







Agenda

- DOCSIS 3.0 Overview
- DOCSIS 3.0 terminology
- DOCSIS modem registration
- Advanced Troubleshooting

Drivers for D3.0 – Other than Verizon & AT&T!





DOCSIS 3.0 Overview

- DOCSIS 3.0 Specification(s) DOCSIS 3.0 Interface Specifications (Released December 2006) Equipment readily available Downstream data rates of 160 Mbps or higher 256QAM => ~40Mbps Channel Bonding 4 or more channels 8 x 256QAM => ~304 Mbps Upstream data rates of 120 Mbps or higher Channel Bonding 4 or more channels 64QAM => ~30Mbps Internet Protocol version 6 (IPv6) 4 x 64QAM =>~108 Mbps - Current System (IPv4) is limited to 4.3B numbers IPv6 greatly expands the number of IP addresses Expands IP address size from 32 bits to 128 bits IPv6 supports 3.4×10³⁸ addresses; Colon-Hexadecimal Format 4923:2A1C:0DB8:04F3:AEB5:96F0:E08C:FFEC
- 100% backward compatible with DOCSIS 1.0/1.1/2.0



DOCSIS Comparison

| DOCSIS Version | Max Downstream Throughput (net) | Max Upstream Throughput (net) |
|----------------|--|--|
| 1.x | 42.88 (38) Mbit/s | 10.24 (9) Mbit/s |
| 2.0 | 42.88 (38) Mbit/s | 30.72 (27) Mbit/s |
| 3.0 | n x 42.88 (38) Mbit/s 8 x 38 = 304 Mbit/s | n x 30.72 (27) Mbit/s 4 x 27 = 108 Mbit/sec |

© The Volpe Firm | Proprietary and Confidential



DOCSIS® 3.0 Assumed Downstream RF Channel Transmission Characteristics

| Parameter | Value |
|---|---|
| Frequency range | 108 to 1002 MHz edge to edge |
| RF channel spacing (design bandwidth) | 6 MHz |
| Transit delay from head-end to most distant customer | ≤ 0.800 ms (typically much less) |
| Carrier-to-noise ratio in a 6 MHz band | Not less than 35 dB |
| Carrier-to- CTB, CSO, X-MOD, Ingress | Not less than 41 dB |
| Amplitude ripple | 3 dB within the design bandwidth |
| Group delay ripple in the spectrum occupied by the CMTS | 75 ns within the design bandwidth |
| Micro-reflections bound for dominant echo | -10 dBc@ <= 0.5 μsec -20 dBc@ <= 1.5 μsec -30 dBc@ > 1.5 μsec |
| Maximum analog video carrier level at the CM input | 17 dBmV |





DOCSIS® 3.0 Assumed Upstream RF Channel Transmission Characteristics

| Parameter | Value |
|--|---|
| Frequency range | 5 to 85 MHz edge to edge |
| Carrier-to-interference plus ingress ratio | Not less than 25 dB |
| Carrier hum modulation | Not greater than –23 dBc (7%) |
| Burst noise | Not longer than 10 µsec at a 1 kHz average rate for most cases |
| Amplitude ripple 5-42 MHz | 0.5 dB/MHz |
| Group delay ripple 5-42 MHz | 200 ns/MHz |
| Micro-reflections—single echo | -10 dBc@ <= 0.5 μsec -20 dBc@ <= 1.0 μsec -30 dBc@ > 1.0 μsec |
| Seasonal and diurnal reverse gain (loss) variation | Not greater than 14 dB min to max |





The Bonded Upstream



[©] The Volpe Firm | Proprietary and Confidential



Power Variance – 6dB Bonded vs. Unbonded

| Constellation | Constellation Gain G _{const} Relative to 64 QAM (dB) | L | P _{min} (dBmV) M | н | P _{max} (dBmV) TDMA | P _{max} (dBmV) S-CDMA | P _{min} - G _{const} (dBmV) | P _{max} - G _{const} (dBmV) TDMA | P _{max} - G _{const} (dBmV) S-CDMA |
|---------------|--|----|---------------------------------|----|------------------------------------|--------------------------------------|---|--|--|
| QPSK | -1.18 | 17 | 20 | 23 | 61 | 56 | 18.18 | 62.18 | 57.18 |
| 8 QAM | -0.21 | 17 | 20 | 23 | 58 | 56 | 17.21 | 58.21 | 56.21 |
| 16 QAM | -0.21 | 17 | 20 | 23 | 58 | 56 | 17.21 | 58.21 | 56.21 |
| 32 QAM | 0.00 | 17 | 20 | 23 | 57 | 56 | 17.00 | 57.00 | 56.00 |
| 64 QAM | 0.00 | 17 | 20 | 23 | 57 | 56 | 17.00 | 57.00 | 56.00 |
| 128 QAM | 0.05 | 17 | 20 | 23 | N/A | 56 | 16.95 | N/A | 55.95 |

DOCSIS 3.0 Cable Modem 1 Channel Transmit Power Levels

DOCSIS 3.0 Cable Modem 4 Channel Transmit Power Levels

| Constellation | Constellation Gain G _{const} Relative to 64 QAM (dB) | L (| P _{min} (dBmV) M | н | P _{max} (dBmV) TDMA | P _{max} (dBmV) S-CDMA | P _{min} - G _{const} (dBmV) | P _{max} - G _{const} (dBmV) TDMA | P _{max} - G _{const} (dBmV) S-CDMA |
|---------------|--|-----|---------------------------------|----|------------------------------------|--------------------------------------|--|--|--|
| QPSK | -1.18 | 17 | 20 | 23 | 55 | 53 | 18.18 | 56.18 | 54.18 |
| 8 QAM | -0.21 | 17 | 20 | 23 | 52 | 53 | 17.21 | 52.21 | 53.21 |
| 16 QAM | -0.21 | 17 | 20 | 23 | 52 | 53 | 17.21 | 52.21 | 53.21 |
| 32 QAM | 0.00 | 17 | 20 | 23 | 51 | 53 | 17.00 | 51.00 | 53.00 |
| 64 QAM | 0.00 | 17 | 20 | 23 | 51 | 53 | 17.00 | 51.00 | 53.00 |
| 128 QAM | 0.05 | 17 | 20 | 23 | N/A | 53 | 16.95 | N/A | 52.95 |

© The Volpe Firm | Proprietary and Confidential



Measuring Upstream Carrier Amplitudes





Real Life Scenario

♦ Cable8/1/3-upstream0 WLN15 - 0 - 0 - 0/25.0 Mhz WL_WLN15 25.000 MHz
 ♦ Cable8/1/3-upstream1 WLN15 - 0 - 0 - 0/28.2 Mhz WL_WLN15 28.200 MHz
 ♦ Cable8/1/3-upstream2 WLN15 - 0 - 0 - 0/31.4 Mhz WL_WLN15 31.400 MHz
 ♦ Cable8/1/3-upstream3 WLN15 - 0 - 0 - 0/34.6 Mhz WL_WLN15 37.000 MHz
 93.76 (73.66%) 30.93 (●24.30%) 2.59 (♥2.04%)
 126.85 77 30.6 🚃

- Upstream at 37 MHz 64-QAM, 6.4 MHz BW
 - Twice as wide and 3 dB lower than other carriers
- 24.3% FEC errors, 30.6 dB MER
- 25 MHz, 28.2 MHz, 31.4 MHz @ 64-QAM, 3.2 MHz okay
- Why? What is the problem, what is the recommended solution without going into the field?
- cable upstream 3 equalization-coefficient





Terminology & Registration





© The Volpe Firm | Proprietary and Confidential



Downstream Terminology

- Primary Downstream Channel(s)
 - Masterclock, UCD, MAPs, etc.
 - CMs Registration + PDU
- Non-Primary Capable Channel(s)
 - PDU only
 - D3.0 modems
- Downstream Service Group (DSG)
 - DS bonded CHs available to CM
- Upstream Channel Descriptor UCD
 - MAC message to CMs describing US CH





Upstream Terminology

Upstream Channel

- Physical Upstream Channel (DOCSIS RF), or
- Logical Upstream Channel (share same RF ch)
- Upstream Bonding Group (UBG)
 - Set of US bonded channels for CM





DOCSIS Communications Model





Cable Modem Registration - DOCSIS 1.x/2.0

- CM registration requires the physical layer for signal transport

- DOCSIS and IP protocol layers are necessary to communicate the proper messages for modems to come online
- The next slides illustrate the interaction of these layers



© The Volpe Firm | Proprietary and Confidential

(17)





[©] The Volpe Firm | Proprietary and Confidential





CM Registration Summary

- Downstream channel search
- Ranging
- DHCP
- ToD
- TFTP
- Registration
- Optional BPI Encryption
- Ranging occurs at least every 30 seconds when online
 - T3 timeout part of this and typically indicate upstream problems
 - T4 timeout typically indicate downstream problems



D3.0 Modem Registration





Advanced Troubleshooting









Advanced Field Troubleshooting

- Why is DOCSIS 3 Troubleshooting Different?
 - Multiple Bonded Channels
 - Downstream
 - Not that different.
 - The channels are constant carrier
 - Multiple downstream channels have been around forever
 - Upstream
 - Still most vulnerable portion of plant
 - The modem is no longer limited to a single upstream transmit path
 - In some ways this is actually easier with DOCSIS 3.0





You Likely Know Your Problems

- Downstream Typically not so bad
 - CTB, CSO, CNR under digital channels
 - Levels not correct into home (high, low, tilt)
 - Suck-outs, especially if you have contractors doing disconnects
 - Cheap modulators & upconverters never save you money
 - DOCSIS 3.0 headaches Channel bonding, isolation, legacy
- Upstream Your Achilles heal
 - Easy: AWGN noise, impulse noise, coherent noise, CPD, Laser clipping
 - Hard: Group delay, frequency response, micro-reflections
 - Insane: DOCSIS 3.0 multiple upstreams power levels
- Theft of Service



© The Volpe Firm | Proprietary and Confidential



Likely Upstream Problems

- Four times the US bandwidth (four bonded channels) creates a new dynamic for troubleshooting and monitoring:
- 6.4 MHz*4 = 25.6 MHz (without guard bands)
- Increased likelihood for laser clipping
- Increased probability for problems with ingress, group delay, microreflections, and other linear distortions
- Inability to avoid problem frequencies such as Citizens' Band, Ham, Shortwave, and hop between CPD 6MHz spacing
- Where are you going to put your sweep points?



Test Equipmenthas

| http://commiscotrak03:8080/Acterna0C5/demodOuery.de?action_FLEX_PortSelectedBoartLabel_8PM 7.Po - Internet_Explorer_optimized | Vanceo | |
|--|--|--|
| 🛞 🛞 = 🔀 Mtp://com/mcptrak03.8080/Action = 500 SelectedSportLabel=RPM 7 Port 18portType=RPM30008portLide=2346 | 💌 😔 🔀 Google | • م] |
| Efe Edt View Favorites Io + Favorites Inhttp://com | å• ⊠ · ⊡ ⊕• | Bage - Safety - Tools - 🔞 - 🛪 |
| JOSU Pantrak Report ADAU Report ADAU <td><complex-block></complex-block></td> <td>724 Unique MAC#: 65 200 200 200 2200</td> | <complex-block></complex-block> | 724 Unique MAC#: 65 200 200 200 2200 |
| MIN: 23.96 AVG: 25.71 Center: 42.750 MHz | | Stop: 85,000 MHz |
| Pocket. 425 Time: 2010-10.07 11 MAC: 00.24.82.60.06.74 | - MER - UNEQ MER - Carrier Level - d With the ansatz - Carrier Level - d With the ansatz - carrier Level - d - d - d - d - d | Un-SQ Symbols |

© The Volpe Firm | Proprietary and Confidential



Downstream Impairments

| 4 | | ٠ | ~ | * | | ٠ | â; | 讀 | 1 | 2 | 1 | pie : | 1 | 潮 | 1 |
|------------|------|-----|----|---|---|---|----|--------------|--|-----------------|-----------------------|----------------|----------------|-----------------|-----|
| * | * | * | 4 | * | æ | * | * | ×. | N. | 14 | | ipe. | 1 | * | j. |
| ٠ | 4 | 2 | | | ۲ | 4 | 8 | 200 | and the second s | 15 | 1 | - 1997 | | <i>1</i> 4 | 4 |
| H | .5 | ۲ | | 4 | ٠ | 3 | 4 | ولمؤ | 1 | 1 | 1 | | 36 | 2 | 1 |
| a . | 5 | æ | 51 | | 4 | | | 1 | ÷. | ÷. | ÷. | 1. ES | | * | 1 |
| Þ. | | * | | ÷ | | | Ø. | ×. | 1 | * | \mathcal{H}_{i}^{n} | ÷. | de | 2. | 1 |
| * | * | | # | * | | + | Ħ | ÷ | . \$\$ | * | V) | 19 | 4 | A. | 1 |
| * | | ÷ | 6 | * | * | Æ | si | 14 | 1 | 100 | | 120 | 100 | . 3 <u>6</u> 29 | ÷ę. |
| Goo | od N | 1EF | 2 | | | | | No | ise | | | | | | |
| | | | | | | | | Gaus poor | sian ly de | noise fined | imp and | airme sprea | ents. ad ou | Cluste t. | ers |
| | | | | | | | | Poss | ible (BE let | Cause Vels I | es: ow ir | nuts | to | | |

Low RF levels, low inputs to RF amplifiers

| | ۲ | * | 4 | * | .* | * | ۰ |
|-----|-------------|----------------|----|------------|----|------------|----------------|
| ×. | 7 89 | b . | .* | . M | - | Å | . 🍇 |
| · 🔶 | * | Ý. | ٠ | . * | .* | ÷ | |
| * | - 🥵 | ¥ | * | 8 | * | # 1 | ` * |
| * | £. | * | Ŕ | æ | ÷ | * | * |
| × | | * | ę | 19 | * | * | * |
| * | ٠ | * | 1 | ٠ | ٠. | * | . 🕊 |
| * | 4 | a i | * | \$ | * | 4 | à |

Intermittent Interference

On/Off interference below the desired QAM signal. Isolated dots appear away from the main cluster.

Possible Causes:

Laser clipping, intermittent ingress (2-way radios & paging systems)



Downstream Impairments

| * : | * : | ŧ, | ÷ | ₹ę. | * | 1 | 1 |
|------------|-------------|----------|----|-----|--------------|-----|------|
| * | 4 | 77 | | * | .* | ÷. | 3 |
| * | ŧ. | 1 | ٠ | -4 | 8- | ÷ | .* |
| ÷ | ₩. | R | 4 | - | * | -46 | ÷ |
| * | \$ 2 | 8. | ٠ | •7 | × | ۶ | 14 |
| | 4 | ŧ | ø. | ie: | * ę . | ð: | °.59 |
| ø. | Ť | 3 | 4 | * | * | - 7 | - |
| * | 4 | W | ħ | * | ÷+ | ¥ | ÷,* |

Compression

Non-linear distortion. Clusters are "pulled in" at the corners.

Possible Causes:

Overdriven or bad RF/IF amps, IF/RF filters, up/down converters, IF equalizers, bad clock recovery circuits



Phase Noise

Phase shift of I & Q data. The clusters appear to rotate around the center of the constellation.

Possible Causes: Headend IF amplifiers and Up/Down converters

| 6.20 | | 200 | and a second | -2:37 | 10 | 1.10 | A. B. |
|---------------------------|--------|----------------|--------------|---------|----------------|-----------|--------------------|
| $\ell_{c,2}^{(r_0)}$ | 19 | 100 | N.W. | 5. A. | 14 | 12 | in the second |
| TINE | Ser. | 19 | 1.2 | State . | 824 A | 12.4 | Selly. |
| $\tilde{z}^{\mu}_{,\chi}$ | 1 | -(-)X | 200 | Sec. | and the second | 1.15 | 1 |
| 10,3 | and a | N. | 24 | Sec. | 8 | 2.2 | $\{ \cdot \}$ |
| 2109. 2109. | 100 | 167 A | 5.4 | 100 | And . | 19. 10 A. | 14 24 7.84 |
| 12 | (inter | 14.0 | 100 | 1 | 10.0 | 83 | 5 ²⁹ .5 |
| 12.41 | | and the second | 12.2 | 11 | 2 | 1.8 | Party - |

Coherent Disturbance

Interference from a signal under the desired QAM signal. Clusters appear doughnut shaped.

Possible Causes:

Ingress, CW Interference



Modulation Error Ratio (MER)



- The quality of a QAM signal can be defined by the dispersion of the constellation's points considering the target value
- The error or dispersion power is calculated by the value mean square of the error vectors (real value VS target value)
- MER is the ratio in dB between the average power of the signal and the power of the error vectors



MER

| BER | 64-QAM MER | 256-QAM MER | Quality |
|---------------|---------------|----------------|-----------|
| 10 -10 | >35 | >35 | Excellent |
| 10 -8 | 27-34 | 31-34 | Good |
| 10 -6 | 23-26 | 28-30 | Marginal |
| 10 -5 | <23 | <28 | Fail |
| | | | |



Upstream Ingress Cancellation – On default



© The Volp 32 Proprietary and Confidential

Something New – DOCSIS 3.0



© The Volpe Firm | Proprietary and Confidential

Testing DOCSIS 3.0 Meter – JDSU / Viavi DSAM





| | Cable Mode | em | | | NCT |
|------|------------|--------|--------|------|---------|
| Freq | Enc. | BW | Туре | Leve | I Head. |
| 19.3 | A-TDMA | 6.4MHz | QAM16 | 35.8 | 19.2 |
| 25.7 | A-TDMA | 6.4MHz | QAM16 | 35.3 | 19.7 |
| 32.1 | A-TDMA | 6.4MHz | QAM16 | 36.3 | 18.7 |
| 38.5 | A-TDMA | 6.4MHz | QAM16 | 36.8 | 18.2 |
| | | | | | |
| File | ▲ Viev | N • | Limits | ▲ S | ettings |



| ▶ meas | sure | | 5 CSIS3 0 |
|-----------------------------|--------------------------|---------------------------|-------------------------------|
| OFF | | | DOC256 80 |
| through | put | platinumv11. | cm |
| +112000 +96000 +80000 | upstream 4007 | m 7 kb/s | +280000 +240000 +200000 |
| +64000 | | downstream 189135 kb/s | +160000 +120000 |
| +32000_ +16000_ 0 | - 4x _bonded | 8x bonded | +80000 +40000 0 |
| File | View | ^ | |

© The Volp 34 Proprietary and Confidential



DOCSIS 3.0 Channel Bonding Eight channel downstream





VeEX CX380 CM Screen Shot

| Cable Modem | | | | | | | | | | | |
|--------------------|----------------|-------------|--------------|---------|-----------------|------------------------|---------------|-------------|-------------|------------|-----------------|
| >Home/Cable Modem | | | | | | | | | | | |
| Cable Modem | Web/FTP | Ping | Trace Route | 1 | /oIP | | | | | | |
| Setup | Result | s | IP | Lin | ık 🛛 | | | ~ 4 | | | |
| Downstream (Ch) | 639.00 | 645.00 | 651.00 | 657.00 | | | • D3 | 8x4 | Chanr | iel Bond | ling: |
| Symbol Rate | 5.361 MSps | 5.361 MSps | 5.361 MSps | 5.361 N | /ISps | | | aile | | | U |
| Modulation | 256 QAM | 256 QAM | 256 QAM | 256 QA | M | | | ans | | | |
| Level | 5.6 dBmV | 5.3 dBmV | 5.4 dBmV | 5.8 dBi | mV | | | | | | |
| SNR (dB) | 45.1 | 45.3 | 45.4 | 45.8 | | | | | | | |
| Pre-BER | 0.0e+00 | 0.0e+00 | 0.0e+00 | 0.0e+0 | 0 | | | | | | |
| Pre-Error Seconds | 0 | 0 | 0 | 0 | Cable Medem | _ | | | | | |
| Post-BER | 0.0e+00 | 0.0e+00 | 0.0e+00 | 0.0e+0 | | - d | | | | | 😑) (🔥) 🔁 |
| Post-Error Seconds | 0 | 0 | 0 | 0 | >Home/Cable M | odem | | | | | |
| | | | | | Cable Modem | Web/F | IP I | Ping | Trace Route | VolP | |
| | | | | | Setup | | Results | | IP | Link | |
| | | Page 1 | of 3 🕑 | | Downstream (C | h) <mark>663.00</mark> | 669.0 | 0 | 675.00 | 681.00 | |
| TbI:VX_TEST | Loc:Com | cast Outlet | TP:Off | | Symbol Rate | 5.361 MS | ips 5.361 | MSps | 5.361 MSps | 5.361 MSps | |
| | | | | | Modulation | 256 QAM | 256 G | AM | 256 QAM | 256 QAM | |
| | | | | | Level | 5.8 dBm\ | / 6.0 dl | ∃mV | 5.4 dBmV | 4.5 dBmV | |
| | | | | | SNR (dB) | 44.6 | 45.2 | | 45.4 | 43.0 | |
| | | | | | Pre-BER | 0.0e+00 | 0.0e+ | 00 | 0.0e+00 | 0.0e+00 | |
| | | | | | Pre-Error Seco | nds <mark>0</mark> | 0 | | 0 | 0 | |
| | | | | | Post-BER | 0.0e+00 | 0.0e+ | 00 | 0.0e+00 | 0.0e+00 | |
| | | | | | Post-Error Seco | onds <mark>0</mark> | 0 | | 0 | 0 | |
| | | | | | | | | | | | |
| © The Volpe | Firm Proprie | etary and C | Confidential | | | | • | Page 2 of 3 | 3 🕑 | | Ethernet Tools |
| | | | | | Tbl:VX_TEST | L | .oc:Comcast O | utlet | TP:Off | 16-0 | 1-2012 12:44:51 |



A Clean Upstream: Or Is It for 64-QAM?



© The Volpe Firm | Proprietary and Confidential



Impact to Adaptive EQ from Impulse Noise

| CISCOOPK#SCU DI | ny | | | | | | | | |
|-----------------|---------|-----|--------|-------|--------|--------|-------|--------|--------|
| MAC Address | I/F | Sid | USPwr | USMER | Timing | DSPwr | DSMER | Mode | DOCSIS |
| | | | (dBmV) | (SNR) | Offset | (dBmV) | (SNR) | | Prov |
| | | | | (dB) | | | (dB) | | |
| a47a.a4b7.c60e | C1/0/U0 | 1 | 45.75 | 36.12 | 2398 | 0.00 | | atdma* | 1.1 |
| a47a.a4b7.c60e | C1/0/U1 | 1 | 45.75 | 36.12 | 2333 | 0.00 | | atdma* | 1.1 |
| a47a.a4b7.c60e | C1/0/U2 | 1 | 45.75 | 36.12 | 2399 | 0.00 | | atdma* | 1.1 |
| a47a.a4b7.c60e | C1/0/U3 | 1 | 45.75 | 36.12 | 2399 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U0 | 2 | 45.25 | 36.12 | 2400 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U1 | 2 | 45.25 | 36.12 | 2400 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U2 | 2 | 45.25 | 36.12 | 2397 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U3 | 2 | 45.25 | 36.12 | 2400 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U0 | 3 | 44.25 | 36.12 | 3958 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U1 | 3 | 44.75 | 36.12 | 3958 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U2 | 3 | 44.75 | 36.12 | 2121 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U3 | 3 | 44.25 | 36.12 | 3958 | 0.00 | | atdma* | 1.1 |
| CiscoUBR#scm pl | hy | | | | | | | | |
| MAC Address | I/F | Sid | USPwr | USMER | Timing | DSPwr | DSMER | Mode | DOCSIS |
| | | | (dBmV) | (SNR) | Offset | (dBmV) | (SNR) | | Prov |
| | | | | (dB) | | | (dB) | | |
| a47a.a4b7.c60e | C1/0/U0 | 1 | 45.75 | 18.92 | 2398 | 0.00 | | atdma* | 1.1 |
| a47a.a4b7.c60e | C1/0/U1 | 1 | 45.75 | 36.12 | 2333 | 0.00 | | atdma* | 1.1 |
| a47a.a4b7.c60e | C1/0/U2 | 1 | 45.75 | 36.12 | 2399 | 0.00 | | atdma* | 1.1 |
| a47a.a4b7.c60e | C1/0/U3 | 1 | 45.75 | 36.12 | 2399 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U0 | 2 | 45.25 | 36.12 | 2400 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U1 | 2 | 45.25 | 36.12 | 2400 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U2 | 2 | 45.25 | 36.12 | 2397 | 0.00 | | atdma* | 1.1 |
| 0023.74f6.7ad9 | C1/0/U3 | 2 | 45.25 | 36.12 | 2400 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U0 | 3 | 44.25 | 36.12 | 3958 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U1 | 3 | 44.75 | 36.12 | 3958 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U2 | 3 | 44.75 | 36.12 | 2121 | 0.00 | | atdma* | 1.1 |
| 0026.2482.9dc4 | C1/0/U3 | 3 | 44.25 | 36.12 | 3958 | 0.00 | | atdma* | 1.1 |
| | | | | | | | | | |

© The Volp 3B Proprietary and Confidential



Ways to Mitigate Impact of Impulse Noise

- Clean up plant
- Improve robustness of modulation profile from:
 - cable modulation-profile 224 initial 5 34 0 48 16qam scrambler 152 no-diff 64 fixed qpsk1 1 2048
 - cable modulation-profile 224 station 5 34 0 48 16qam scrambler 152 no-diff 64 fixed qpsk1 1 2048
- To:
 - cable modulation-profile 224 initial 5 34 0 48 16qam scrambler 152 no-diff 384 fixed qpsk1 0 2048
 - cable modulation-profile 224 station 5 34 0 48 16qam scrambler 152 no-diff 384 fixed qpsk1 0 2048
- Changing 64 to 384 increases the preamble length, thus enhancing the training sequence on capturing the packet and lessening the effects of impulse noise
- Changing the 1 to a 0 enables dynamic interleaving mode, increasing the effectiveness of Forward Error Correction (FEC) as impulse noise increases in the system



Monitoring Transient Events?

- Laser Clipping or Impulse Noise for example...
 - Plan on laser clipping being a popular word





Two 64-QAM Bonded Channels







Laser Clipping – FP Laser



© The Volpe 42 Proprietary and Confidential



Laser Clipping – Hard to See







Ingress Under QAM







Laser Heterodyning







Digital Return – RF above 42 MHz







Partial Service Troubleshooting

a47a.a4b7.c60e 10.10.10.3

0026.2482.9dc4 10.10.10.2

- Partial Service exhibits itself as missing channels
- Does not exhibit as Packetloss or Throughput issue

C1/0/UB

C1/0/U0



w-online

online

2

з

0.50

-0.50

2332

2117

0

Ν

Ν





- An impaired service may or may not exhibit codeword errors and packetloss
- When troubleshooting impaired service, it is critical to view the performance of the individual upstream channels.





| doc | csis | | ⊂i≡[i⊧ Matrix |
|--------|--|------|------------------------------|
| 38.20 | 0MHz QAM64 | 00 | :07:11:05:D5:10 |
| 0.0% | Codeword Errors | 0.0% | MER / Unequalized |
| 0.0% | Carrier Level 12.9 dB | 0.0% | Micro-reflection -41.3 dE |
| 0.0% | 0.3 dB/MHz | 0.0% | Group Delay 30.6 ns/MHz |
| 0.0% | Ingress Under Carrier - 57.5 dBc | 0.0% | Impulse Noise 3.5 |
| • | | | |
| | Packet Histo | ory | Live |
| < Back | View 🔺 | | Settings |

| ▶ do | CSIS | 50 | Matrix | | | |
|------|--|--|------------------------|--|------|-------------------------------------|
| 0.0% | Codeword Errors | MER / | Unequalized | | | |
| 0.0% | Carrier Level 0.0 | м 0.0% | icro-reflection 0.0 | | | |
| | In-Band Response | | Group Delay | | | |
| | 19.000MHz / QA 25.400MHz / QA 31.800MHz / QA | M64 / 6.400MHz M64 / 6.400MHz M64 / 6.400MHz | doc 38.20 | SIS | 00 | ڪ≡رF Matrix 07:11:05:D5:10: |
| | 38.200MHz / QA 38.200MHz / QA | AM64 / 6.400MHz | 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 44.7 / 35.0 dB |
| ОК | Cancel | | 0.0% | Carrier Level 12.9 dB | 0.0% | Micro-reflection -41.3 dB |
| | | | 0.0% | In-Band Response 0.3 dB/MHz | 0.0% | Group Delay 30.6 ns/MHz |
| | | | 0.0% | Ingress Under Carrier - 57.5 dBc | 0.0% | Impulse Noise 3.5 |
| | | | • | | | • |
| | | | | Packet Histo | ory | Live |
| | | | < Back | View 🔺 | | Settings 🔺 |
| | | | | | | |



| doo | csis | | ⇔eF Matrix | doo | csis | | Matrix |
|--------|------------------------------------|------|---------------------------------------|--------|------------------------------------|------|-------------------------------------|
| 38.20 | 00MHz QAM64 | 00 | :07:11:05:D5:10 | 31.80 | 00MHz QAM64 | 00 | :07:11:05:D5:10 |
| 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 44.7 / 35.0 dB | 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 45.7 / 35.0 dB |
| 0.0% | Carrier Level 12.9 dB | 0.0% | Micro-reflection -41.3 dB | 0.0% | Carrier Level 16.0 dB | 0.0% | Micro-reflection -42.7 dB |
| 0.0% | In-Band Response 0.3 dB/MHz | 0.0% | Group Delay 30.6 ns/MHz | 0.0% | In-Band Response 0.3 dB/MHz | 0.0% | Group Delay 25.0 ns/MHz |
| 0.0% | Ingress Under Carrier -57.5 dBc | 0.0% | Impulse Noise 3.5 | 0.0% | Ingress Under Carrier -60.1 dBc | 0.0% | Impulse Noise 4.1 |
| • | | | • • • • • • • • • • • • • • • • • • • | (| | | · · |
| | Packet Histo | ory | Live | | Packet Histo | ory | Live |
| < Back | View 🔺 | | Settings 🔺 | < Back | View 🔺 | | Settings 🔺 |

| do | csis | | ⊂≡F Matrix |
|------|--|--|-------------------------------------|
| | MHz | and | |
| 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 0.0 / 0.0 |
| 0.0% | Carrier Level 0.0 | 0.0% | Micro-reflection 0.0 |
| | In-Band Recourse | | Group Delay |
| • | 19.000MHz / QAI 25.400MHz / QAI B1.800MHz / Q A 38.200MHz / QA 31.800MHz / QA | M64 / 6.4 M64 / 6.4 AM64 / 6 M64 / 6.4 | 00MHz 00MHz 5.400MHz 00MHz |
| ок | Cancel | | |

| doo | csis | | ⊂≡ F Matrix |
|--------|------------------------------------|------|-------------------------------------|
| 31.80 | 00MHz QAM64 | 00 | :07:11:05:D5:10 |
| 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 45.7 / 35.0 dB |
| 0.0% | Carrier Level 16.0 dB | 0.0% | Micro-reflection -42.7 dB |
| 0.0% | In-Band Response 0.3 dB/MHz | 0.0% | Group Delay 25.0 ns/MHz |
| 0.0% | Ingress Under Carrier -60.1 dBc | 0.0% | Impulse Noise 4.1 |
| • | | | |
| 2012 | Packet Histo | ory | Live |
| < Back | View 🔺 | | Settings 🔺 |



51

| do | csis | | ⇔eF Matrix | do | csis | | ⇔≡F Matrix | do | csis | | ⇔eF Matrix |
|--------|------------------------------------|------|-------------------------------------|--------|------------------------------------|------|-------------------------------------|--------|------------------------------------|------|-------------------------------------|
| 38.20 | 00MHz QAM64 | 00 | :07:11:05:D5:10 | 31.80 | 00MHz QAM64 | 00 | :07:11:05:D5:10 | 25.40 | 00MHz QAM64 | 00 | :07:11:05:D5:10 |
| 0.0% | Codeword Errors | 0.0% | MER / Unequalized 44.7 / 35.0 dB | 0.0% | Codeword Errors | 0.0% | MER / Unequalized 45.7 / 35.0 dB | 0.0% | Codeword Errors | 0.0% | MER / Unequalized 46.9 / 35.0 dB |
| 0.0% | Carrier Level 12.9 dB | 0.0% | Micro-reflection -41.3 dB | 0.0% | Carrier Level 16.0 dB | 0.0% | Micro-reflection -42.7 dB | 0.0% | Carrier Level 16.1 dB | 0.0% | Micro-reflection -41.9 dB |
| 0.0% | 0.3 dB/MHz | 0.0% | Group Delay 30.6 ns/MHz | 0.0% | In-Band Response 0.3 dB/MHz | 0.0% | Group Delay 25.0 ns/MHz | 0.0% | In-Band Response 0.3 dB/MHz | 0.0% | Group Delay 17.6 ns/MHz |
| 0.0% | Ingress Under Carrier -57.5 dBc | 0.0% | Impulse Noise 3.5 | 0.0% | Ingress Under Carrier -60.1 dBc | 0.0% | Impulse Noise 4.1 | 0.0% | Ingress Under Carrier -61.6 dBc | 0.0% | Impulse Noise 4.3 |
| • | | | · · · | • | | | • • • | • | | | · · |
| | Packet Histo | ry | Live | | Packet Hist | ory | Live | | Packet Hist | ory | Live |
| < Back | View 🔺 | | Settings | < Back | View 🔺 | | Settings 🔺 | < Back | View 🔺 | | Settings 🔺 |

| do | csis | | ⊂i≡[]F Matrix |
|------|------------------------------------|------------------------|--------------------------------|
| | MHz | | |
| 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 0.0 / 0.0 |
| 0.0% | Carrier Level 0.0 | 0.0% | Micro-reflection 0.0 |
| | In-Band Reconse | | Group Delay |
| _ | 19.000MHz / QAI | 464 / 6.4 | 00MHz |
| 00 A | 31.800MHz / QAI 38.200MHz / QAI | M64 / 6.4 M64 / 6.4 | 00MHz 00MHz |
| | 25.400MHz / QA | M64 / 6.4 | 400MHz * |
| OK | Cancel | | |

| doc | | 0.0 | Matrix |
|--------|------------------------------------|------|-------------------------------------|
| 0.0% | Codeword Errors | 0.0% | MER / Unequalized 46.9 / 35.0 dB |
| 0.0% | Carrier Level 16.1 dB | 0.0% | Micro-reflection -41.9 dB |
| 0.0% | 0.3 dB/MHz | 0.0% | Group Delay 17.6 ns/MHz |
| 0.0% | Ingress Under Carrier -61.6 dBc | 0.0% | Impulse Noise 4.3 |
| • | | | |
| | Packet Histo | огу | Live |
| < Back | View 🔺 | | Settings 🔺 |





| ▶ do | csis | | ≁ ς⇔≡ Matrix |
|------|---|------------------------|--------------------------------|
| | MHz | 111 | |
| 0.0% | Codeword Errors 0 | 0.0% | MER / Unequalized 0.0 / 0.0 |
| 0.0% | Carrier Level 0.0 | 0.0% | Micro-reflection 0.0 |
| 0 | In-Rand Response | | Group Delay |
| | 19.000MHz / Q 25.400MHz / QAI 31.800MHz / QAI | AM64 / 6 M64 / 6.4 | 00MHz |
| | 38.200MHz / QA | M64 / 6.4 M64 / 6.4 | |
| ок | Cancel | | |

| ▶ docs | is | | ⇔eF Matrix | | | | |
|--------|-----------------------------------|-------------------|-------------------------------------|--|--|--|--|
| 19.000 | MHz QAM64 | 00:07:11:05:D5:10 | | | | | |
| 95.5% | Codeword Errors 3 | 100.0% | MER / Unequalized 22.3 / 20.4 dB | | | | |
| 0.0% | Carrier Level 16.1 dB | 100.0% | Micro-reflection -34.3 dB | | | | |
| 100.0% | In-Band Response 2.1 dB/MHz | 100.0% | Group Delay 553.5 ns/MHz | | | | |
| 4.5% | ngress Under Carrier -34.2 dBc | 4.5% | Impulse Noise 3.5 | | | | |
| • | | | • | | | | |
| | Packet Histo | ory | Live | | | | |
| < Back | View 🔺 | | Settings 🔺 | | | | |



| do | csis | ⊂EF Matrix | do | csis | ⇔∈F Matrix | do | csis | ⊂⊂E[F Matrix | ▶ docs | sis | ⇔∈[]F Matrix |
|--------|---|-------------------------------------|--------|---|--|--------|---|-------------------------------------|----------------------|---|-------------------------------------|
| 38.20 | 00MHz QAM64 00 | 0:07:11:05:D5:10 | 31.80 | 00MHz QAM64 | 00:07:11:05:D5:10 | 25.40 | 00MHz QAM64 (| 00:07:11:05:D5:10 | 19.000 | MHz QAM64 00: | 07:11:05:D5:10 |
| 0.0% | Codeword Errors 0.0% | MER / Unequalized 44.7 / 35.0 dB | 0.0% | Codeword Errors 0.0% | MER / Unequalized 45.7 / 35.0 dB | 0.0% | Codeword Errors 0 0.0% | MER / Unequalized 46.9 / 35.0 dB | 95.5% | Codeword Errors 3 100.0% | MER / Unequalized 22.3 / 20.4 dB |
| 0.0% | Carrier Level 12.9 dB 0.0% | Micro-reflection -41.3 dB | 0.0% | Carrier Level 16.0 dB 0.0% | Micro-reflection | 0.0% | Carrier Level 16.1 dB 0.0% | Micro-reflection -41.9 dB | 0.0% | Carrier Level 16.1 dB 100.0% | Micro-reflection -34.3 dB |
| 0.0% | 0.3 dB/MHz 0.0% | Group Delay 30.6 ns/MHz | 0.0% | 0.3 dB/MHz 0.0% | 6 Group Delay | 0.0% | In-Band Response 0.3 dB/MHz 0.0% | Group Delay 17.6 ns/MHz | 100.0 <mark>%</mark> | In-Band Response 2.1 dB/MHz 100.0% | Group Delay 553.5 ns/MHz |
| 0.0% | Ingress Under Carrier -57.5 dBc 0.0% | Impulse Noise 3.5 | 0.0% | Ingress Under Carrier -60.1 dBc 0.0% | Impulse Noise | 0.0% | Ingress Under Carrier -61.6 dBc 0.0% | Impulse Noise | 4.5% | Ingress Under Carrier -34.2 dBc 4.5% | Impulse Noise 3.5 |
| • | | • • | ۰. | | | ۰. | | | 4 | | • |
| | Packet History | Live | | Packet History | Live | | Packet History | Live | | Packet History | Live |
| < Back | View 🔺 | Settings 🔺 | < Back | View 🔺 | Settings 🔺 | < Back | View 🔺 | Settings 🔺 | < Back | View 🔺 | Settings 🔺 |

- Obviously there is an issue with the channel at 19 MHz
- Utilize this method to traverse the network and find the impairment causing this issue



Summary

- CMTS and SNMP data provide good troubleshooting
 - But not all of it
- DOCSIS 3.0
 - Significantly more throughput
 - Supports legacy D2.0 modems
 - D3.0 modems load balance in the upstream w/o loss of service
- Advanced test equipment is an investment that
 - Saves you time and money
 - Gets your subscribers back online and keeps them there
 - Makes you a predictable and reliable service provider
 - Seamlessly integrates headend & field 2 places / 1 person



The *Malpe* Firm

End Module 3 Questions?



