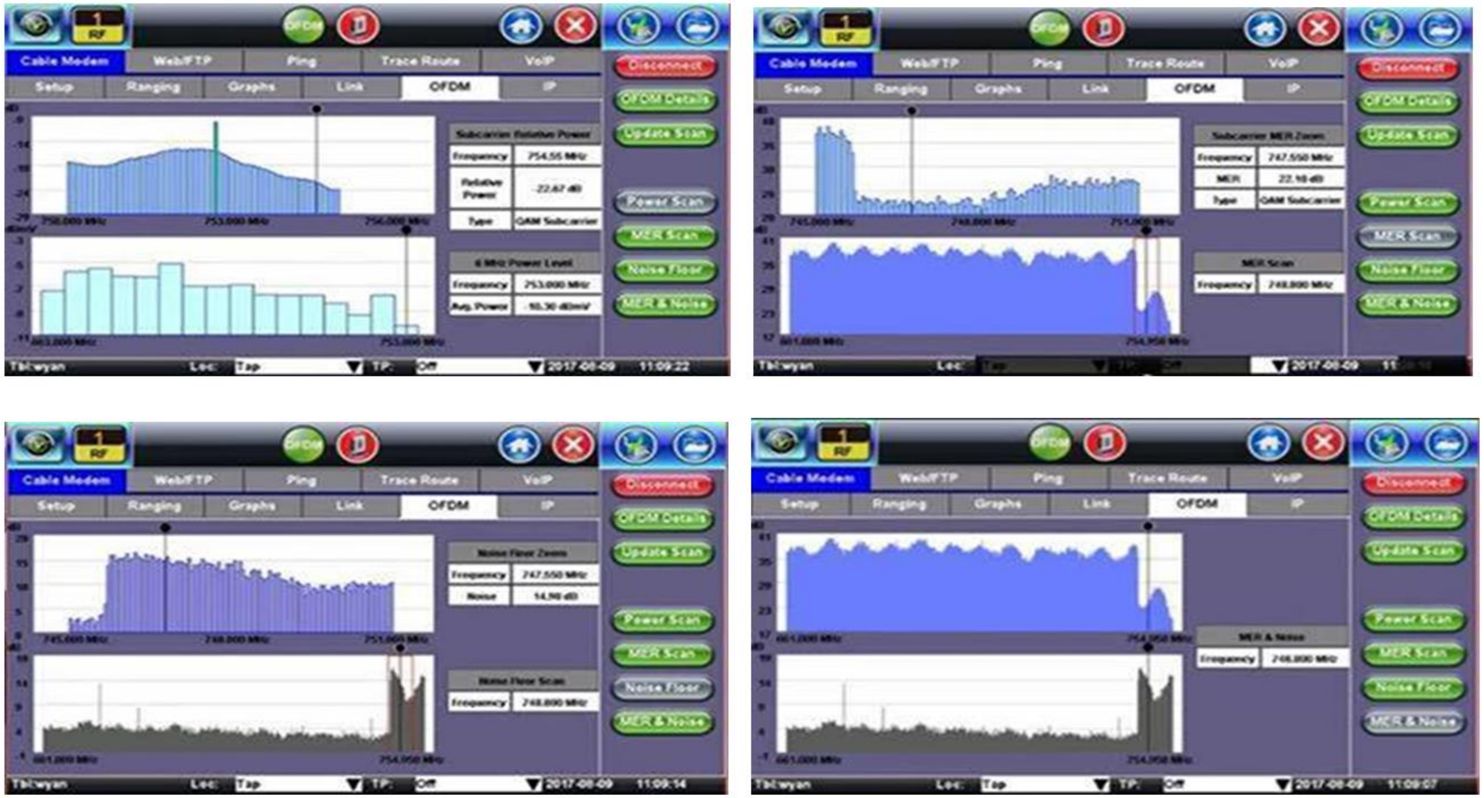
- Customer (in Atlanta) complaining to Large MSO about Modem going offline
- Able to connect 3.1 but quite a few CWE
- Use Sub-Carrier Scan to quickly view the Noise under the Sub-Carriers and Ingress is quickly identified.
- Chased the Ingress to the TAP-referred to OSP to locate the source and resolved issue

MER Scan

Noise Under the OFDM Scan

DOCSIS 3.1

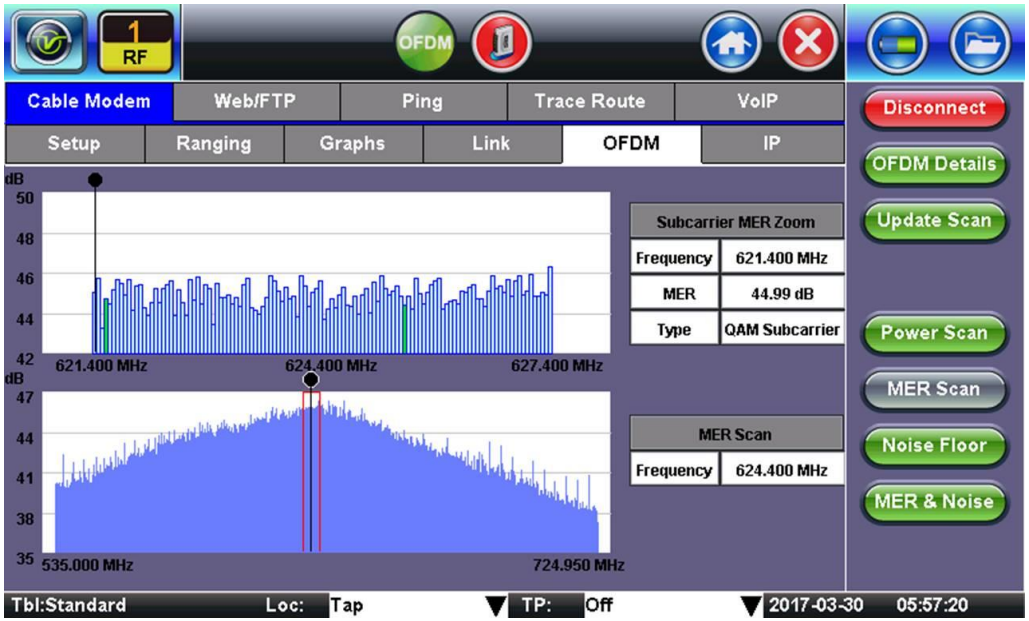
Using Sub-Carrier Scan In Home or Business



- SCTE Vendor Show In IN with a shared drop
- Unable to connect 3.1 so did OFDM Check
- Go to Sub-Carrier Scan and look at the Noise/MER-Ingress quickly identified, noted frequency and suspect LTE Ingress
- Vendor at the nearby table had a test set with a faulty F-Connector that was allowing LTE Ingress into the drop –fixed the F Connector and noted Ingress gone
- Locked up at 3.1!

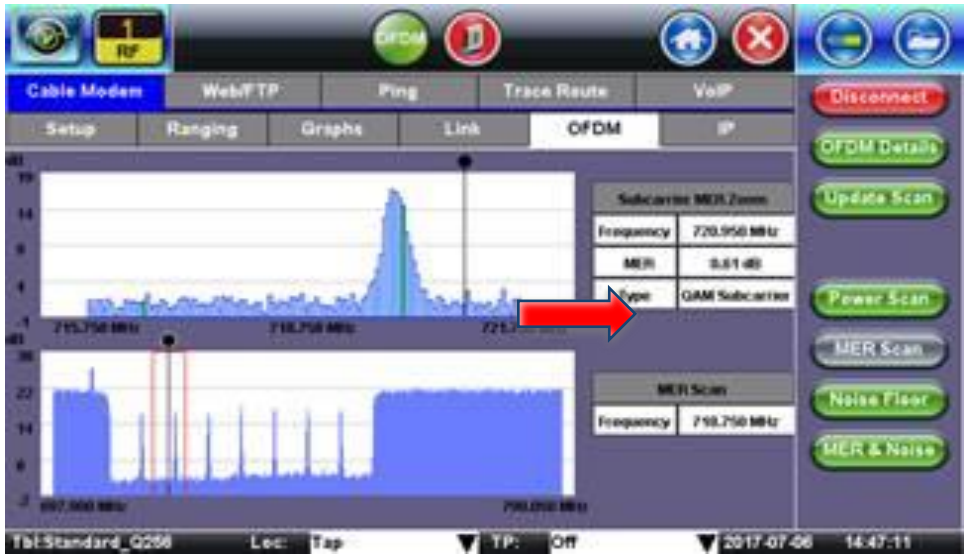
DOCSIS 3.1
Using Sub-Carrier Scan in the Head End

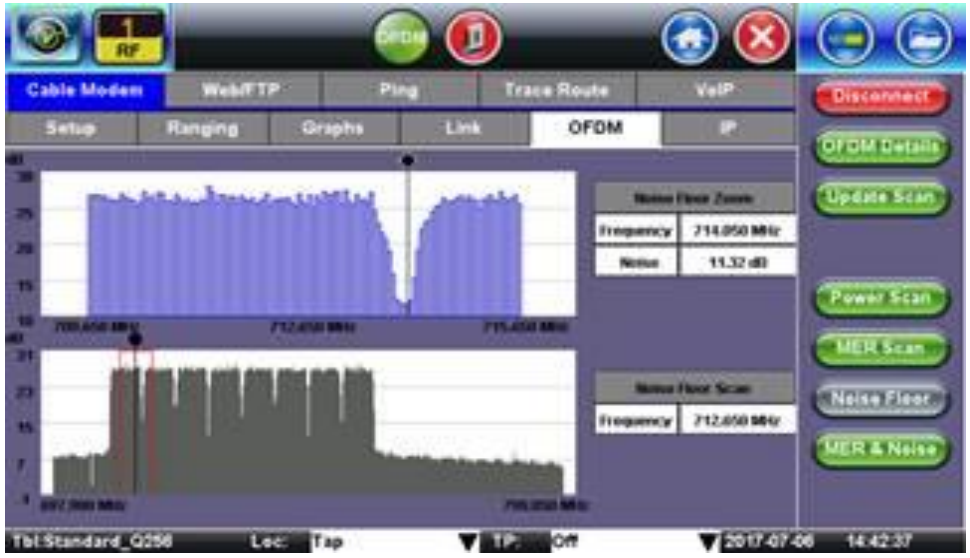
Large "Hump" in the Subcarrier MER Display



- Large MSO in the US
- Turning up OFDM Nodes using a Cisco CMTS and a Line card that services 8 Nodes
- Unable to connect 3.1 on 4 of the nodes so did OFDM Check
- Go to Sub-Carrier Scan and look at the MER Scan and see an easily identifiable "Hump" .
- Changed the line card and Hump is gone and able to connect on all 8 Nodes- wound up being a timing issue on the card

When you Can't Connect at 3.1
OFDM Check Discovers "WHY"





- Helping Major MSO in Needham MA with what was described as a **"Partial Lock"** problem when turning up new OFDM Nodes
- Verified that we were unable to connect 3.1
- Used OFDM Check to look at the OFDM –went to Subcarrier Scan and looked at MER/Noise-clearly identify QAMs in the same frequency "chunk" as the OFDM
- These "filler QAMs" were removed and problem was resolved and we were able to Lock 3.1

Questions???

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