Troubleshooting the Home Network

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Member and Supporter

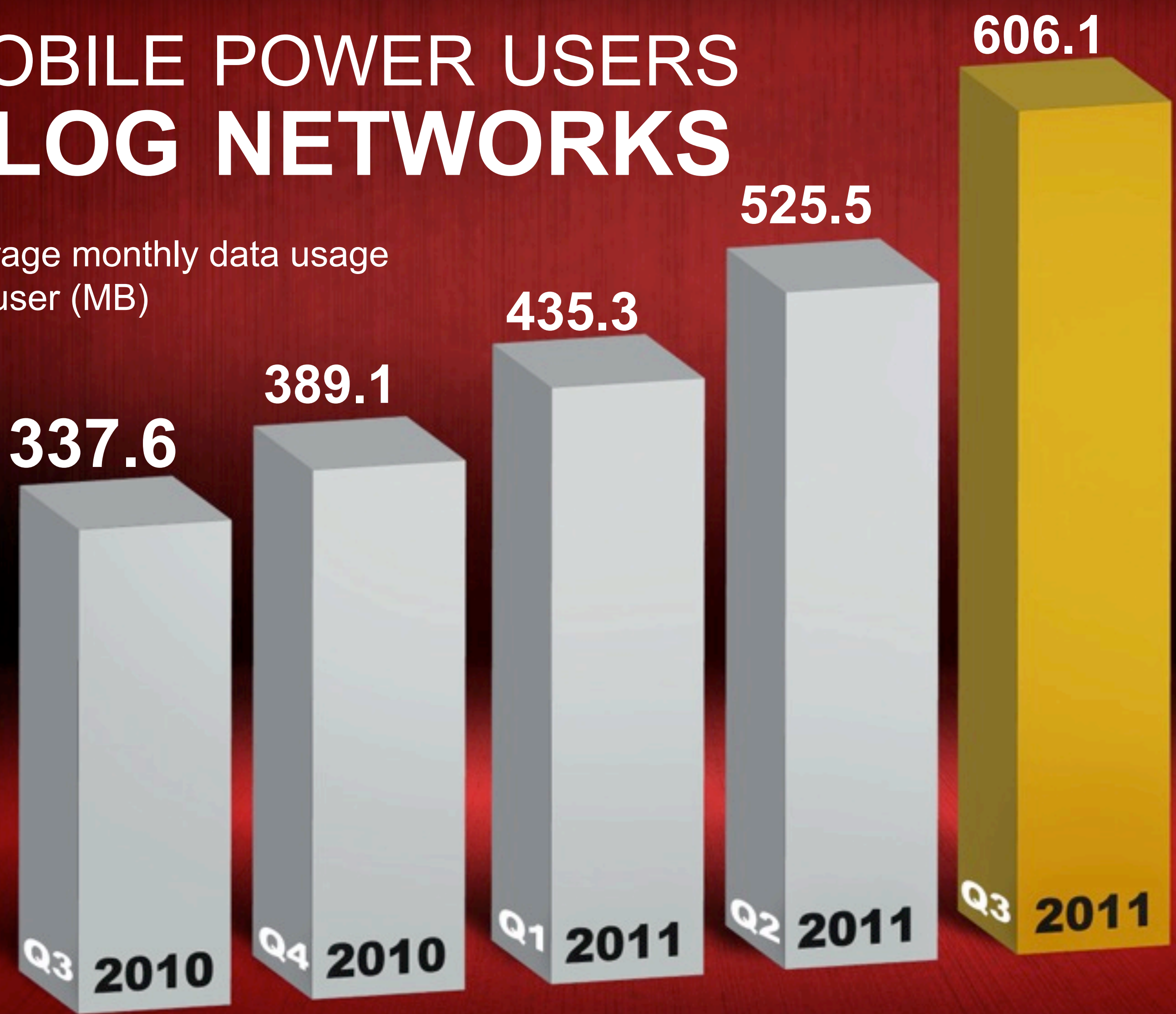
Growing Services Consuming HFC Spectrum

- **More HD Video Services**
  - Growth plans to 100+ HD channels
- **More SD Video Content**
  - Expansion to nx100 SD chs to compete w/ satellite
- **Personalized Video Services**
  - Migration from Broadcast to Unicast services
  - VoD, Startover, MyPrimetime, etc
- **Broadband Internet Services Growth**
  - Migration from Web to Web2.0, Video Streaming and P2PTV Applications
  - Increased per home BW consumption
  - Expansion of the peak hour to whole evening
- **Competitive pressure!**

John Downey

MOBILE POWER USERS **CLOG NETWORKS**

Average monthly data usage per user (MB)



Average monthly per-user data consumption by U.S. smartphone customers jumped 80% from the third quarter of 2010 to the third quarter of 2011.

Source: The Nielsen Company

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STREAMING VIDEO
DOMINATES WEB TRAFFIC

Nearly 60% by 2015

YouTube Broadcast Yourself™ hulu Beeline™ vimeo metacafe REVVER veoh

Source: Pipeline Magazine

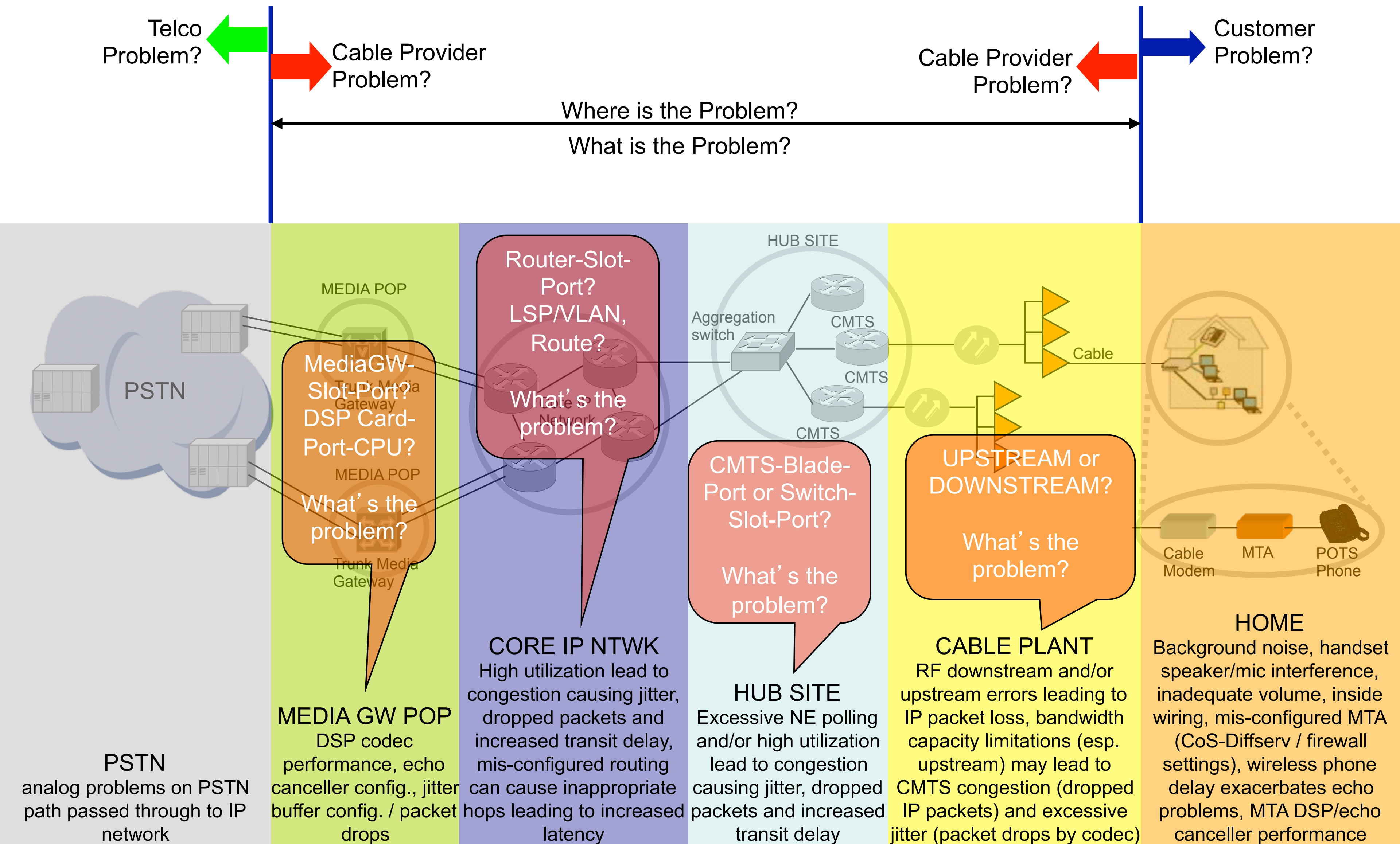
Seeing The Future

EXPLOSION IN CONNECTED DEVICES:

TO 500 BILLION BY 2020

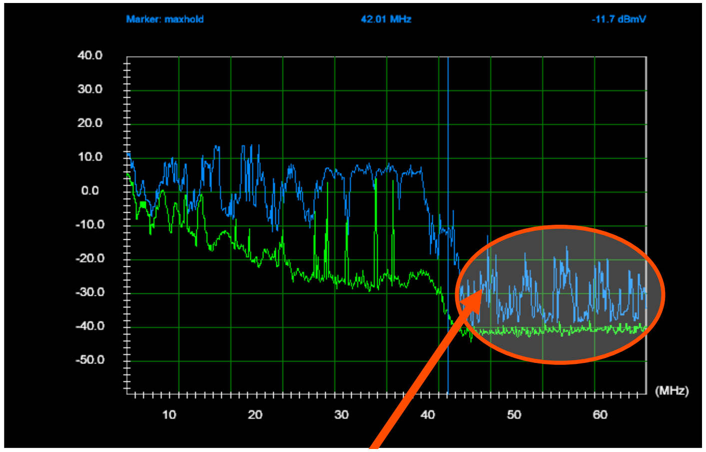
Source: Ericsson, 2011

Voice Quality Impairments – it’s not always the plant!

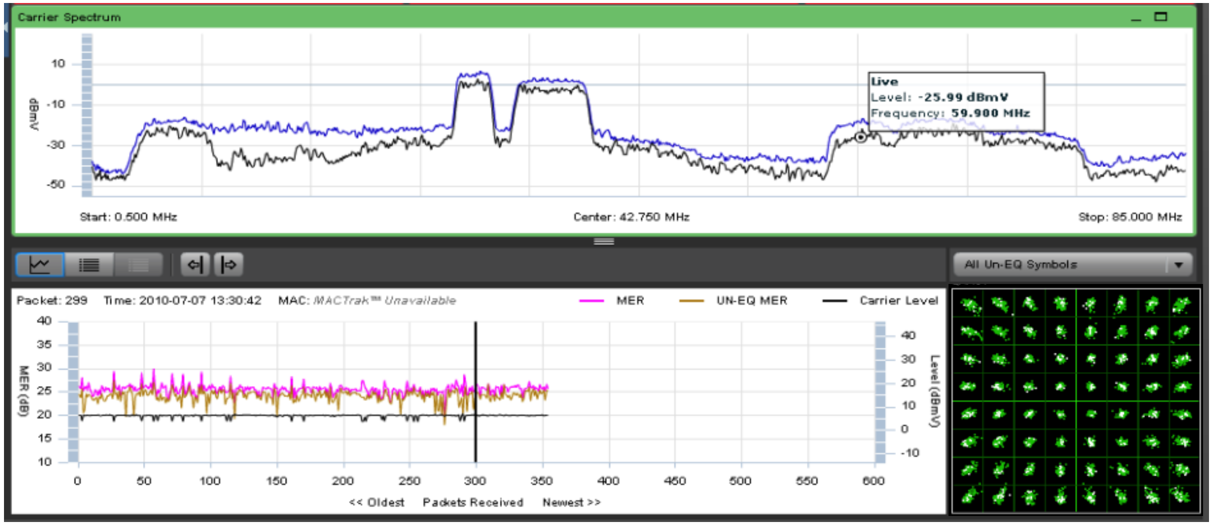


Common Impairments: Laser Clipping

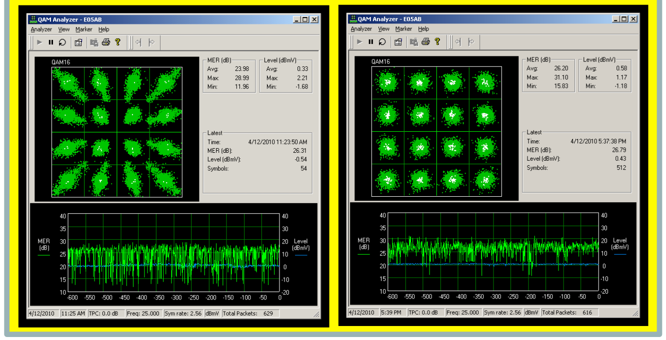
- Caused by Overdriving Laser
  - Low end ingress
  - Improper laser setup
  - Adding carriers without compensating
- Very distinct constellation footprint
  - Also see as junk above diplex in spectrum
  - Optical receiver issues can look similar



Wide band impulse noise above diplex roll-off frequency

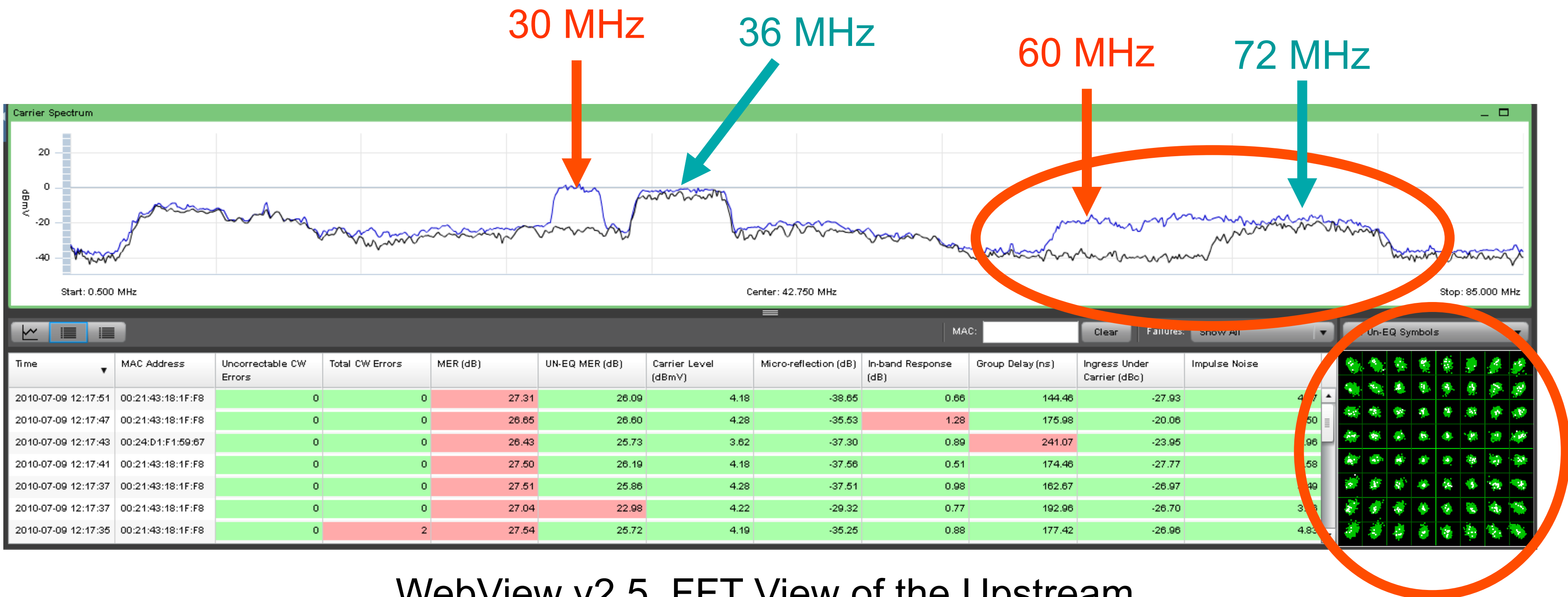


Before/After:
Faulty Optical Receiver
Similar to Laser Clipping



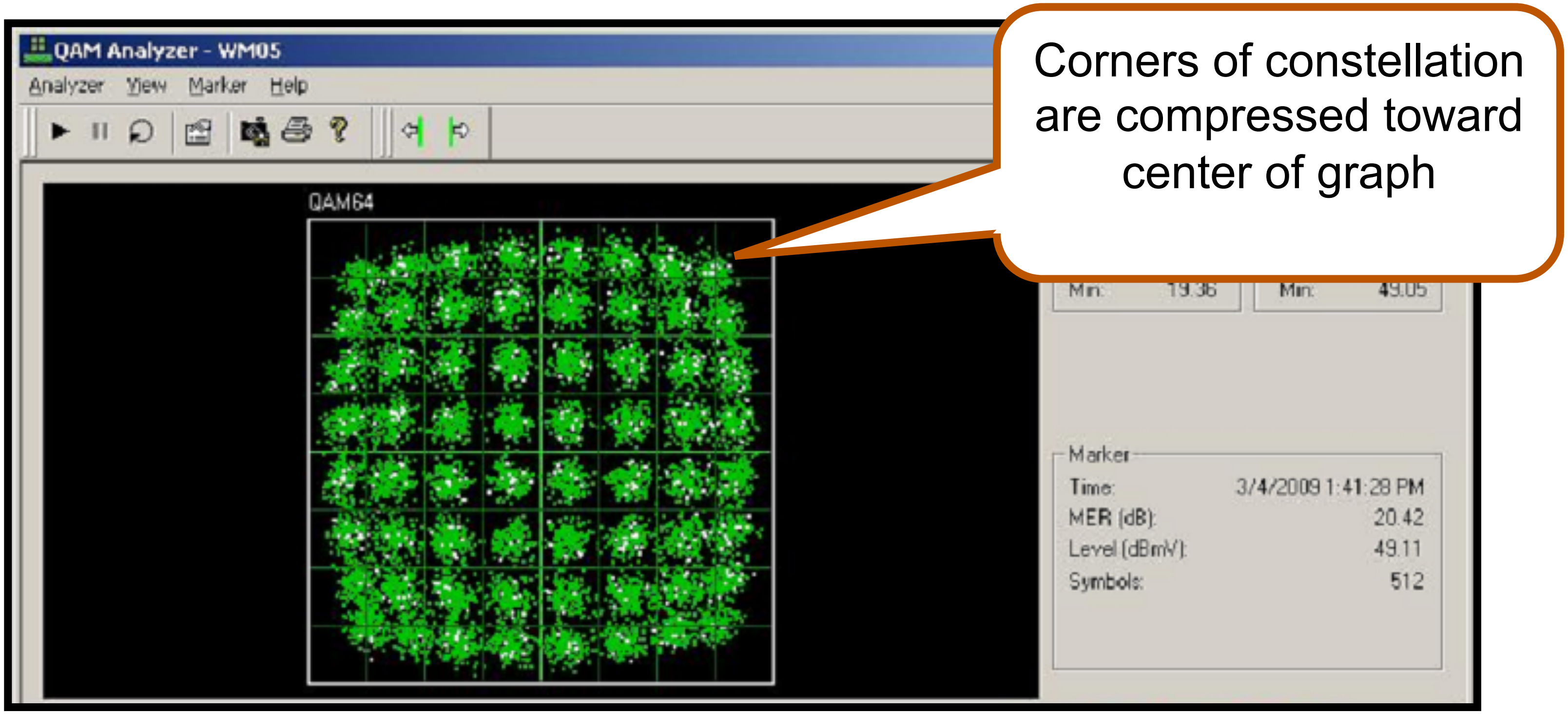
Optical Link is Critical to Upstream Performance

- RF level is too high at input of return laser
  - Verify light level at input of return optical receiver
  - Verify RF level at input of return laser
  - Verify RF spectrum above diplex frequency at input of return laser



Time	MAC Address	Uncorrectable CW Errors	Total CW Errors	MER (dB)	UN-EQ MER (dB)	Carrier Level (dBmV)	Micro-reflection (dB)	In-band Response (dB)	Group Delay (ns)	Ingress Under Carrier (dBc)	Impulse Noise
2010-07-09 12:17:51	00:21:43:18:1F:F8	0	0	27.31	26.09	4.18	-38.65	0.66	144.46	-27.93	[illegible]
2010-07-09 12:17:47	00:21:43:18:1F:F8	0	0	26.65	26.60	4.28	-35.53	1.28	175.98	-20.06	[illegible]
2010-07-09 12:17:43	00:24:D1:F1:59:67	0	0	26.43	25.73	3.62	-37.30	0.89	241.07	-23.95	[illegible]
2010-07-09 12:17:41	00:21:43:18:1F:F8	0	0	27.50	26.19	4.18	-37.56	0.51	174.46	-27.77	[illegible]
2010-07-09 12:17:37	00:21:43:18:1F:F8	0	0	27.51	25.86	4.28	-37.51	0.98	162.67	-26.97	[illegible]
2010-07-09 12:17:37	00:21:43:18:1F:F8	0	0	27.04	22.98	4.22	-29.32	0.77	192.96	-26.70	[illegible]
2010-07-09 12:17:35	00:21:43:18:1F:F8	0	2	27.54	25.72	4.19	-35.25	0.88	177.42	-26.96	[illegible]

WebView v2.5 FFT View of the Upstream



Amplifier Compression

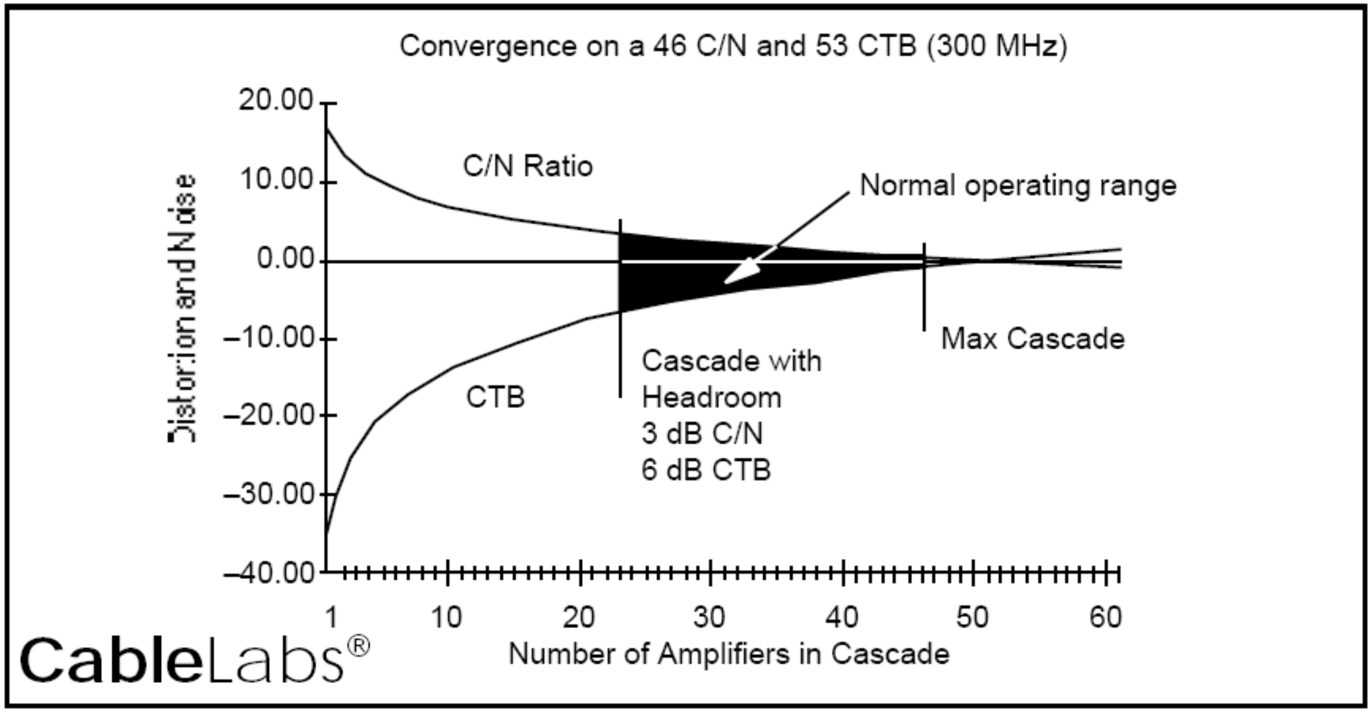
Amplifier compression often manifests as rounding of the corners of the constellation.

Laser clipping often manifests as increased spread in the corners of the constellation.

Both are caused by overdriving an amplifier or laser usually due to ingress or misalignment. (unity gain)

May become more prevalent as more DOCSIS® upstream carriers are added.

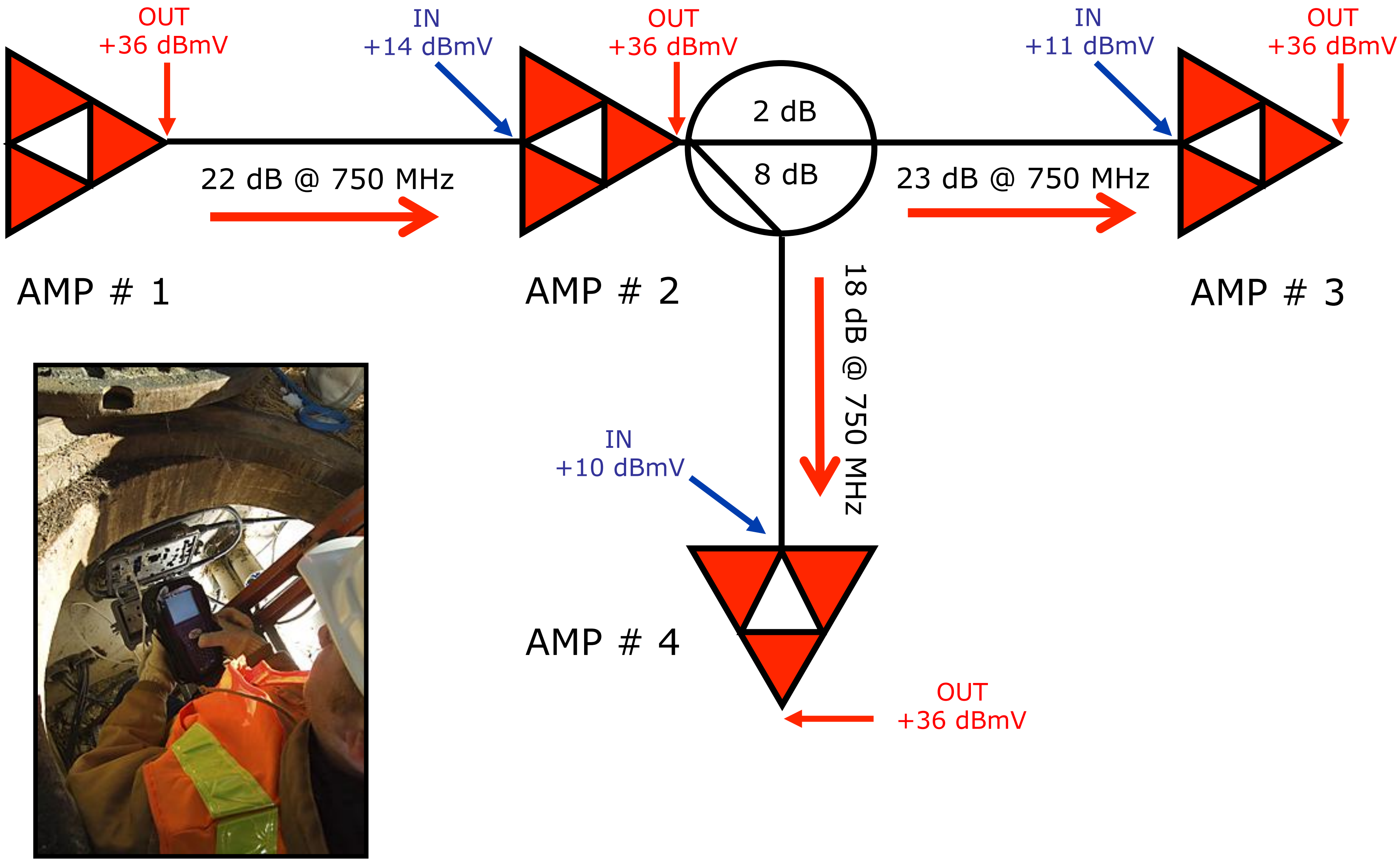
WHY SWEEP?



DISTORTIONS IN A CASCADE

- CATV amplifiers have a trade-off between noise and distortion performance
- Tightly controlling frequency response provides the best compromise between noise and distortion.

Forward Path Unity Gain



Incorrect Levels

- **Low Video Levels**
- **Produces noise in the picture**

- High Video Levels

  Produces distortion in the picture

Low Digital levels

- **Causes Digital signal to Degrade.**

- **This causes Tiling and Loss of high Speed internet access.**

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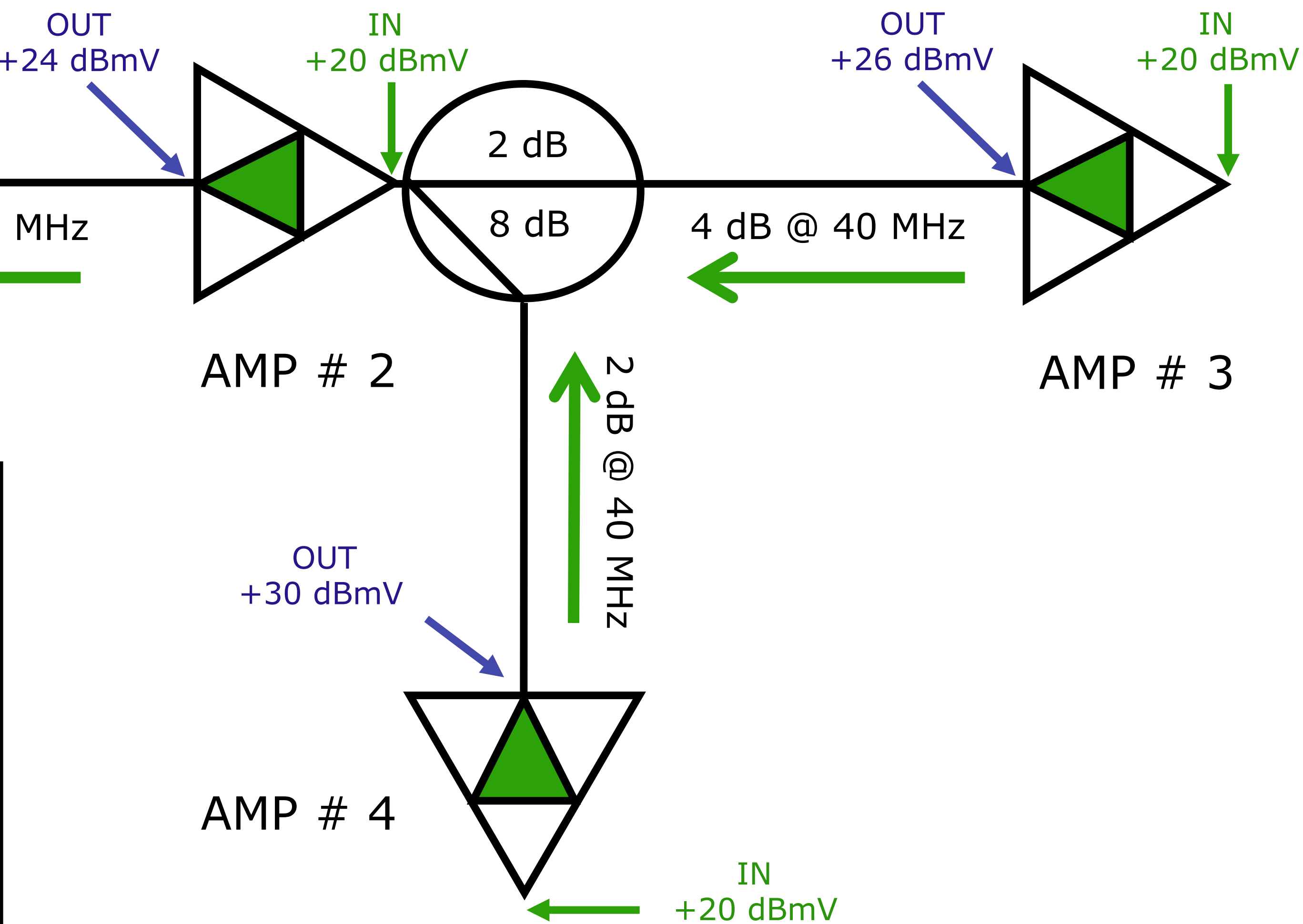
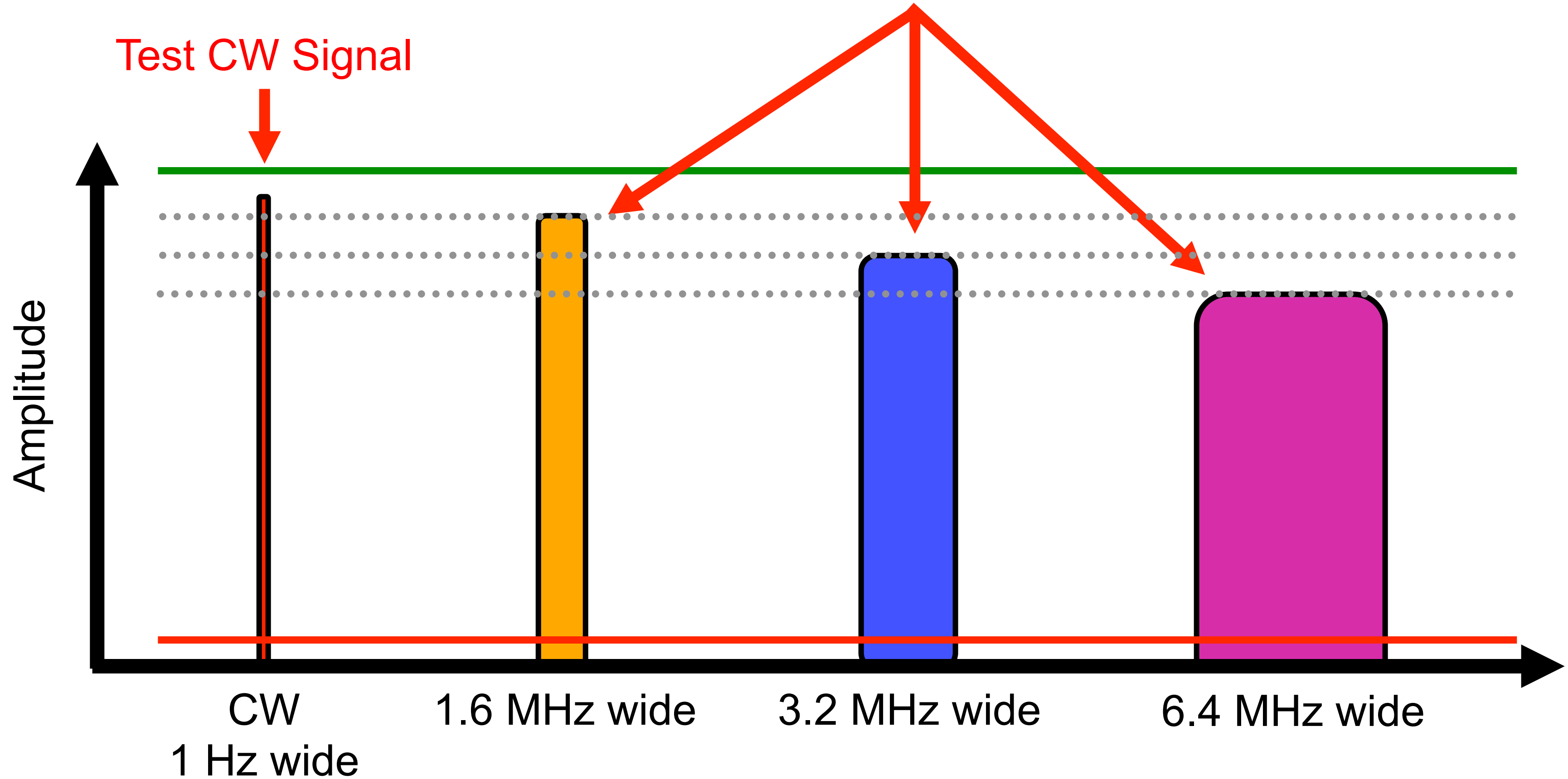
Return Path Unity Gain

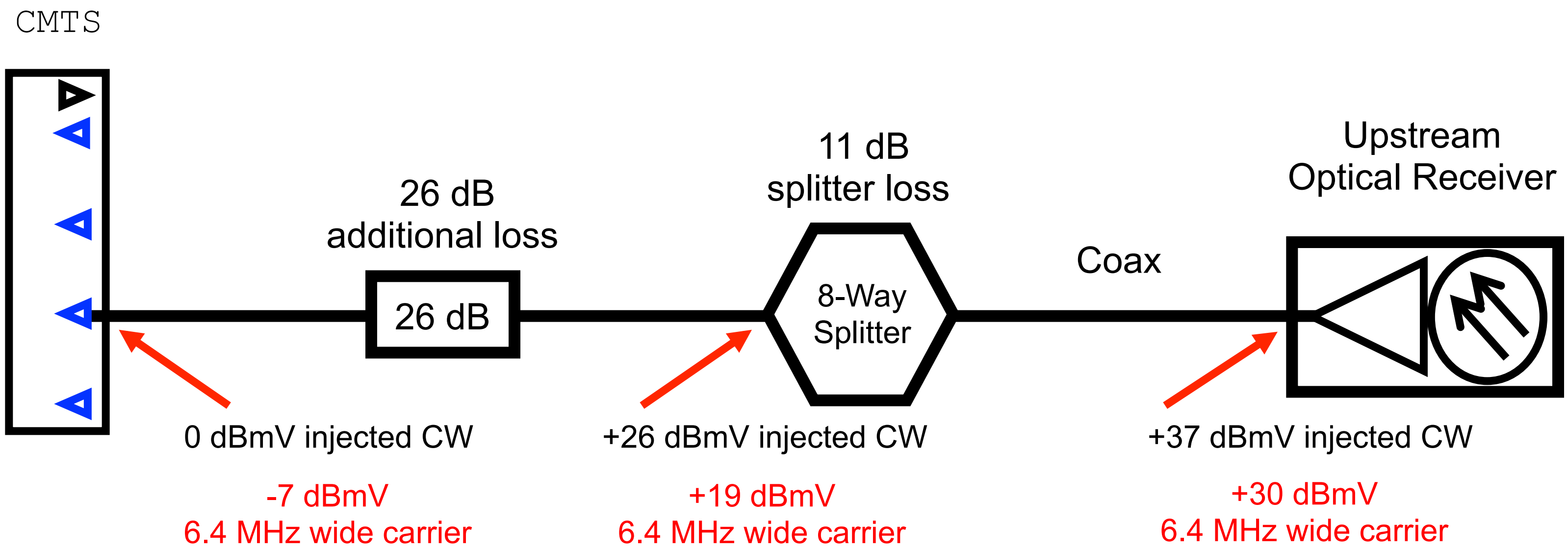


Measuring Upstream Carrier Amplitudes

These three DOCSIS® carriers will NOT have the same peak amplitude when hitting the input port of a CMTS at 0 dBmV "constant power per carrier" and then measured with a typical spectrum analyzer or signal level meter.



Optimize Dynamic Input Range of the CMTS



Example: Some systems will add 26 dB of external padding between the splitter and CMTS to attenuate the injected CW signal down to a peak level of 0 dBmV at the input port of the CMTS. The CMTS is typically configured to instruct the 6.4 MHz modem carriers to hit the input port of the CMTS at 0 dBmV "constant power per carrier".

Docsis 3

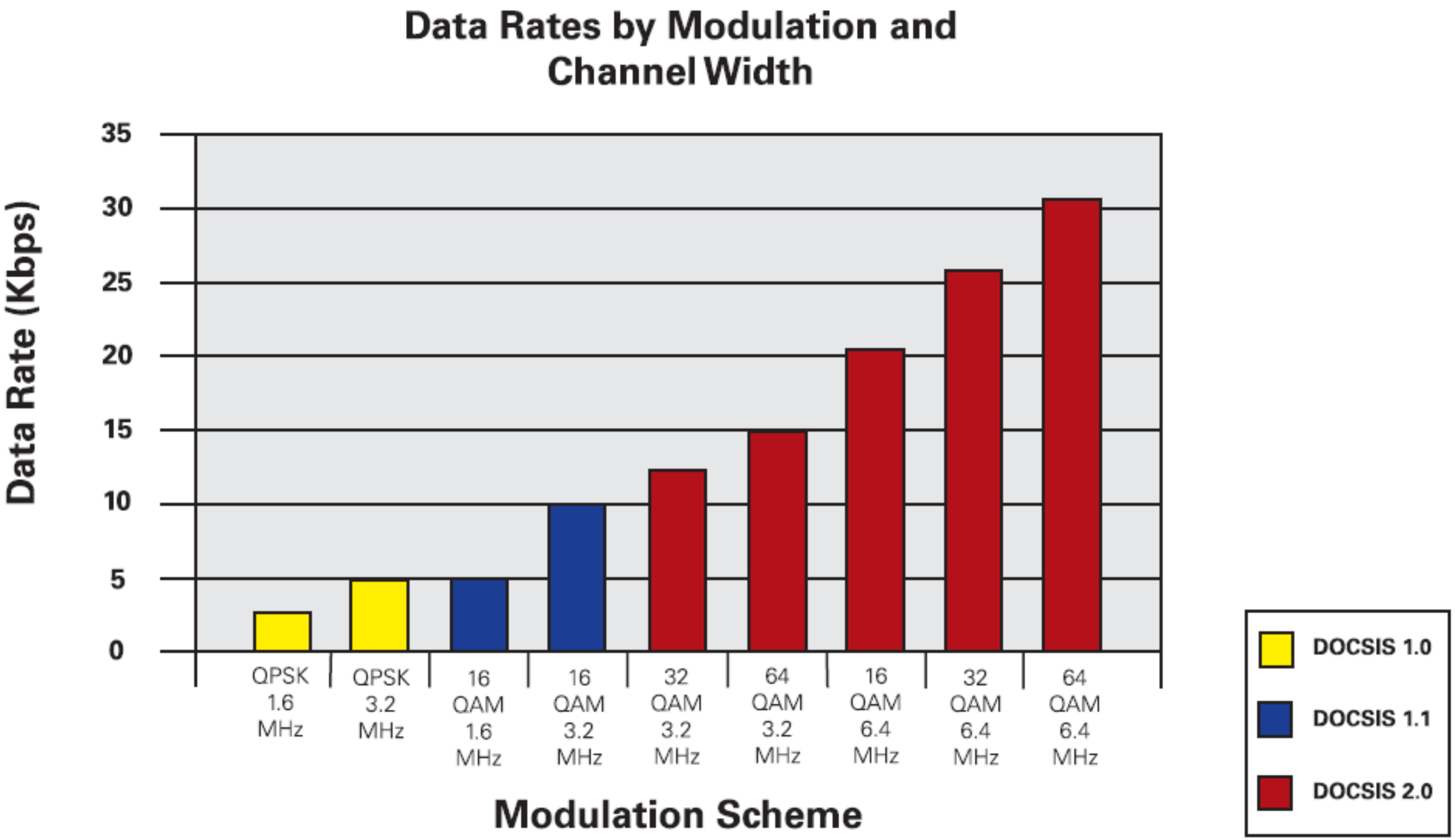
Maximum and (Maximum Usable)DownStream Speeds

	Downstream	
Version	**DOCSIS**	**EuroDOCSIS**
1.x	42.88 (38) Mbit/s	55.62 (50) Mbit/s
2.0	42.88 (38) Mbit/s	55.62 (50) Mbit/s
3.0 ----------4 channel	171.52 (+152) Mbit/s	+222.48 (+200) Mbit/s
3.0 ----------8 channel	+343.04 (+304) Mbit/s	+444.96 (+400) Mbit/s

Channel Requirements

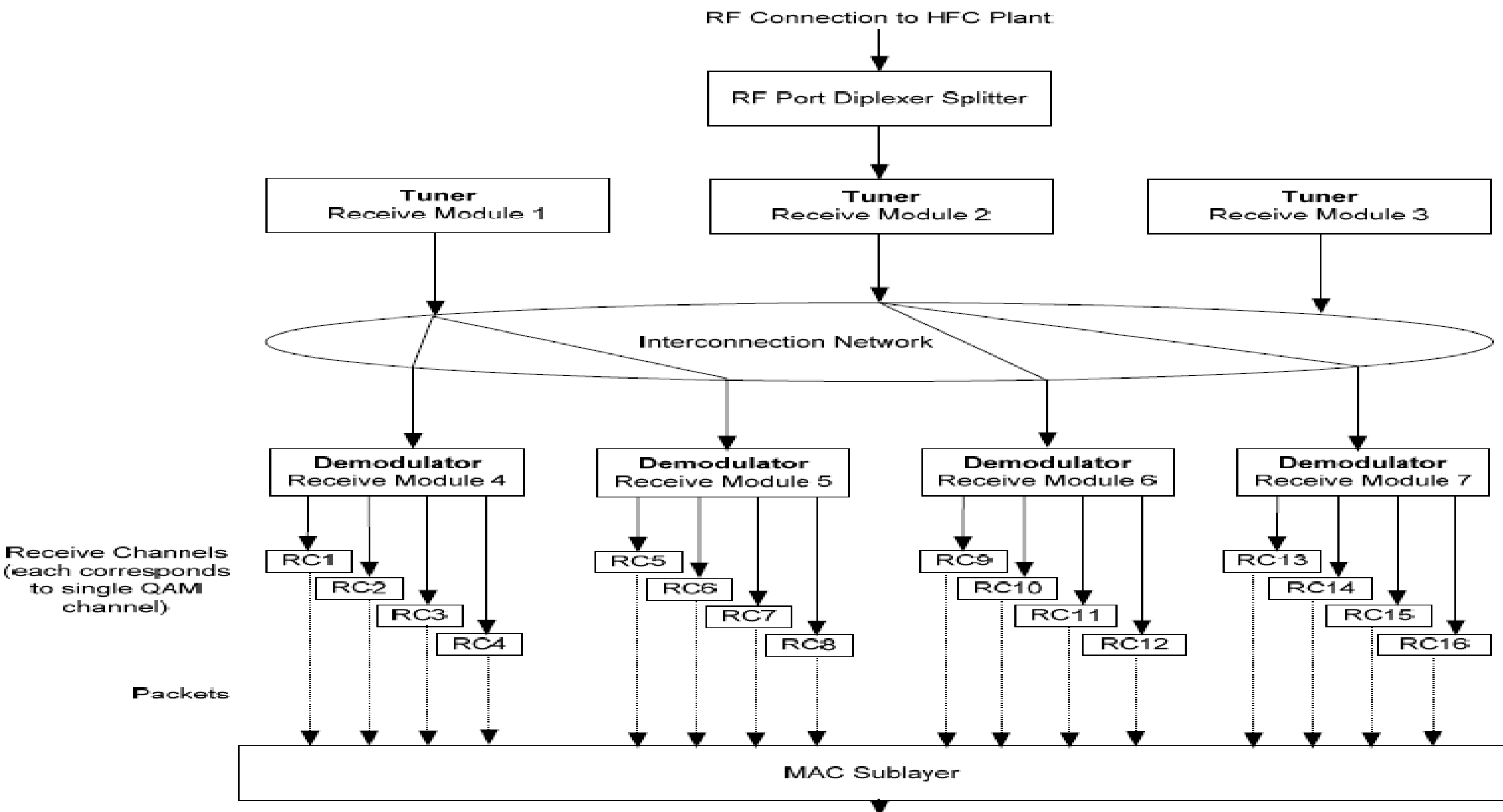
- Combines down and upstream channels for added performance
  - "Technically" could support 10 bonded down streams.
  - Plans are currently for 4 DS and up to 4 u/s channels to be bonded
    - **Do not have to be adjacent to each other – but must be within 60 MHz.**
      - » "Bonded" in data layer – not Physical layer
      - » Each DS channel remains a 6 MHz 256QAM
      - » A DOCSIS 3.0 QAM can be a Primary or Secondary
      - » Primaries carry all info needed for a CM to register
      - » Secondary's do not have registration data – only payload
      - » ALL down streams can be provisioned as primaries but there MUST be at least 1 primary.
    - Possible combinations of u/s and d/s
    - 2x1, 2x2, 3x1, 3x2, 3x3, 4x1, 4x2, 4x3, 4x4
    - Each provides its own performance capability - and is scalable.

Un-Bonded Upstream Data rates



- *Courtesy Motorola*

SCTE Downstream Modem Configuration



Source: SCTE

SCTE Docsis 3.0 Downstream RF Spec

Table 5-1 - Assumed Downstream RF Channel Transmission Characteristics

Parameter	Value
Frequency range	Cable system normal downstream operating range is from 50 MHz to 1002 MHz. However, the values in this table apply only at frequencies ≥ 108 MHz (including Pre-3.0 DOCSIS modes).
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[1,2]
Carrier-to-Composite triple beat distortion ratio	Not less than 41 dB[1,2]
Carrier-to-Composite second order distortion ratio	Not less than 41 dB[1,2]
Carrier-to-Cross-modulation ratio	Not less than 41 dB[1,2]
Carrier-to-any other discrete interference (ingress)	Not less than 41 dB[1,2]
Amplitude ripple	3 dB within the design bandwidth[1]
Group delay ripple in the spectrum occupied by the CMTS	75 ns within the design bandwidth[1]
Micro-reflections bound for dominant echo	-10 dBc @ ≤ 0.5 µs -15 dBc @ ≤ 1.0 µs -20 dBc @ ≤ 1.5 µs -30 dBc @ > 1.5 µs[1]
Carrier hum modulation	Not greater than -26 dBc (5%)[1]
Burst noise	Not longer than 25 µs at a 10 Hz average rate[1]

Parameter	Value
Maximum analog video carrier level at the CM input	17 dBmV
Maximum number of analog carriers	121

1. Measurement methods defined in [NCTA] or [CableLabs1].
2. Measured relative to a QAM signal that is equal to the nominal video level in the plant.

Source: SCTE

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SCTE Docsis 3.0 Upstream RF Spec

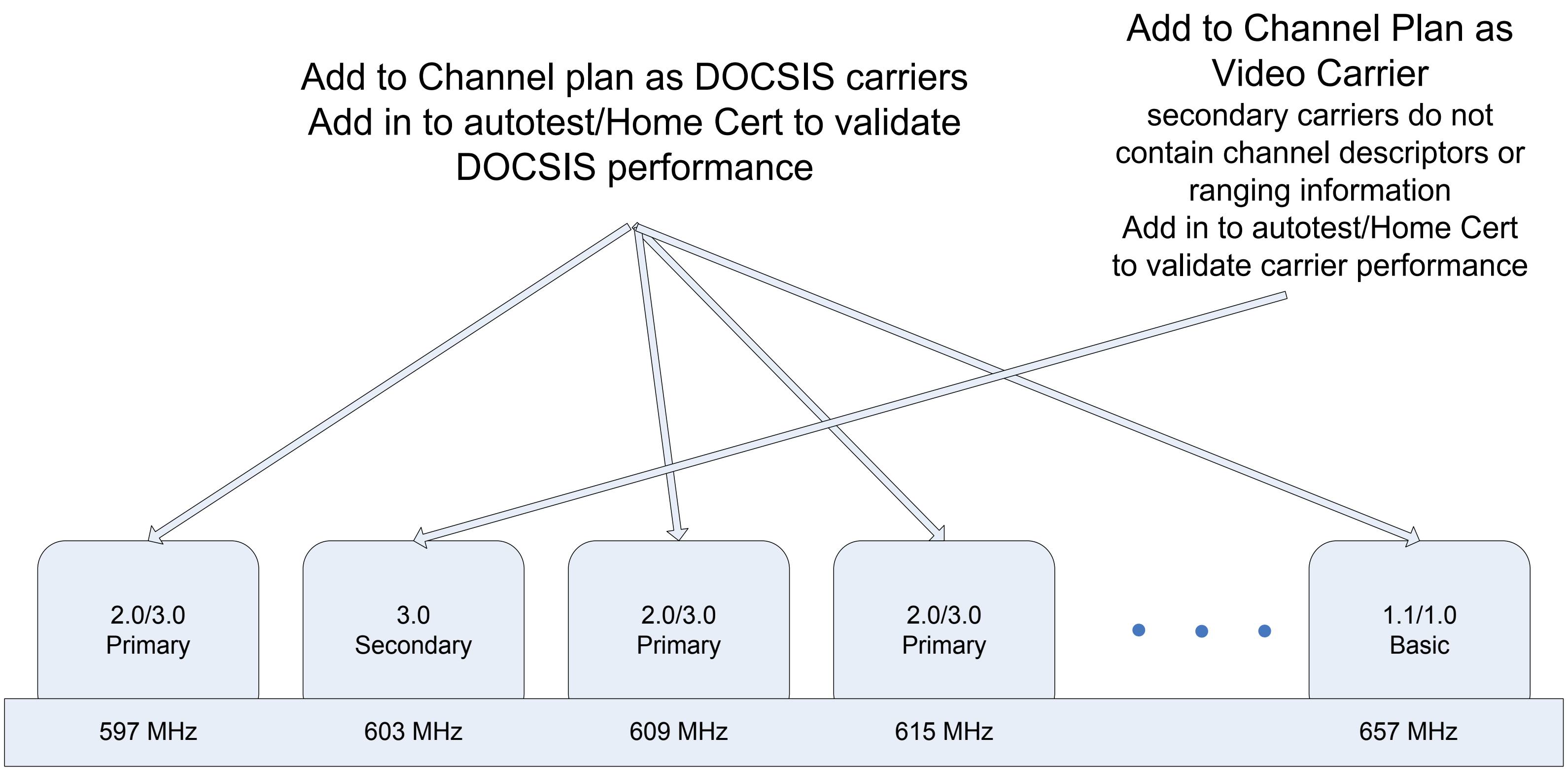
Table 5-2 - Assumed Upstream RF Channel Transmission Characteristics

Parameter	Value
Frequency range	5 to 42 MHz edge to edge or 5 to 85 MHz edge to edge
Transit delay from head-end to most distant customer	≤ 0.800 ms (typically much less)
Carrier-to-interference plus ingress (the sum of noise, distortion, common-path distortion and cross modulation and the sum of discrete and broadband ingress signals, impulse noise excluded) ratio	Not less than 25 dB[1]
Carrier hum modulation	Not greater than -23 dBc (7.0%)
Burst noise	Not longer than 10 µs at a 1 KHz average rate for most cases[2,3]
Amplitude ripple across upstream operating frequency range	0.5 dB/MHz
Group delay ripple across upstream operating frequency range	200 ns/MHz
Micro-reflections – single echo	-10 dBc @ ≤ 0.5 µs -20 dBc @ ≤ 1.0 µs -30 dBc @ > 1.0 µs
Seasonal and diurnal reverse gain (loss) variation	Not greater than 14 dB min to max

1. Ingress avoidance or tolerance techniques may be used to ensure operation in the presence of time-varying discrete ingress signals that could be as high as 10 dBc. The ratios are guaranteed only within the digital carrier channels.
2. Amplitude and frequency characteristics sufficiently strong to partially or wholly mask the data carrier.
3. Impulse noise levels more prevalent at lower frequencies (<15 MHz).

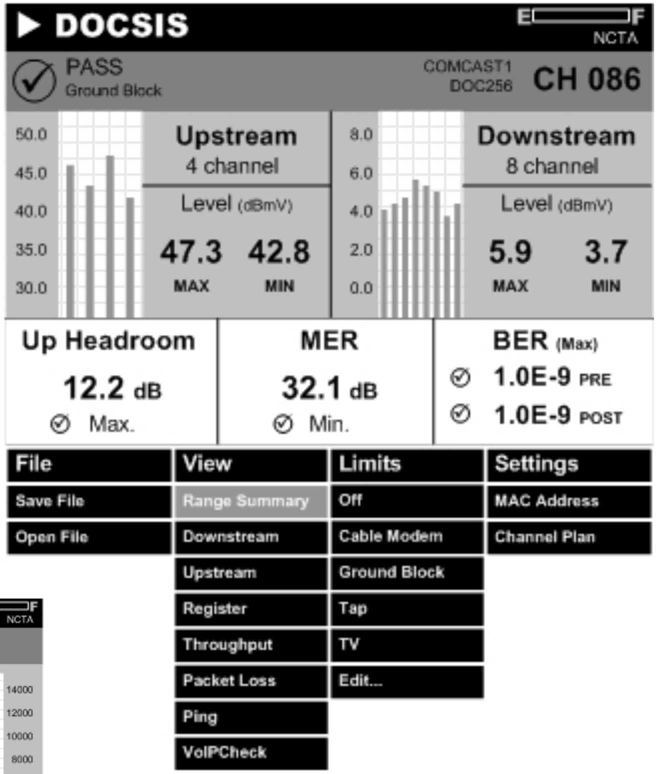
Source: SCTE

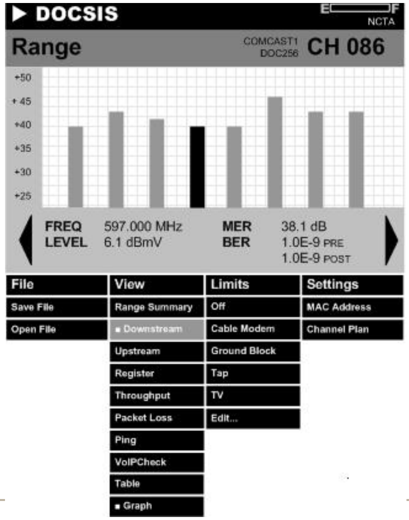
DOCSIS 3.0 Downstreams

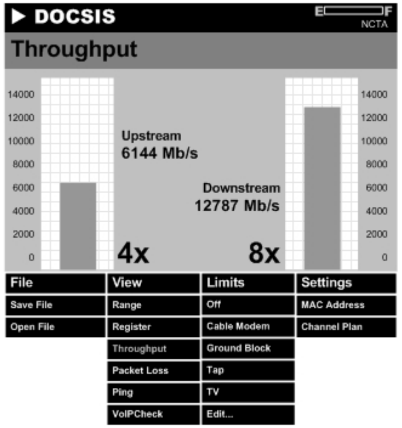


DSAM 3.0 Bonded Carrier testing – coming soon

- Keeping it simple for the technicians
- Validate overall performance
- Identifying individual US/DS channel issues







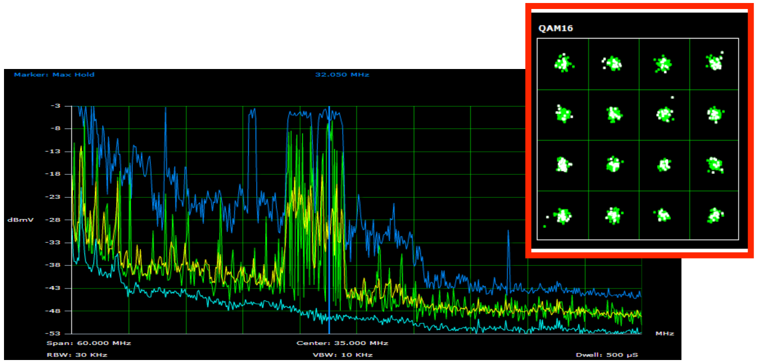
Customer Networks

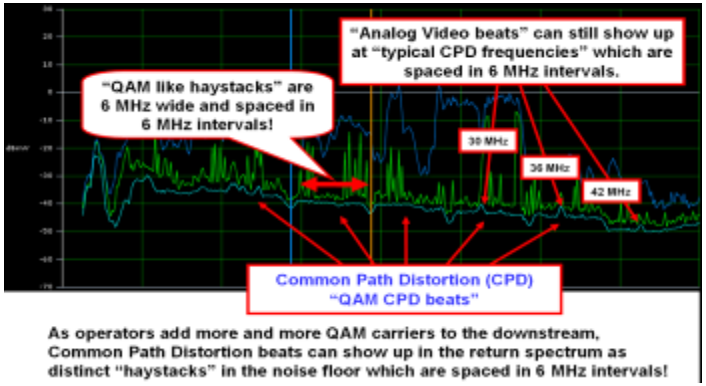
What Type of Problem: Common Impairments

- **Ingress**
  - Still the most common
  - Use return path monitoring system to know when to chase

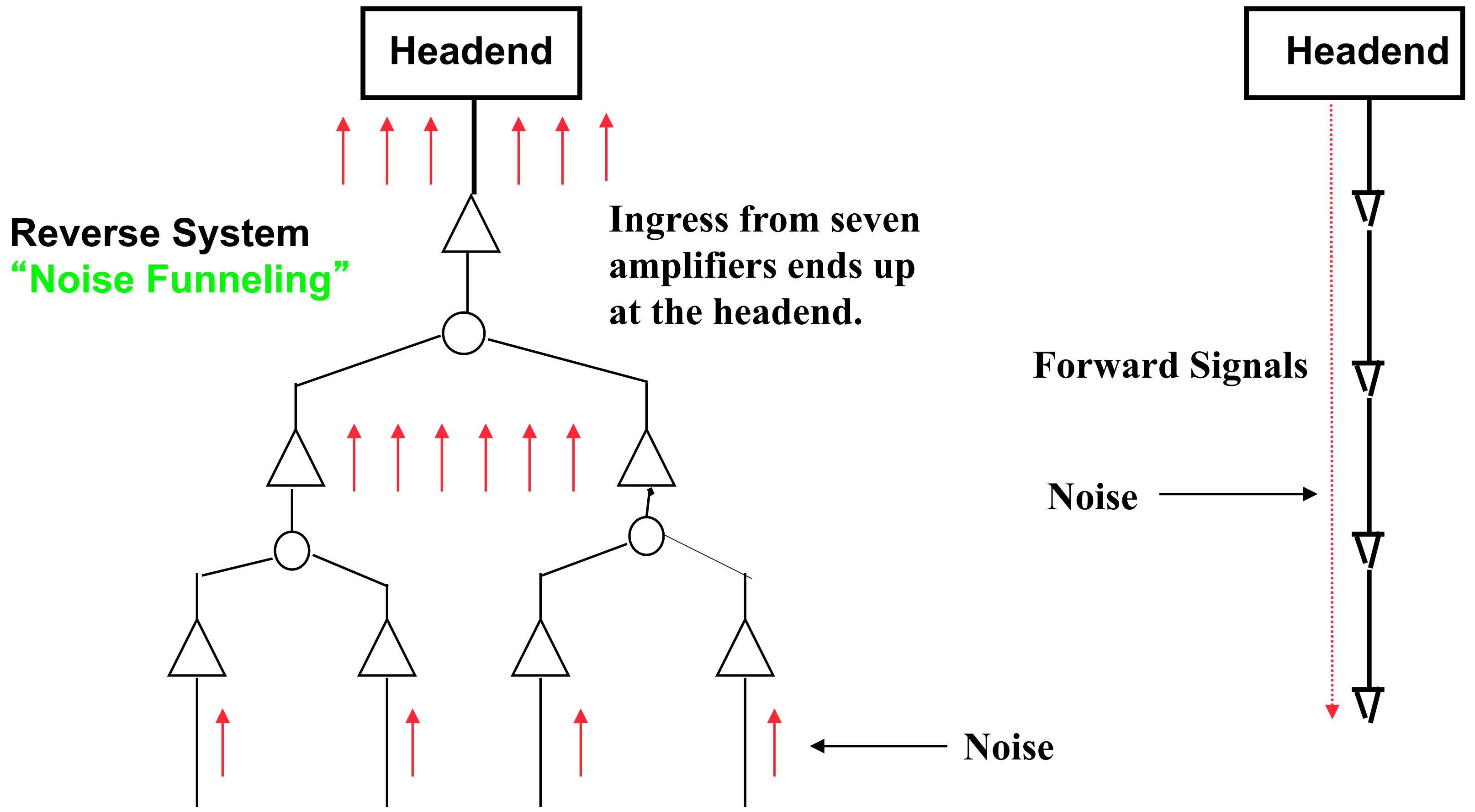
- **Common Path Distortion**
  - Old news in analog DS plant
  - New look in all-digital plant

- **Impulse Noise**
  - Impulse noise troublesome for CMTS
  - RFI detector for power-line noise

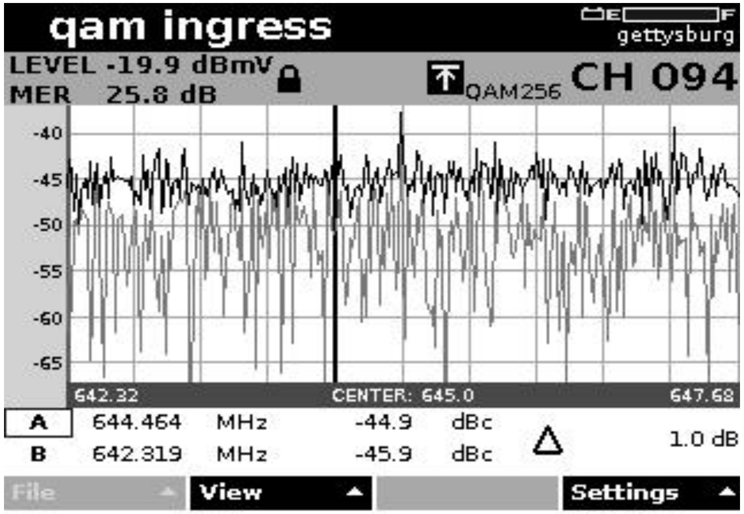


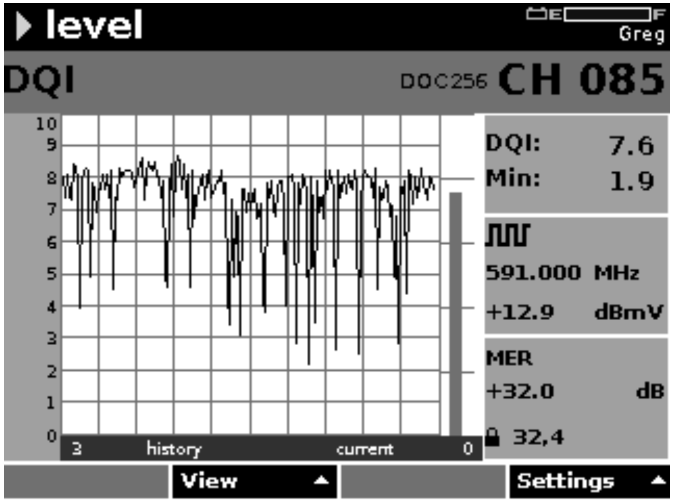


Downstream and Upstream Noise Additions



Testing for Ingress on Forward Digital Carriers





What Causes Signal Leakage & Ingress?

- Most common source of leakage is within the home wiring (approximately 75%) and drop cable (approximately 20%). There's a lot of homes that still have the original wiring from 20-30 years ago!

- Inferior quality coaxial cable, passives, connectors

- Poor installation of splices and connectors - water and weather can result in pulled out, loose or corroded connectors

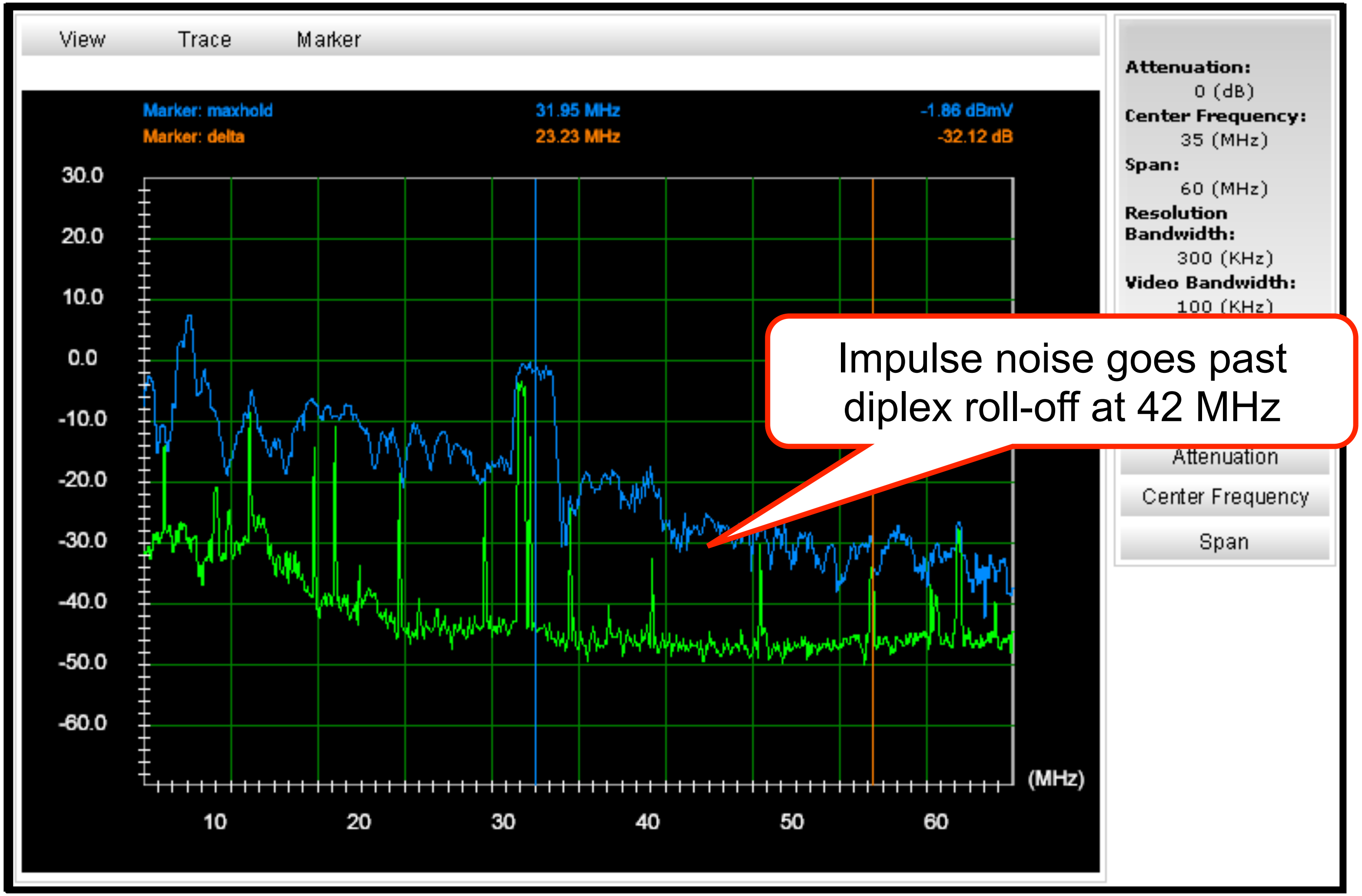
- Illegal connections to neighbor's cable

- Some of the older TV sets with poor tuner shielding can produce leakage and ingress problems

What Causes Signal Leakage & Ingress?

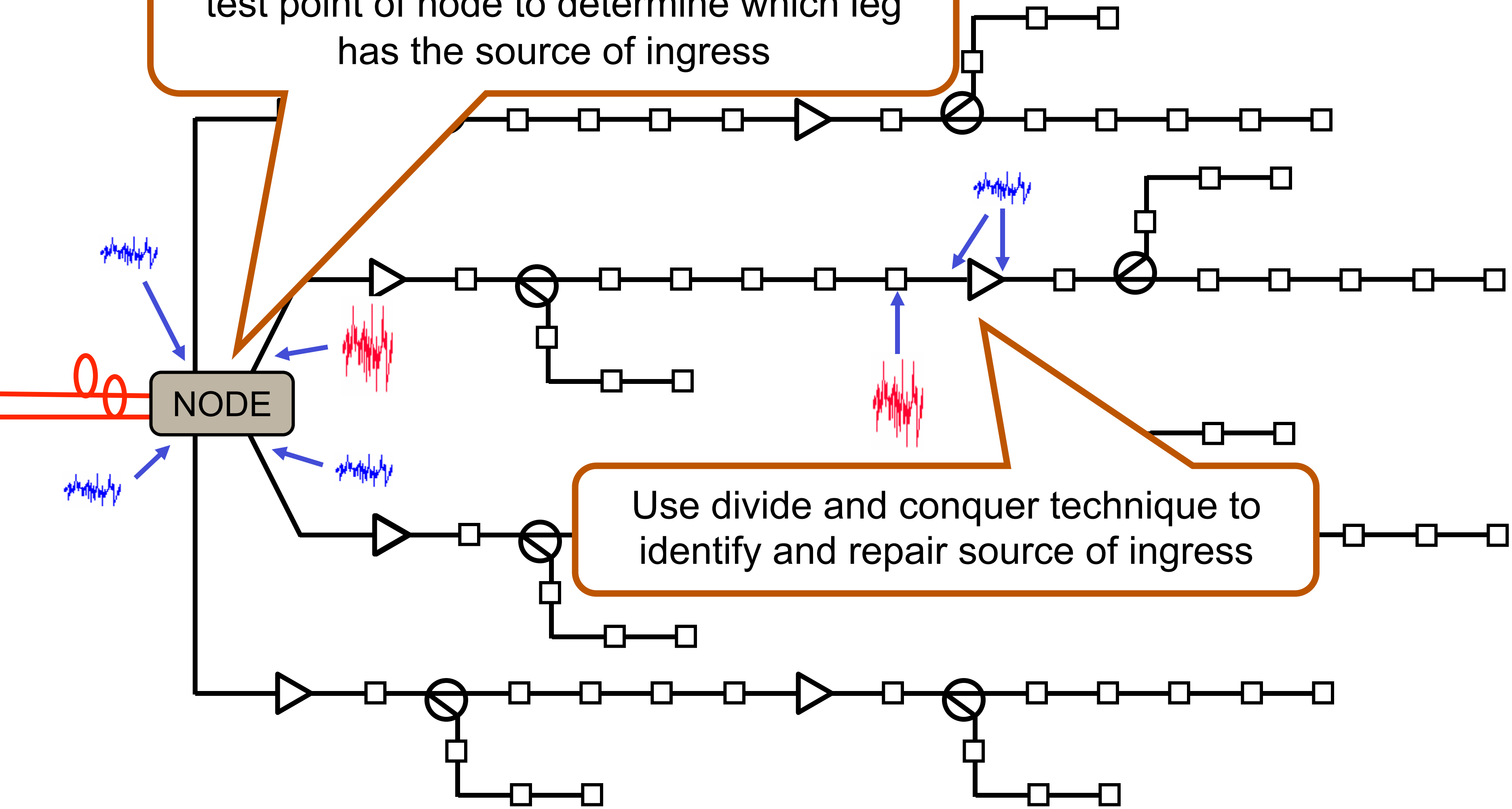
- Some less abundant sources, such as trunk or bridger amplifiers output, are likely to radiate much greater RF energy and produce a bigger effect on the system's total leakage.
- Radial cracks in the expansion loop
- Improperly terminated splitters, jumpers from drops to taps or ground blocks
- Accidents (vehicles crashing into poles)
- The environment, weather, landscape & even animals (squirrel chews) could have an effect

Wide Band Impulse Noise and Laser Clipping



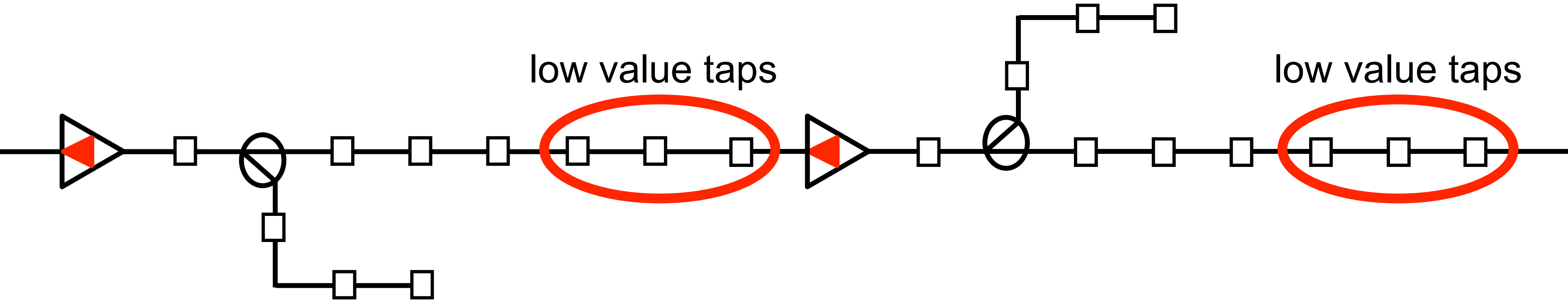
Tracking Down Ingress – Divide and Conquer

View local spectrum on each return path test point of node to determine which leg has the source of ingress



Use divide and conquer technique to identify and repair source of ingress

Typical Problem Areas

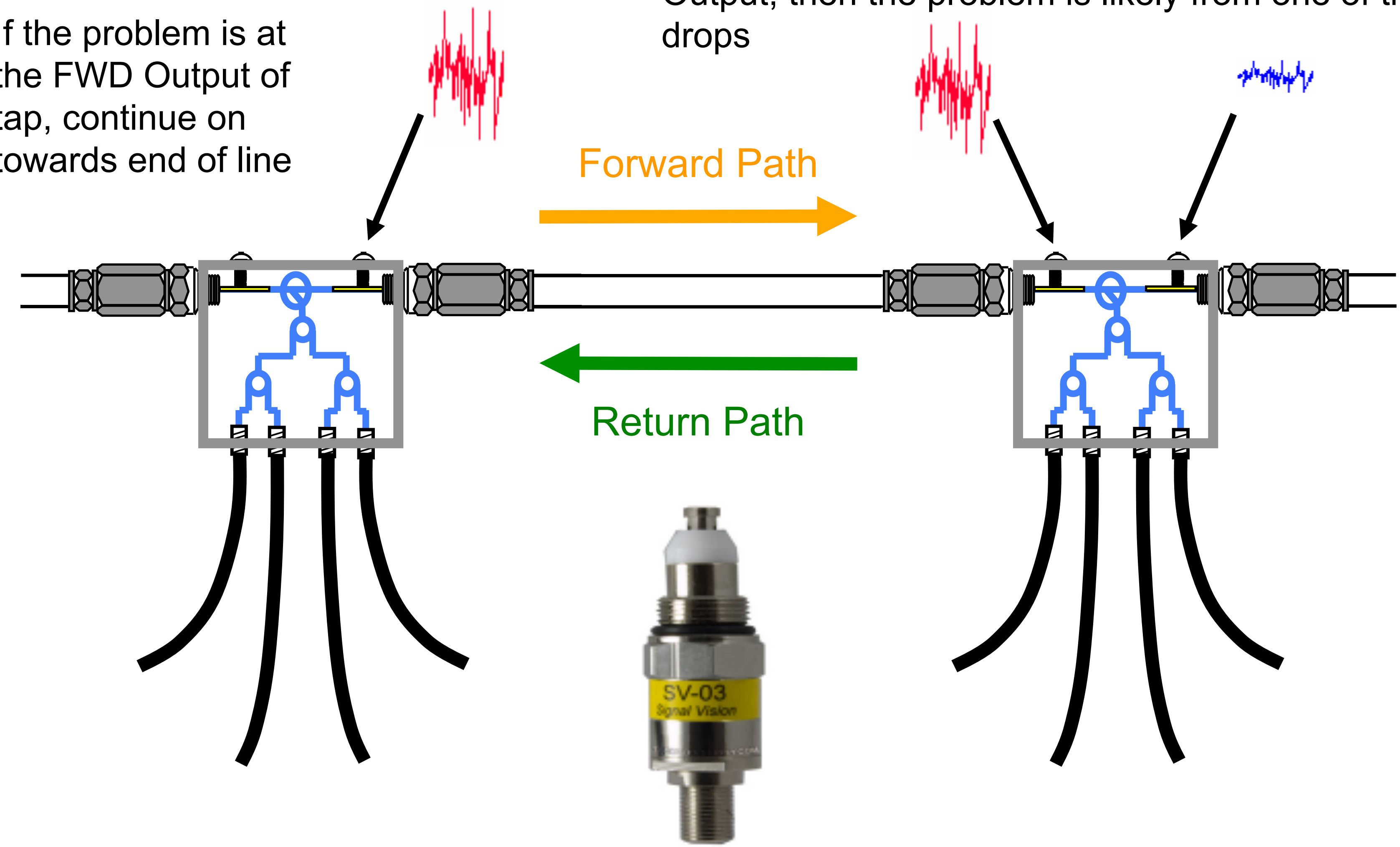


- **Taps**
  - Most ingress comes from houses off of with low value taps of approximately 17 dB or less
- **Home Wiring**
  - Drop Cable, splitters & F Connectors are approximately ~95% of Problem
- **Amplifiers, hard line cable** and the rest of the system are a small percentage of the problem if a proper leakage maintenance program is performed

Taps - Probe the Seizure Screws for Ingress & CPD

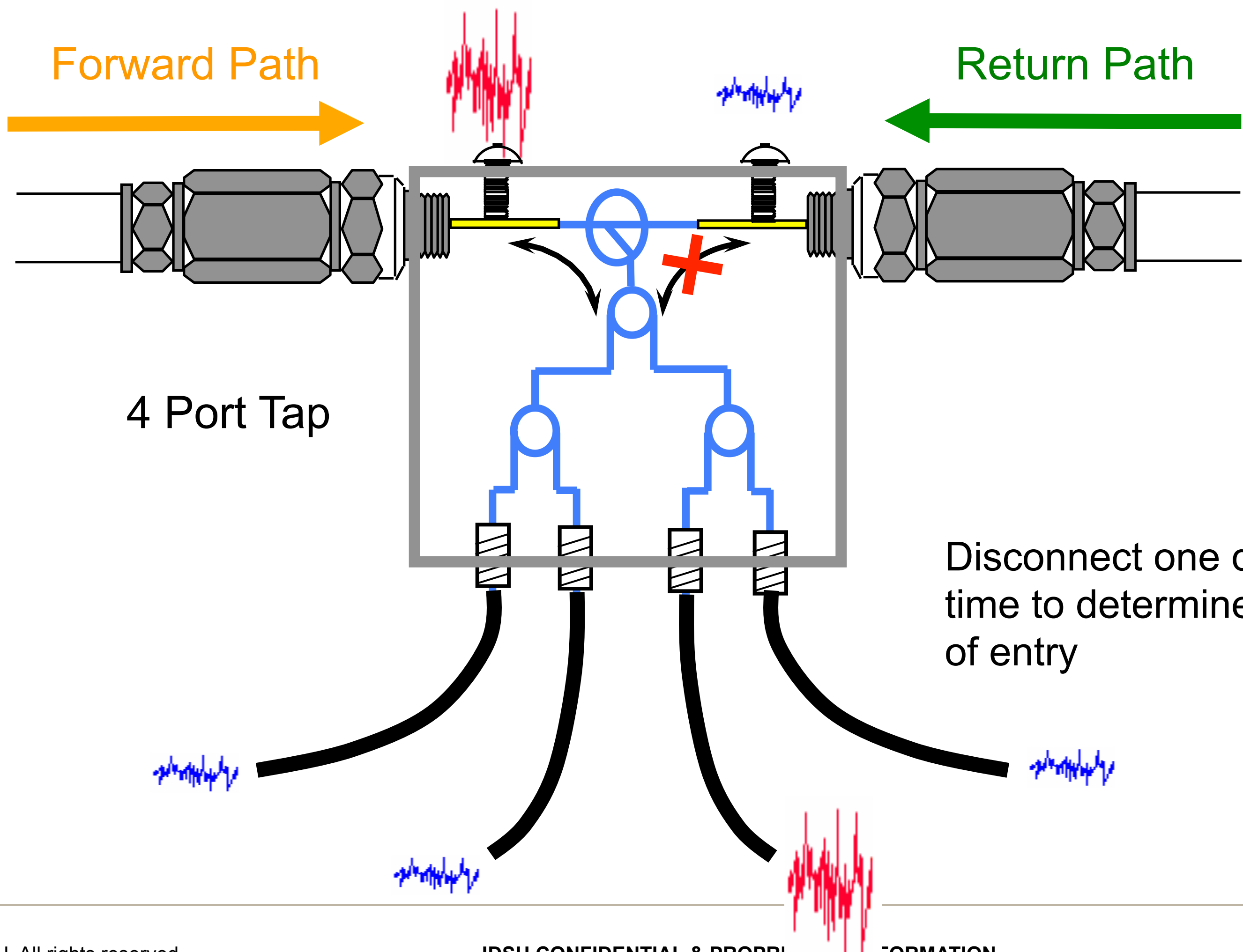
If the problem is at the FWD Input and not the FWD Output, then the problem is likely from one of the drops

If the problem is at the FWD Output of tap, continue on towards end of line



Taps are made up of a Directional Coupler and Splitters

- If the problem is at the Forward Input and not the Forward Output, then the problem is from one of the drops



Disconnect one drop at a time to determine the point of entry

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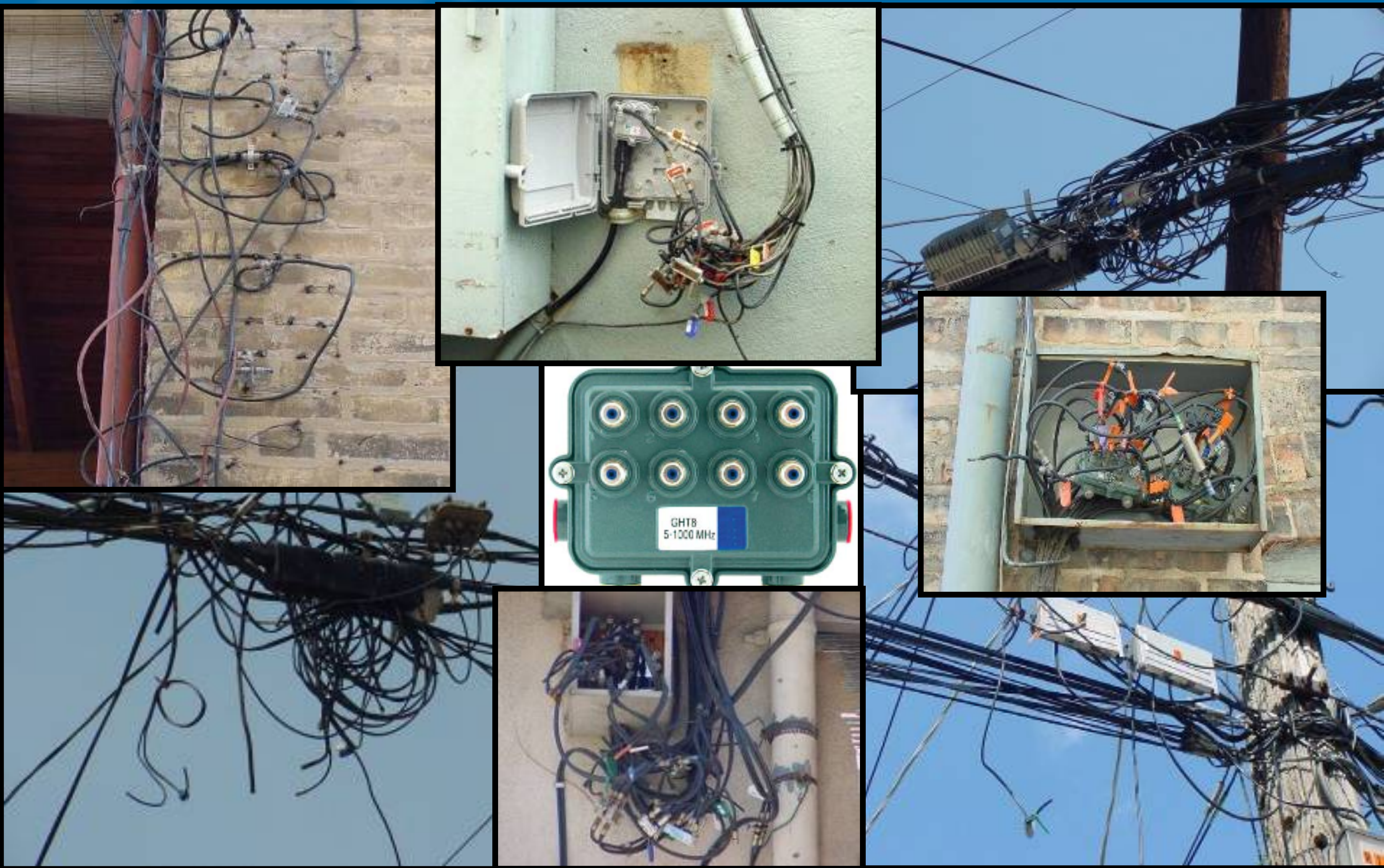
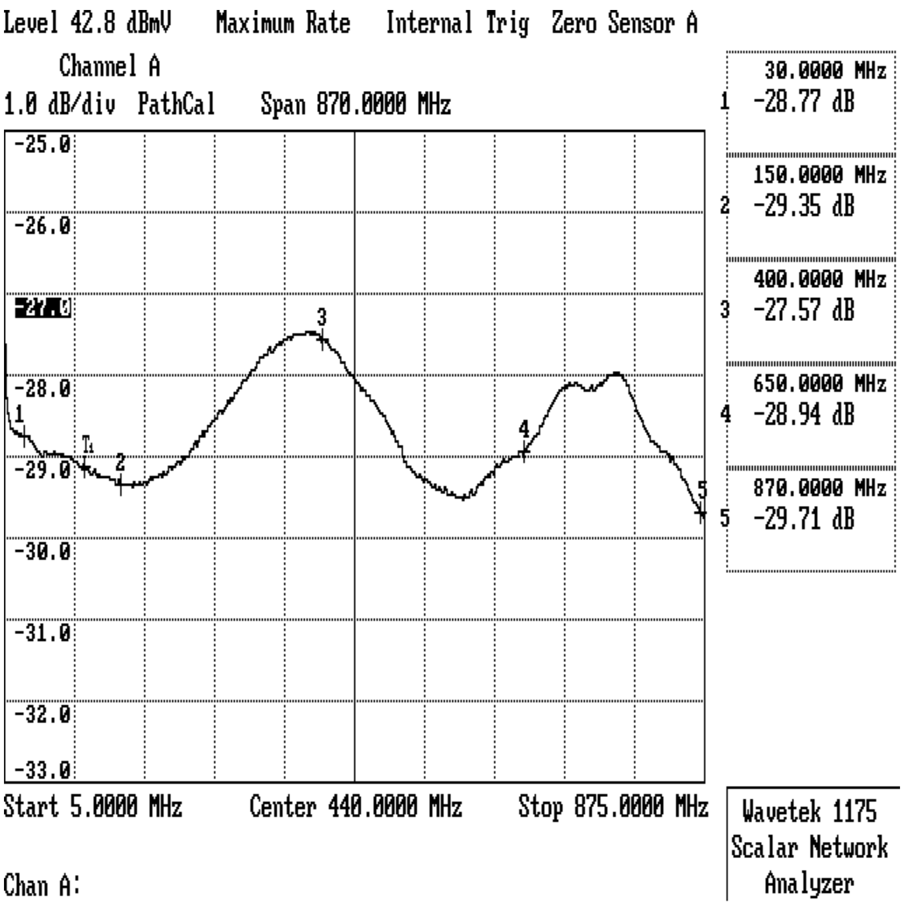
Common problems in HFC Networks

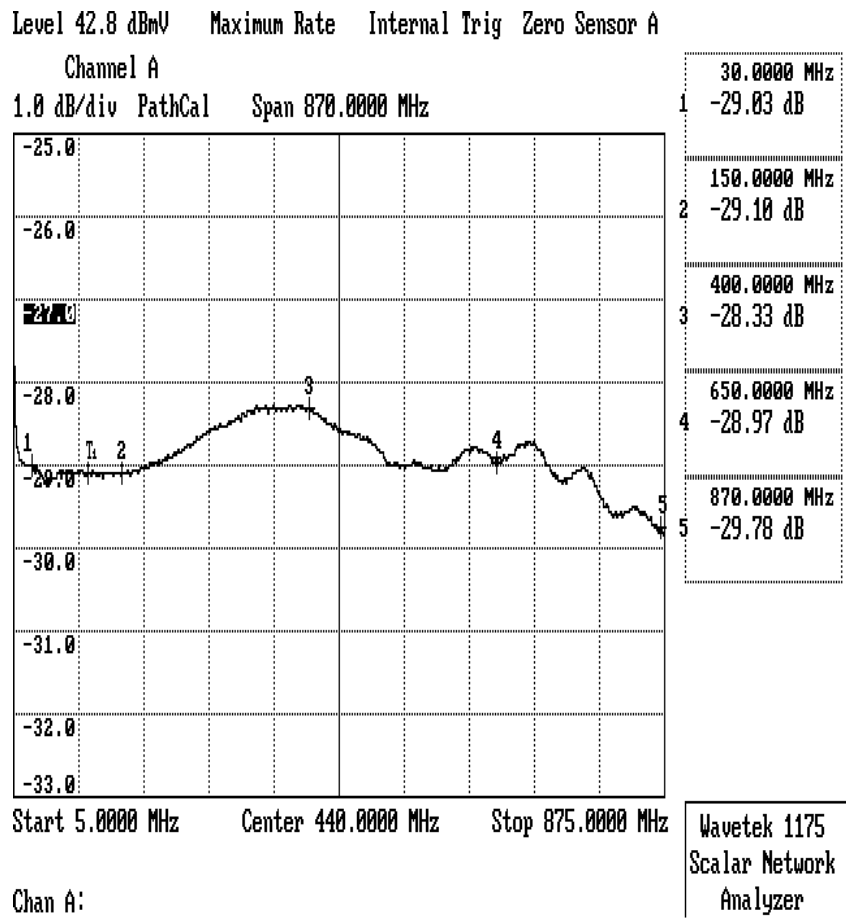


Beware of Taps

Port 1 2thru8 not terminated

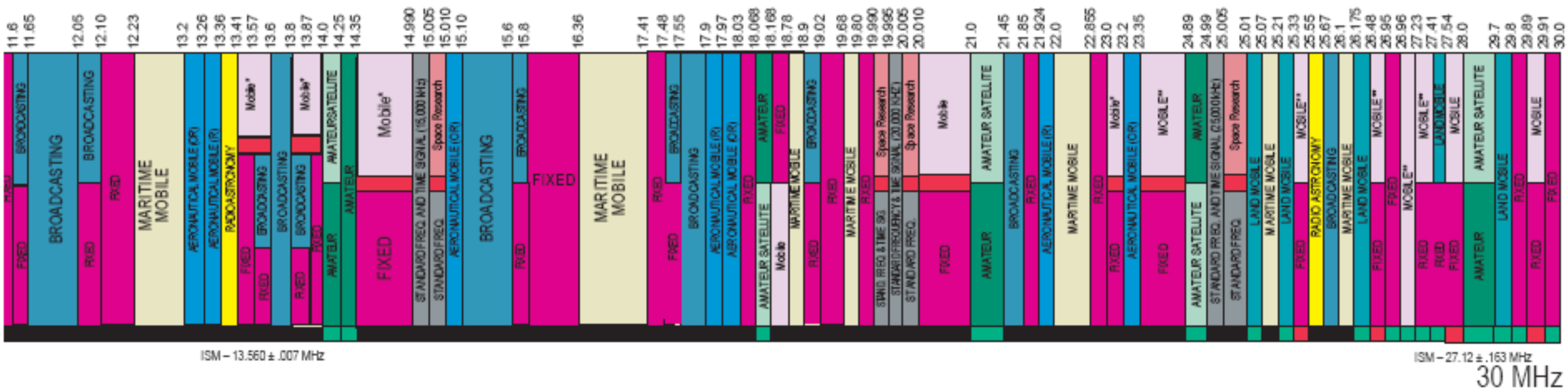


Port 1 2thru8 terminated



Reverse Path Impairments - Ingress

RF ingress — The 5-42 MHz reverse spectrum is shared with numerous over-the-air users.



Signals in the over-the-air environment include high power shortwave broadcasts, amateur radio, citizens band, government, and other two-way radio communications.

There are Many Possible Sources of Interference

Off-Air Broadcast

- AM Radio Station
- FM Radio Station
- TV Station
- Two-way Radio Transmitters
- Citizens Band (CB)
- Amateur (Ham)
- Taxi
- Police
- Business
- Airport/Aircraft
- Paging Transmitters

Federal Communications Commission

FEDERAL COMMUNICATIONS COMMISSION

Electrical Devices

- Doorbell transformers
- Toaster Ovens
- Electric Blankets
- Ultrasonic pest controls (bug zappers)
- Fans
- Refrigerators
- Heating pads
- Light dimmers
- Touch controlled lamps
- Fluorescent lights
- Aquarium or waterbed heaters
- Furnace controls
- Computers and video games
- Neon signs
- Power company electrical equipment
- Alarm systems
- Electric fences
- Loose fuses
- Sewing machines
- Hair dryers
- Electric toys
- Calculators
- Cash registers
- Lightning arresters
- Electric drills, saws, grinders, and other power tools
- Air conditioners
- TV/radio booster amplifiers
- TV sets
- Automobile ignition noise
- Sun lamps
- Smoke detectors

LTE Overview

Frequency Bands and Channel Numbers

E-UTRA Band	Downlink (DL) band				Uplink (UL) band				Duplex Mode
	F_{DL_low}	F_{DL_High}	$N_{Offs\text{-}DL}$	Range of N_{DL}	F_{UL_low}	F_{UL_High}	$N_{Offs\text{-}UL}$	Range of N_{UL}	
1	2110 MHz	2170 MHz	18000	18000 – 18599	1920 MHz	1980 MHz	0	0 – 599	FDD
2	1930 MHz	1990 MHz	18600	18600 – 19199	1850 MHz	1910 MHz	600	600 - 1199	FDD
3	1805 MHz	1880 MHz	19200	19200 – 19949	1710 MHz	1785 MHz	1200	1200 – 1949	FDD
4	2110 MHz	2155 MHz	19950	19950 – 20399	1710 MHz	1755 MHz	1950	1950 – 2399	FDD
5	869 MHz	894MHz	20400	20400 – 20649	824 MHz	849 MHz	2400	2400 – 2649	FDD
6	875 MHz	885 MHz	20650	20650 – 20749	830 MHz	840 MHz	2650	2650 – 2749	FDD
7	2620 MHz	2690 MHz	20750	20750 – 21449	2500 MHz	2570 MHz	2750	2750 – 3449	FDD
8	925 MHz	960 MHz	21450	21450 – 21799	880 MHz	915 MHz	3450	3450 – 3799	FDD
9	1844.9 MHz	1879.9 MHz	21800	21800 – 22149	1749.9 MHz	1784.9 MHz	3800	3800 – 4149	FDD
10	2110 MHz	2170 MHz	22150	22150 – 22749	1710 MHz	1770 MHz	4150	4150 – 4749	FDD
11	1475.9 MHz	1500.9 MHz	22750	22750 – 22999	1427.9 MHz	1452.9 MHz	4750	4750 – 4999	FDD
12	728 MHz	746 MHz	23000	23000 – 23179	698 MHz	716 MHz	5000	5000 – 5179	FDD
13	746 MHz	756 MHz	23180	23180 – 23279	777 MHz	787 MHz	5180	5180 – 5279	FDD
14	758 MHz	768 MHz	23280	23280 – 23379	788 MHz	798 MHz	5280	5280 – 5379	FDD
…									
17	734 MHz	746 MHz	23730	23730 – 23849	704 MHz	716 MHz	5730	5730 – 5849	FDD
…									
33	1900 MHz	1920 MHz	36000	36000 – 36199	1900 MHz	1920 MHz	36000	36000 – 36199	TDD
34	2010 MHz	2025 MHz	36200	36200 – 36349	2010 MHz	2025 MHz	36200	36200 – 36349	TDD
35	1850 MHz	1910 MHz	36350	36350 – 36949	1850 MHz	1910 MHz	36350	36350 – 36949	TDD
36	1930 MHz	1990 MHz	36950	36950 – 37549	1930 MHz	1990 MHz	36950	36950 – 37549	TDD
37	1910 MHz	1930 MHz	37550	37550 – 37749	1910 MHz	1930 MHz	37550	37550 – 37749	TDD
38	2570 MHz	2620 MHz	37750	37750 – 38249	2570 MHz	2620 MHz	37750	37750 – 38249	TDD
39	1880 MHz	1920 MHz	38250	38250 – 38649	1880 MHz	1920 MHz	38250	38250 – 38649	TDD
40	2300 MHz	2400 MHz	38650	38650 – 39649	2300 MHz	2400 MHz	38650	38650 – 39649	TDD

DL Center Frequency $(F_{DL}) = F_{DL\_low} + 0.1(N_{DL} - N_{Offs\text{-}DL})$

Channel Number $(N_{DL}) = (F_{DL} - F_{DL\_low})/0.1 + N_{Offs\text{-}DL}$

Signal Analysis
LTE Downlink Channels

DL Channels	Description	Modulation Format	Purpose
PBCH	Physical Broadcast channel	QPSK	Carrier Cell specific information.
PDCCH	Physical Downlink Control Channel	QPSK	Transports format, resource and hybrid-ARQ information related to DL-SCH, UL-SCH and PCH.
PDSCH	Physical Downlink Shared Channel	QPSK, 16QAM, 64QAM	User data payload.
PMCH	Physical Multicast Channel	QPSK, 16QAM, 64QAM	Payload for multiple users, Multimedia Broadcast Multicast service (MBMS)
PCFICH	Physical Control Format Indicator Channel	QPSK	Carries the number of symbols (1,2 or 3) used for control channels (PDCCH) in a subframe.
PHICH	Physical Hybrid ARQ Indicator Channel	BPSK	Carries the error detection (hybrid ARQ ACK/NAK) feedback to the UE for the UL blocks received by the eNB.
P-SCH	Primary Synchronization Channel	Zadoff – Chu	Used for cell search and cell identification. Carries part of the cell ID
S-SCH	Secondary Synchronization Channel	BPSK	Used for cell search and cell identification. Carries the remainder of the Cell ID
RS	Reference Signal (Pilot)	Complex I+Q pseudo random sequence	Used for DL channel estimation. Exact sequence derived form Cell ID. Enable UE to calculate transmission corrections.

MODULATION SCHEMES

In-Home Wiring is a Challenge

- Each home is a “headend” for the reverse path
- Home wiring frequently has inferior components and craftsmanship
- Replacing all home wiring is economically unacceptable,
- Each year the cable industry buys somewhere in the neighborhood of 2 billion feet of drop cable.

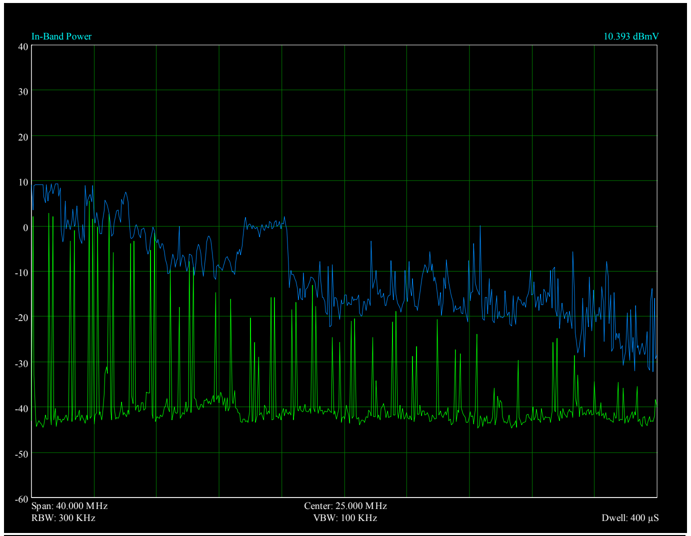
In-Home Wiring Is A Potentially Large Stumbling Block

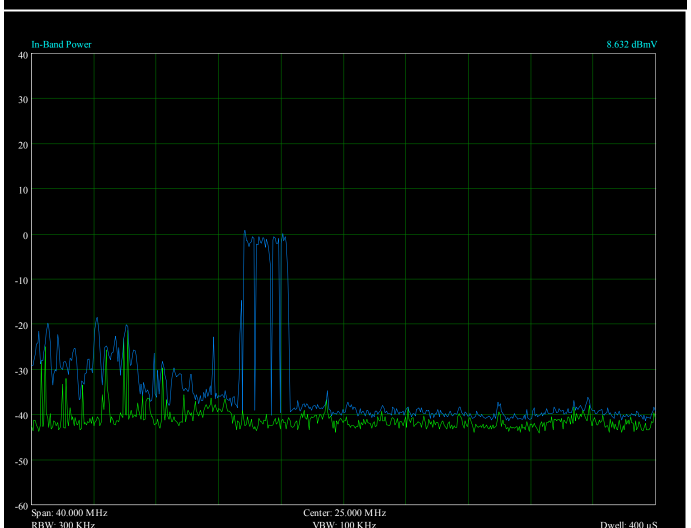
- **The subscriber drop remains the weakest link in the cable network**
- **Seven out of ten service calls are generated by problems at the drop**
- **Ingress caused in the home wreaks havoc on the reverse path**
  - **Must be found in the home before connecting to network when possible**
  - **Must be monitored continuously and eliminated quickly**
- **Replacing all home wiring is economically unacceptable, testing is required to find faults and bring the home wiring up to standards necessary for new services.**

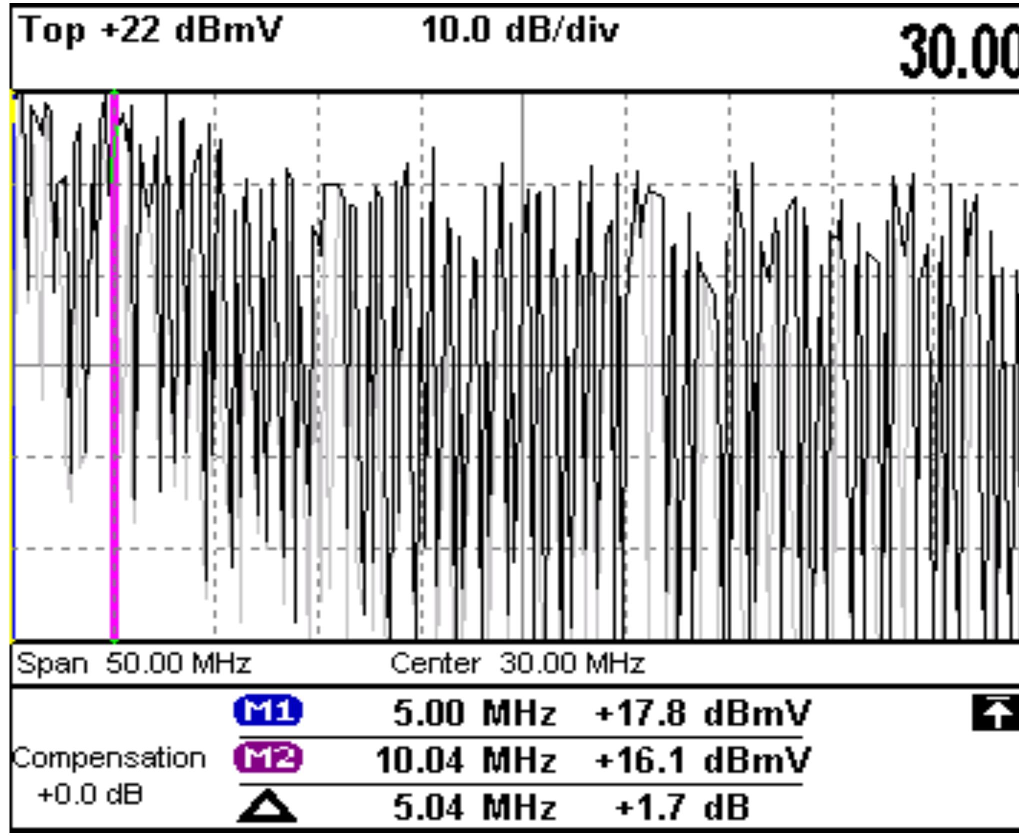
Common Problems Typically Identified in the Drop

- Kinked or damaged cable (including cracked cable, which causes a reflection and ingress)
- Use of staples that perforate or compress coaxial cable resulting in impedance mismatches
- Cable-ready TVs and VCRs connected directly to the drop (Return loss on most cable-ready devices is poor)
- Older splitters and amplifiers may not be rated for 750MHz, 860MHz or 1GHz
- Some traps and filters have been found to have poor return loss in the upstream, especially those used for data-only service

Electrical Impulse Noise from One House





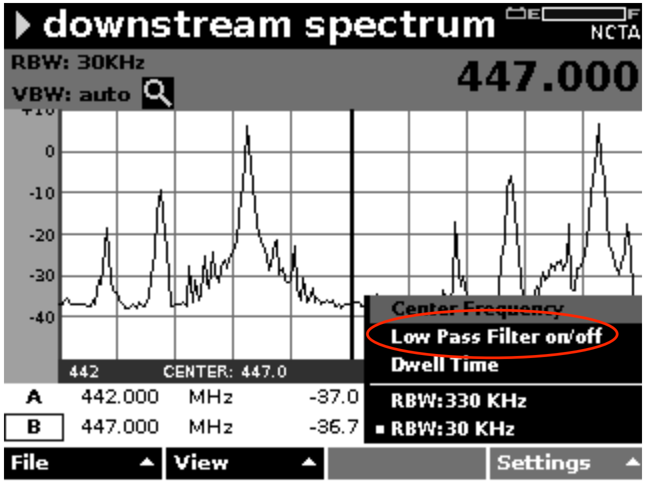


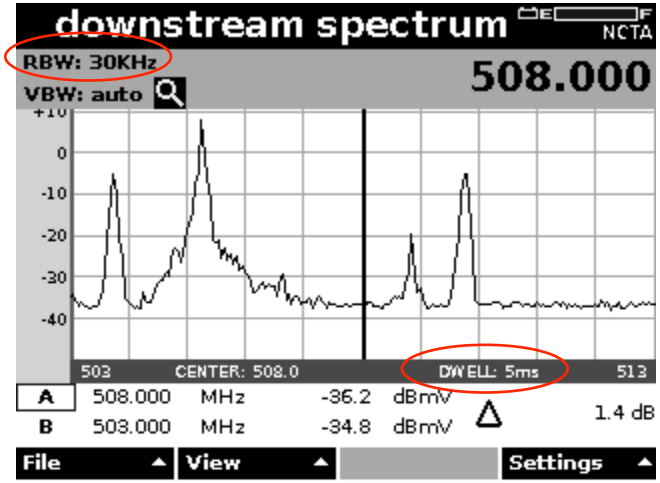
- Reverse Spectrum shot at customer's drop

Tools for Troubleshooting

Users can now adjust the spectrum mode to better see intermittent ingress, harmonics, and other channel anomalies. They can also look over both the upstream and downstream spectrums in one mode as well as isolate the return path from the forward path, eliminating noise leaking down into the return path.

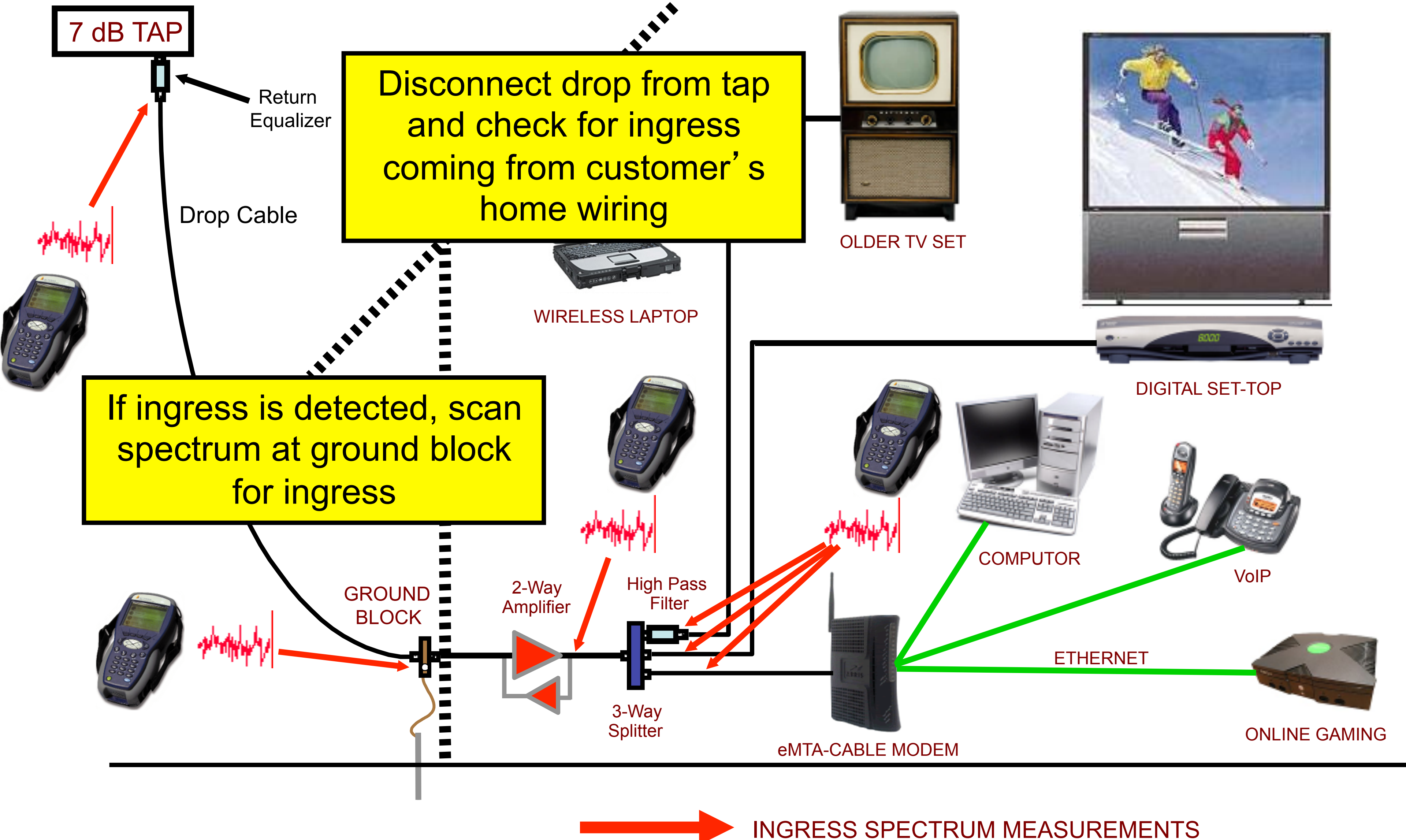
- View 4MHz – 1GHz, in either 10 or 50 MHz spans, without changing modes
- While viewing return spectrum; enable a Low Pass Filter
  - Cuts out the higher frequency noise
  - Cleaner return path view; lower noise floor
- Increase Dwell time (1-25ms) per frequency scan
  - Find intermittent impairments better/quicker
- Adjust resolution bandwidth (RBW) from 330KHz to 30KHz
  - Shows more spectrum characteristics with smaller spectral slices adding to the overall resolution



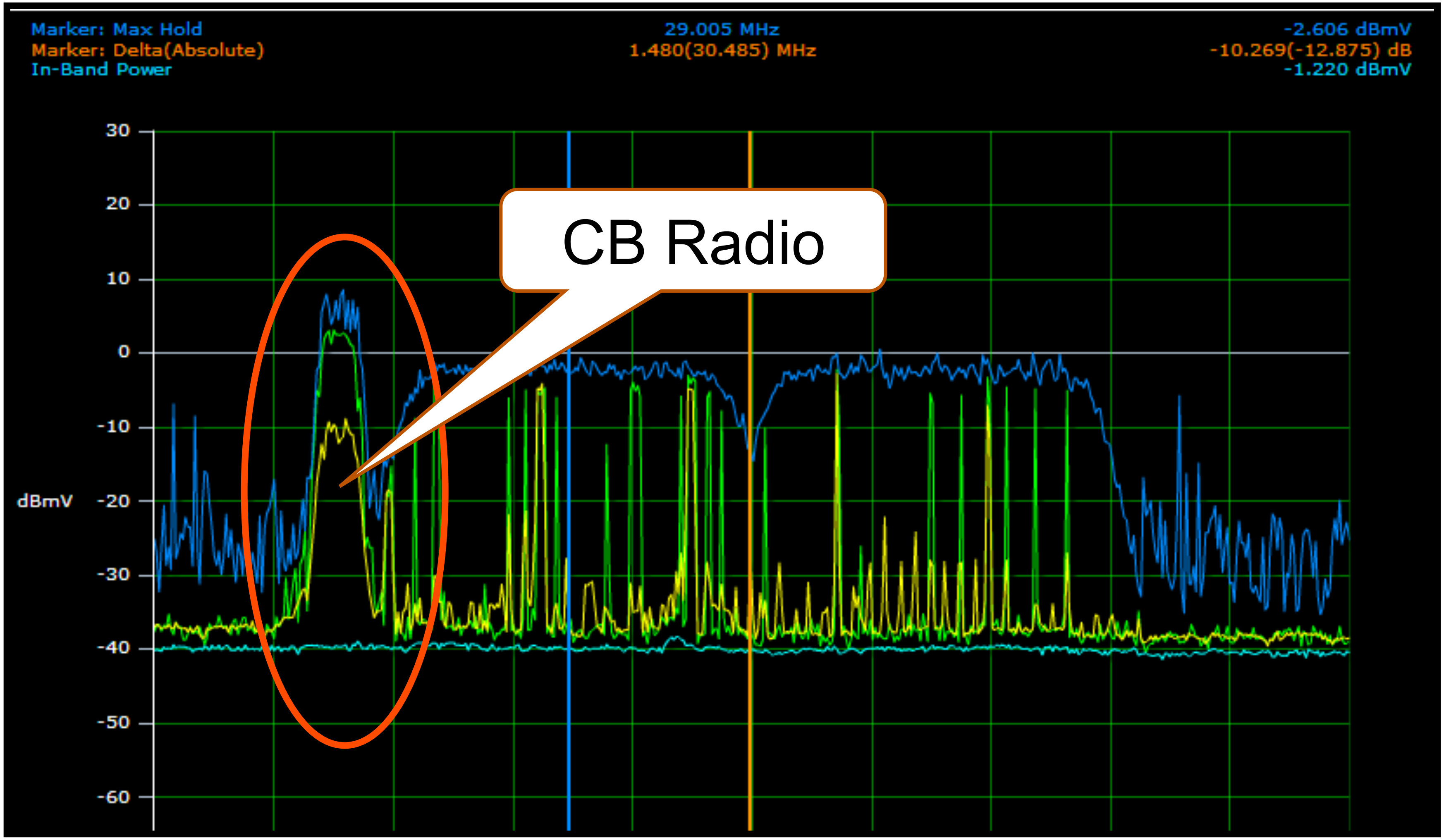


*All HW versions

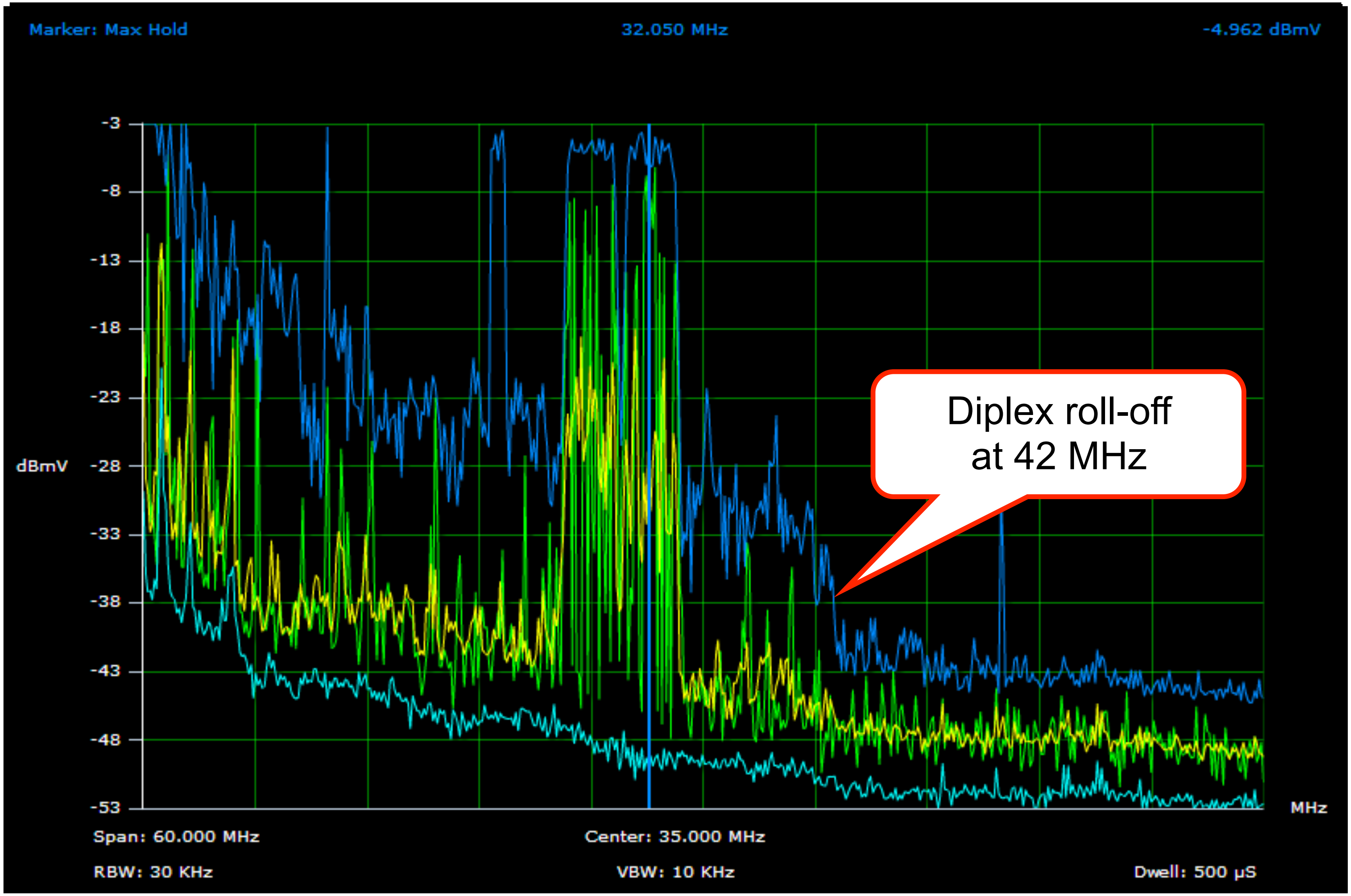
Testing the Home for Ingress Contribution



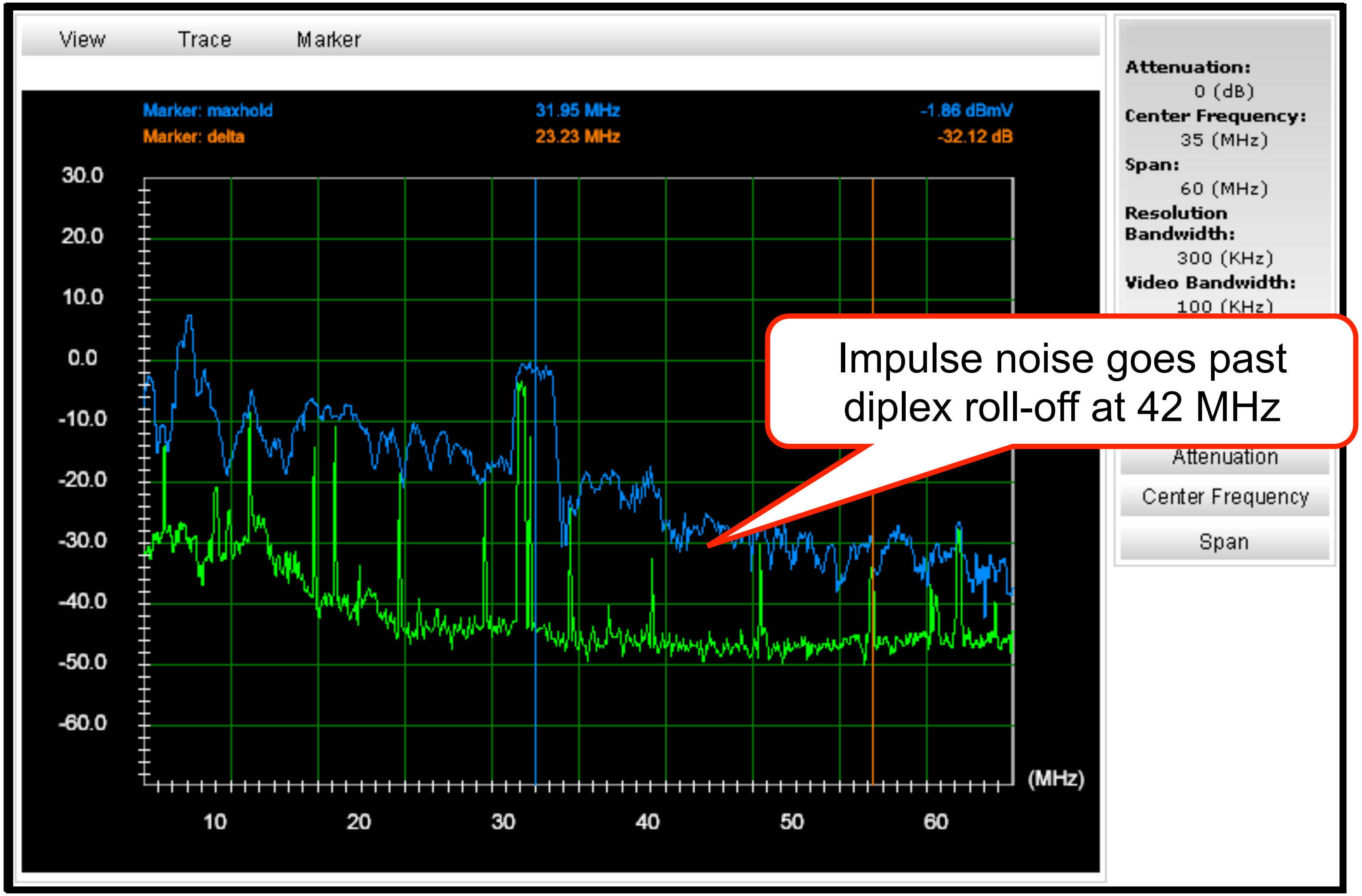
Ingress - CB Radio



Wideband Impulse Noise = Code Word Errors!



Wide Band Impulse Noise and Laser Clipping



A 7/16” wrench is a “hi-tech” tool?!

“Finger tight ain’t good enuff!”

Home Networks

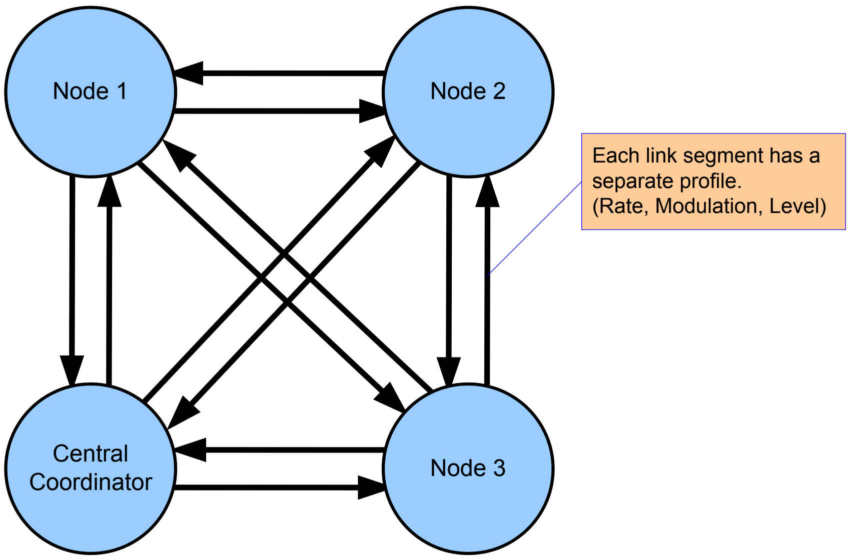
Home Networking Technologies

- Ethernet
  - Runs on Cat-5
  - Less than 5% of Homes wired for Ethernet
- MoCA™ Multimedia over Coax Alliance
  - Runs on existing Coax
- HPNAv3 Home Phone Network Alliance
  - Runs on Coax OR over existing phone lines
- HomePlug® A/V
  - Runs over AC wiring
- Proprietary over coax
  - TV Net(Coaxsys)/HomeRan(TMT Networks)
- Wireless 802.11 b/g/a
  - Range limited due to propagation through walls

HPNA Technical Features

Technical Specification Overview	
Throughput (MAC/ PHY)	128 / 200 Mbps
Latency	10 ms
Jitter	< 1 ms
PER	1e-7 ~(1e-10 BER)
Number of Nodes	8 max
Max Length	400 ft
Loss Budget	50 dB
Modulation	OFDM
Frequency	4-12 MHz or 12-28 MHz
RF Power	-7 dBm
QoS	Yes

True Mesh Network



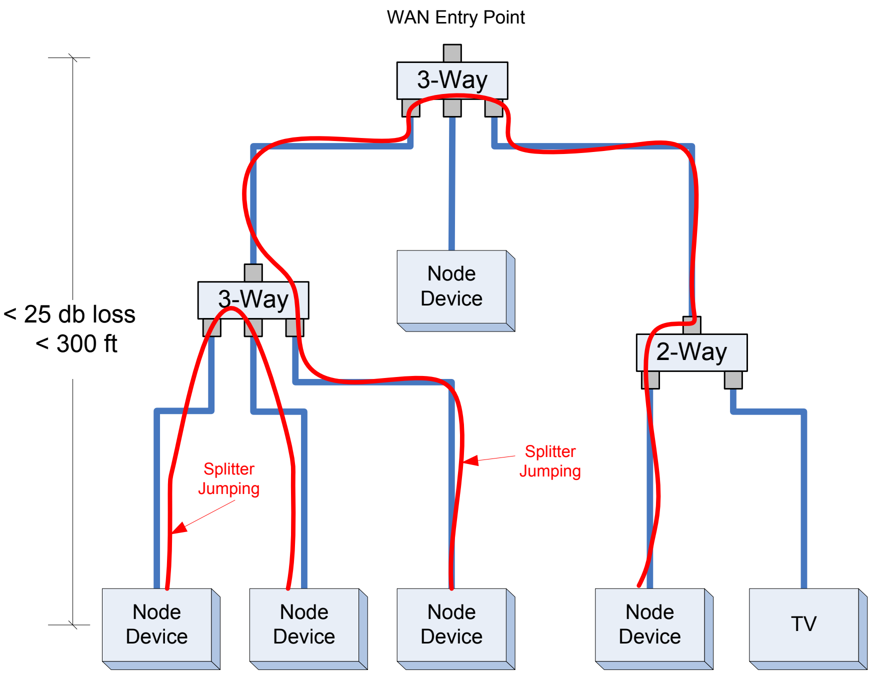
HomePNA™ - Home Networking

Ethernet to Coax
HPNA Adapter

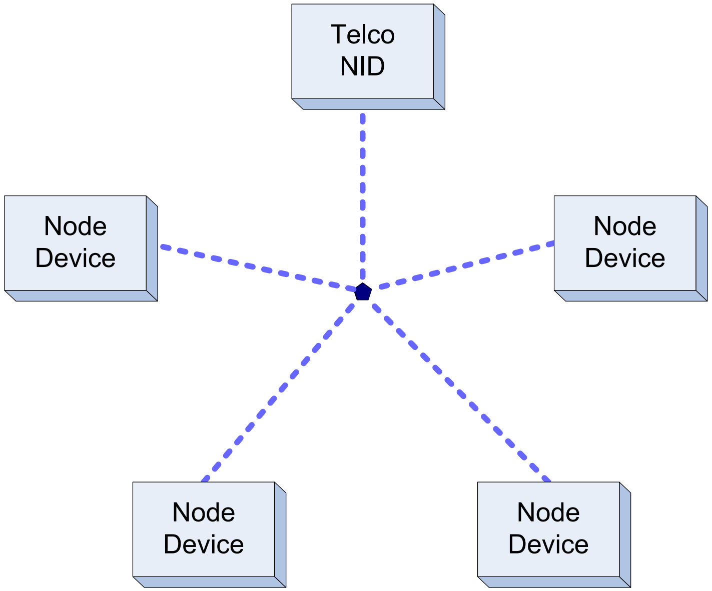
Features
- Uses your existing coaxial wiring
- Perfect for transferring large multimedia files such as movies, music, and photos
- Uses existing coax cabling
- Supports speeds up to 144 Mpbs burst, 95 Mbps sustained
- Complies with the HPNA 3.1 over coax specification (ITU G.9954)
- Supports point-to-point and point-to-multipoint network configurations

HPNA Physical Network Topology

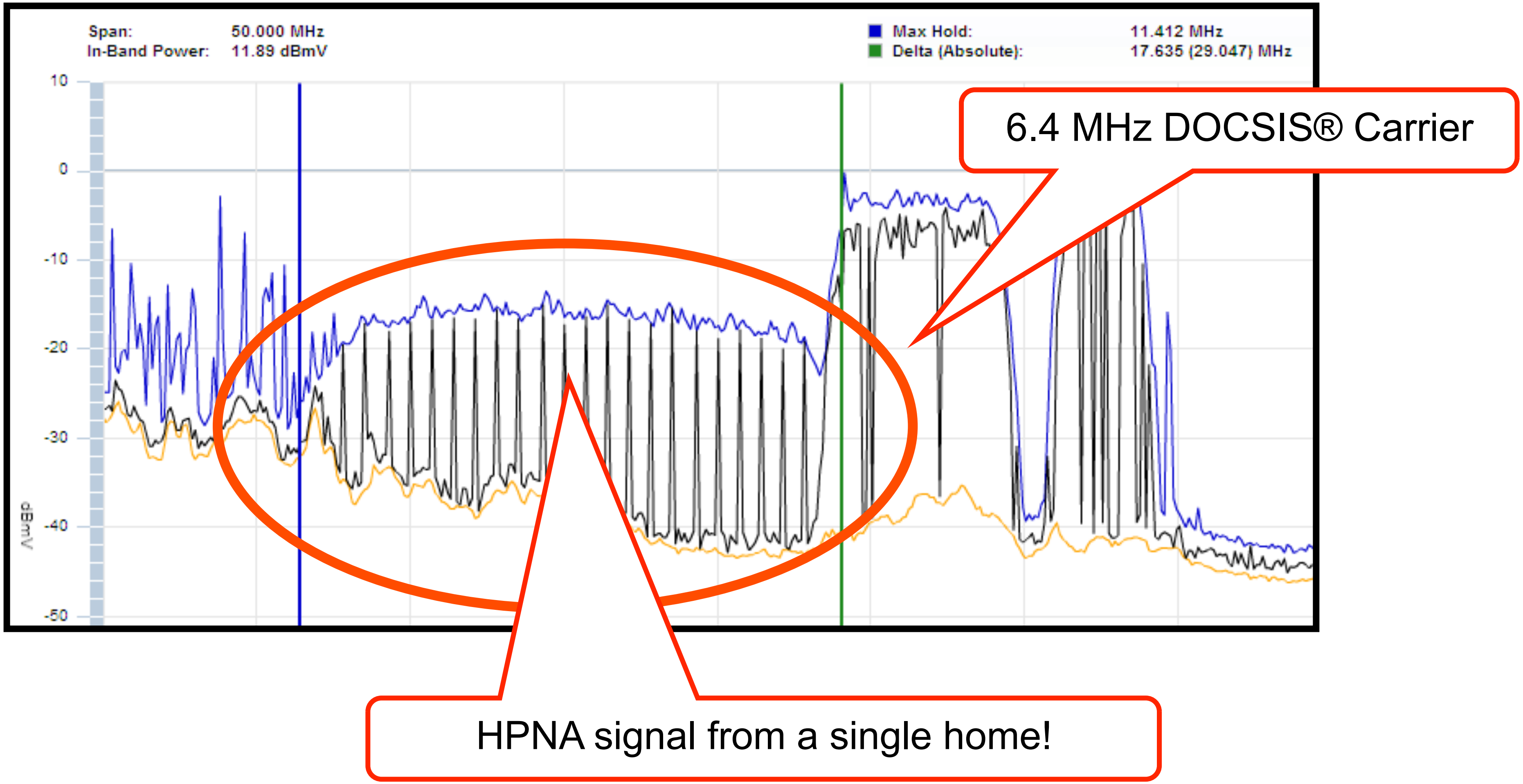
Coax Network Configuration



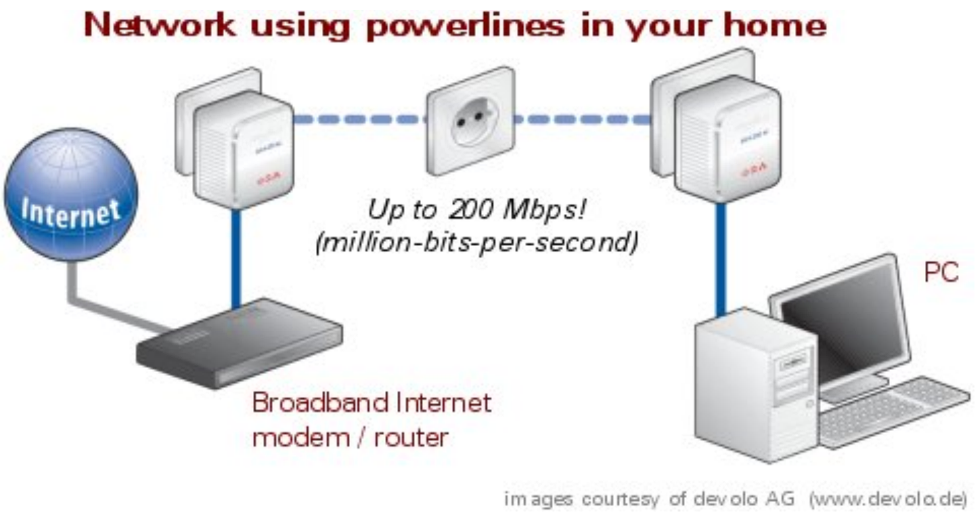
Twisted Pair Star Configuration



Wideband HomePNA™ Ingress in the Return Path

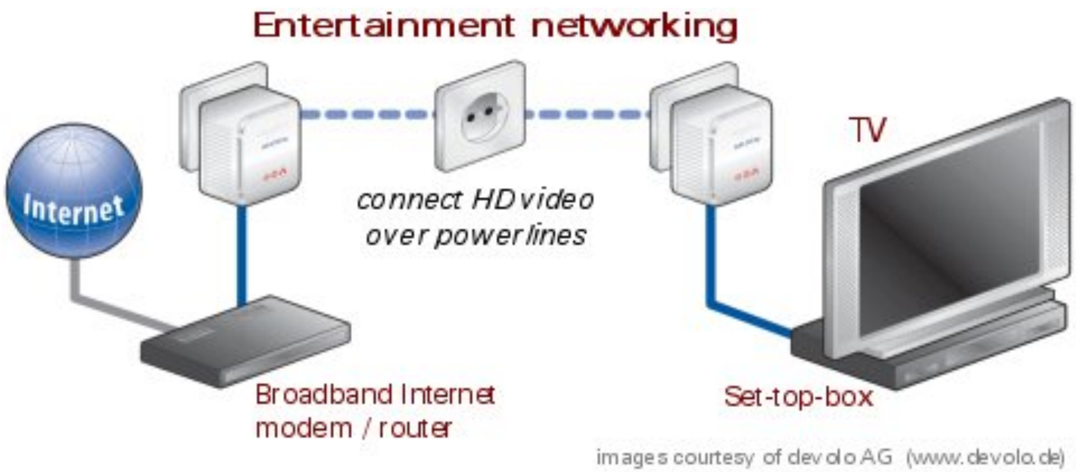


"The HomePNA™ Alliance develops triple-play home networking solutions for distributing entertainment data over both existing coax cable and phone lines. "



"Products based on the HomePlug 1.0 and HomePlug AV specifications can bridge an existing networking technology (such as a wireless or Ethernet network) and your home's power lines. "

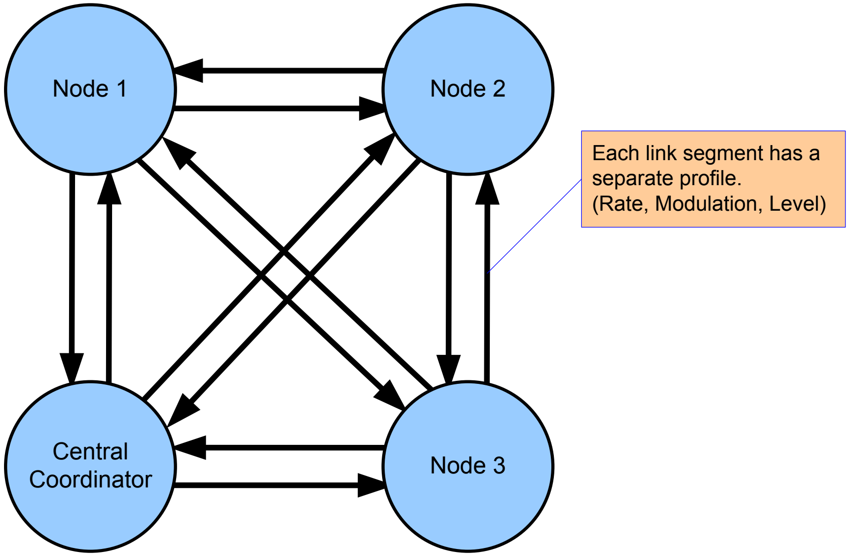
Network your TV with HomePlug AV



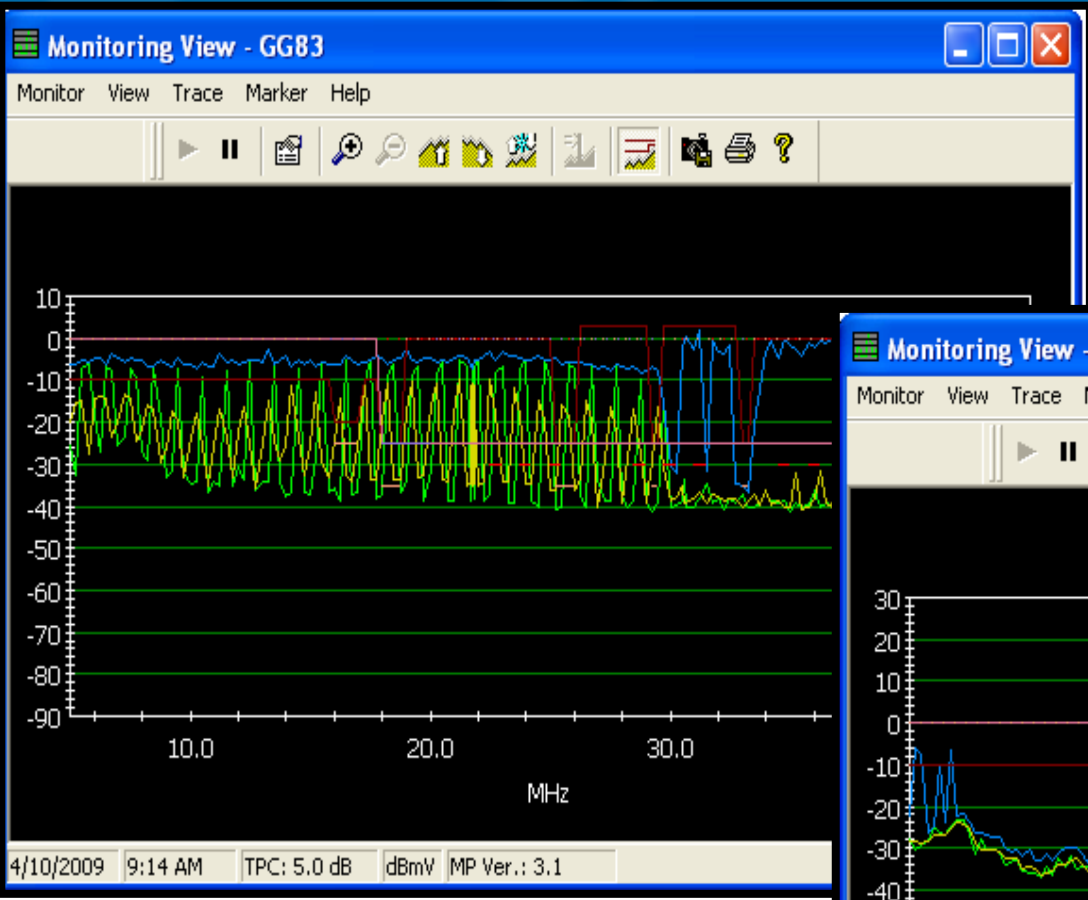
HomePlug AV Technical Features

- 150 Mbps MAC / 200Mbps Phy
  - Expected performance of 50-80 Mbps in most installs
- Works over existing AC power lines
- Actively adapts to the wiring
- Can support multiple networks on a single media. (with performance degradation)
- True peer-to-peer mesh network
- OFDM Modulation
- 2-28 MHz
- Encrypted data transfer
- QoS

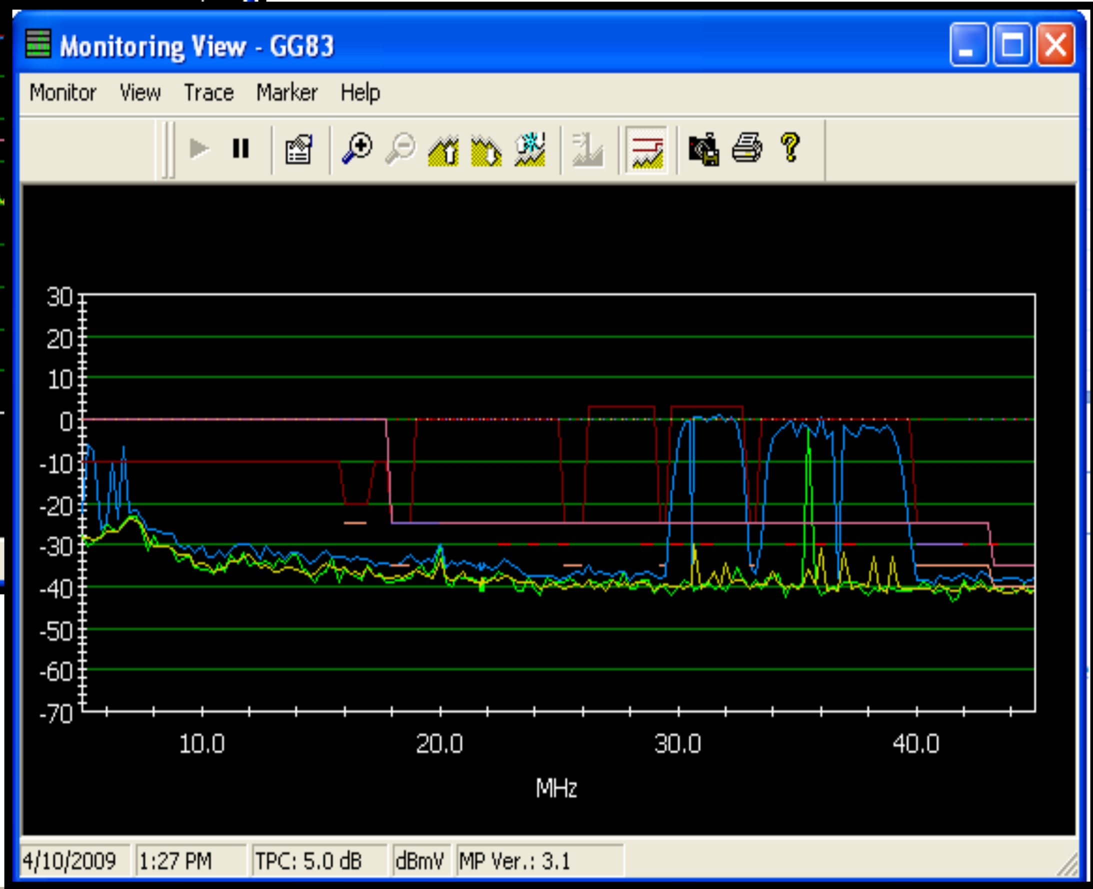
True Mesh Network



Home Plug Interference

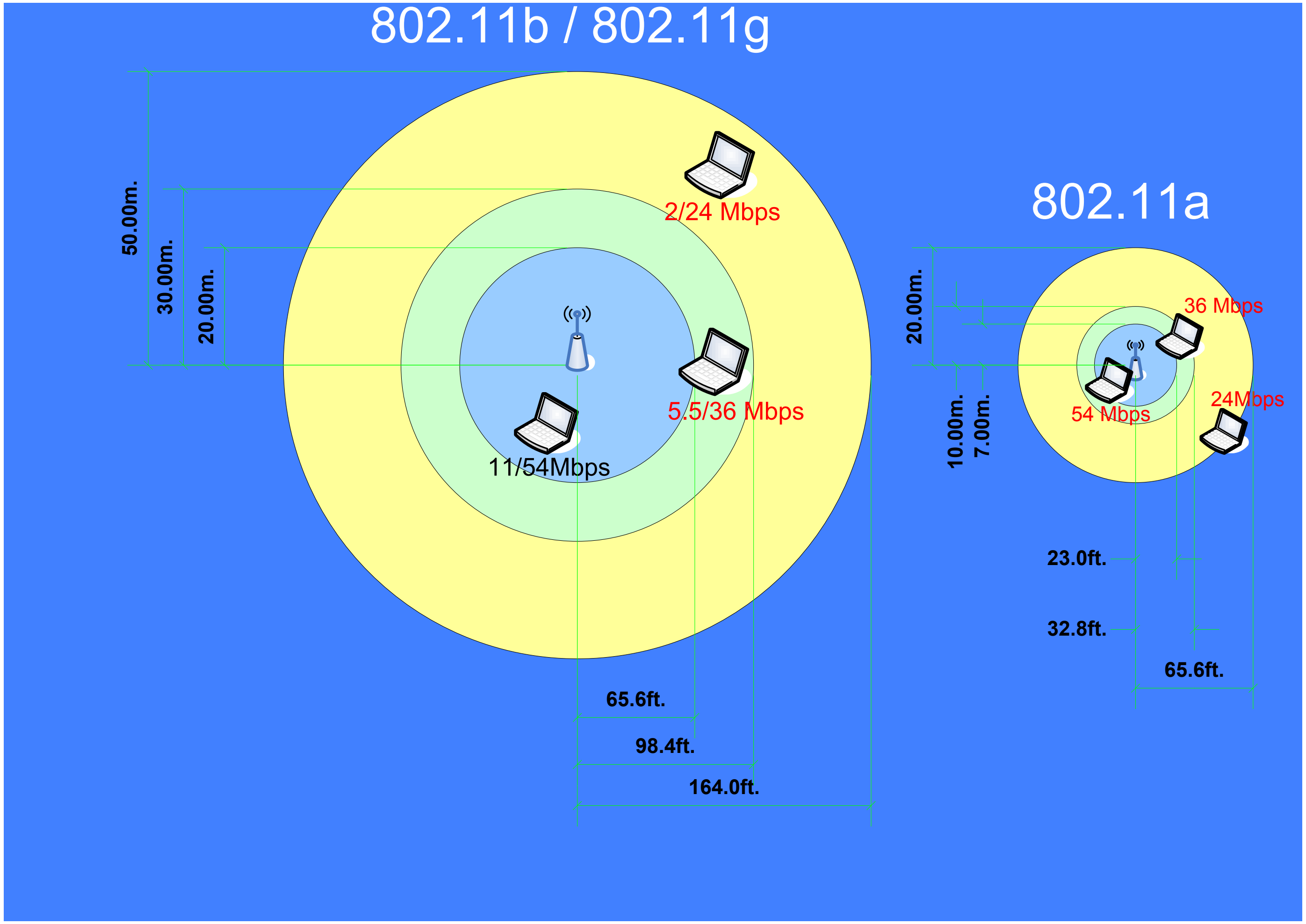


HomePlug uses 917 OFDM sub-carriers. OFDM modulation allows co-existence of several distinct data carriers in the same wire.



"The number of whole-home DVR installations is expected to grow at a CAGR of over 100 percent from 2006 to 2008."
-- In-Stat

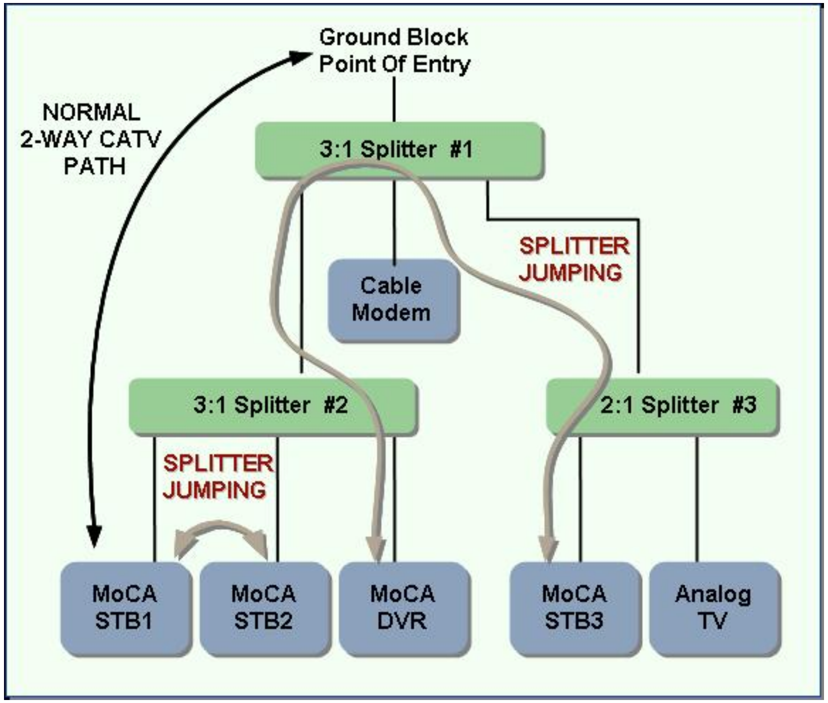
Wireless



802.11b / 802.11g
50.00m.
30.00m.
20.00m.
2/24 Mbps
5.5/36 Mbps
11/54Mbps
65.6ft.
98.4ft.
164.0ft.
802.11a
20.00m.
10.00m.
7.00m.
36 Mbps
54 Mbps
24Mbps
23.0ft.
32.8ft.
65.6ft.

What is MoCA?

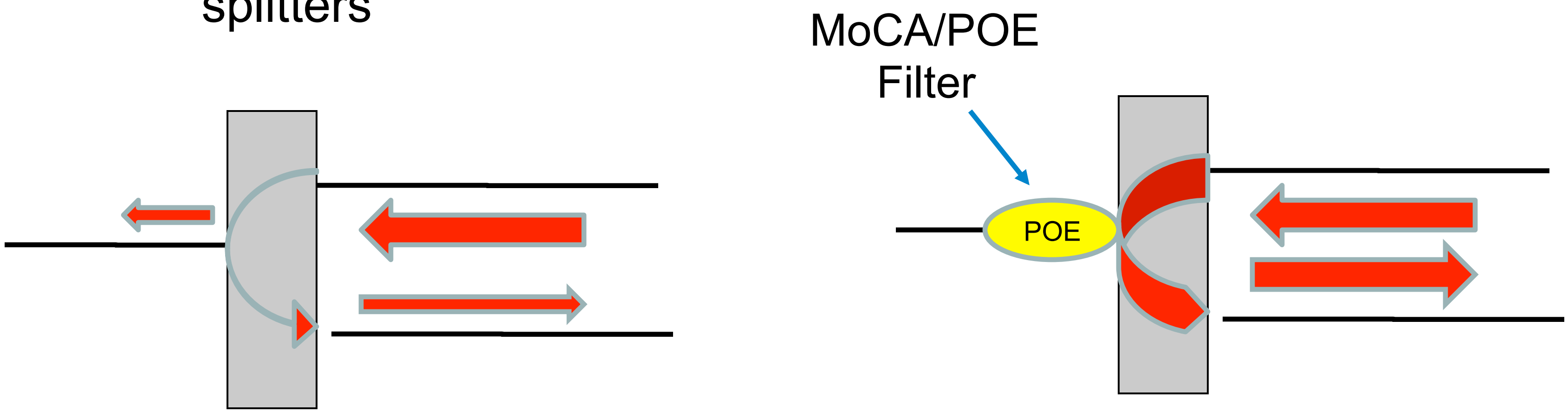
- Stands for: Multimedia over Coax Alliance
- Main applications:
  - **Whole Home DVR**
  - **Connect IP enabled devices**
- MoCA is very robust
  - 50-60dB of loss
- Excess Attenuation is the biggest killer of MoCA



- Several Operators estimate that MoCA services will first be available end of this year or early next year

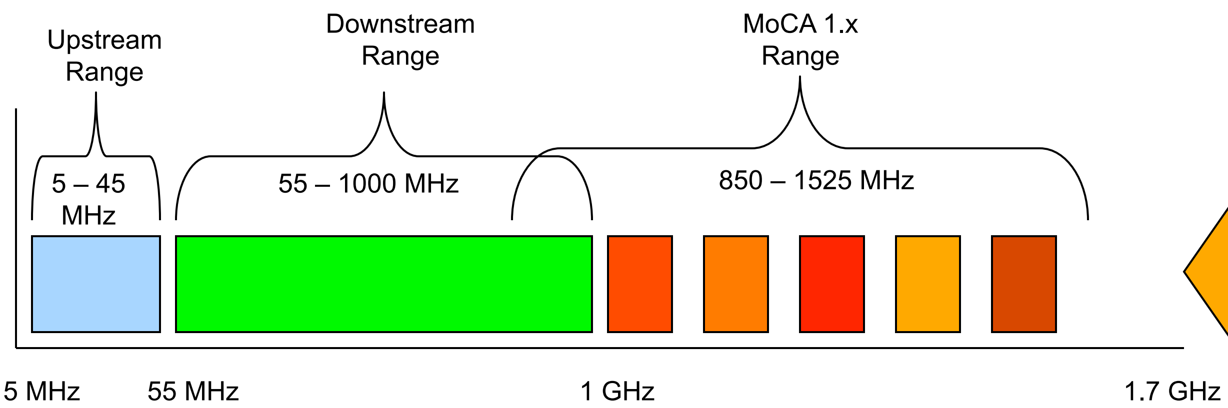
Point of Entry (POE) Filter

- A MoCA filter (aka: POE filter) performs two jobs.
  - First it removes the MoCA signal from entering a neighbors house
    - Stops MoCA signal from leaving the home
  - Second it gives MoCA a point of reflection for the signal
    - MoCA relies on the signals to "bounce" output to output on splitters



MoCA Just Evolved to V2.0

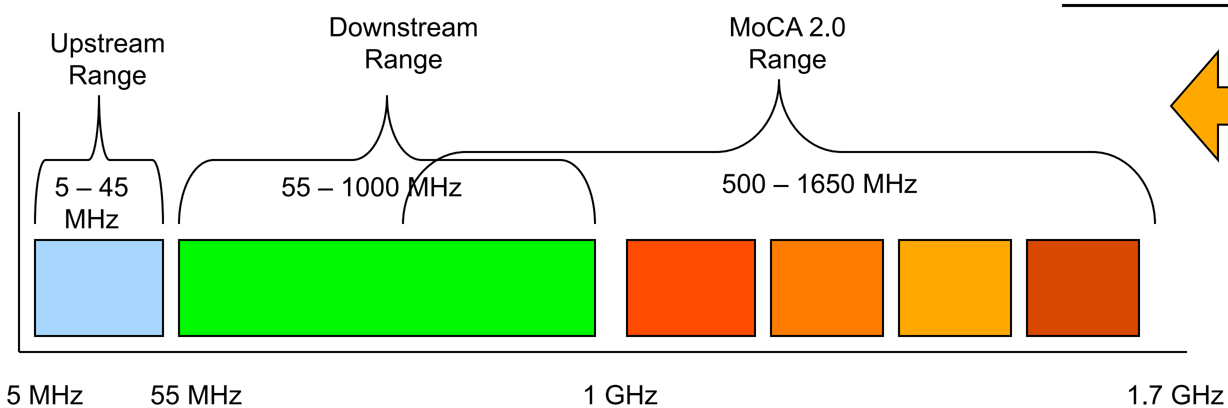
MoCA 1.x Frequency View



850MHz and 1.525GHz
50MHz wide 'channels'
Speeds up to 175Mbps

DIFFERENT HARDWARE

MoCA 2.0 Frequency View



500MHz and 1.65GHz
100MHz wide 'channels'
Speeds above 400Mbps

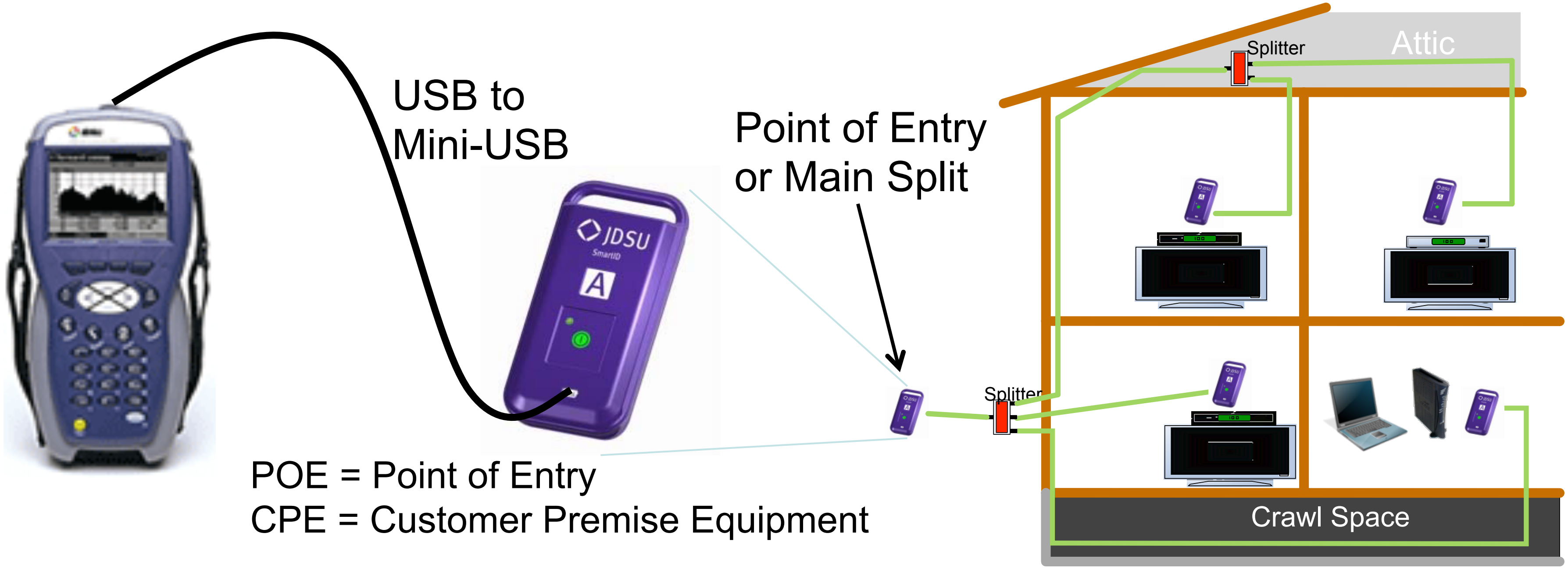
JDSU

MoCA 2.0 Detailed

- MoCA 2.0 (June 15, 2010) - Similar to MoCA 1.1 but with the following differences:
  - Three new modes of operation:
    - Basline Mode:
      - 400+ Mbps MAC throughput
      - 700 Mbps PHY Rate
      - Single 100 MHz Channel
    - Enhanced Mode
      - 800+ Mbps MAC throughput
      - 1.4 Gbps PHY Rate
      - Two bonded 100 MHz Channels ("Channel Bonding")
    - "Turbo" mode for a point-to-point configuration that allows:
      - 500+ Mbps MAC throughput between two connected devices when operating in Baseline mode
      - 1+ Gbps MAC throughput when operating in Enhanced mode
  - All three modes now have an extended frequency range
    - 500 MHz through 1650 MHz (center frequencies)
  - Backward compatibility with MoCA 1.0 and 1.1 devices
    - MoCA 2.0 devices can operate at MoCA 2.0 speeds while MoCA 1.x devices are communicated to at their maximum respectable speeds on the same network

NOTE: MoCA 2.0 is different hardware than previous MoCA 1.1 HW versions

Verifying the Customers RF Network

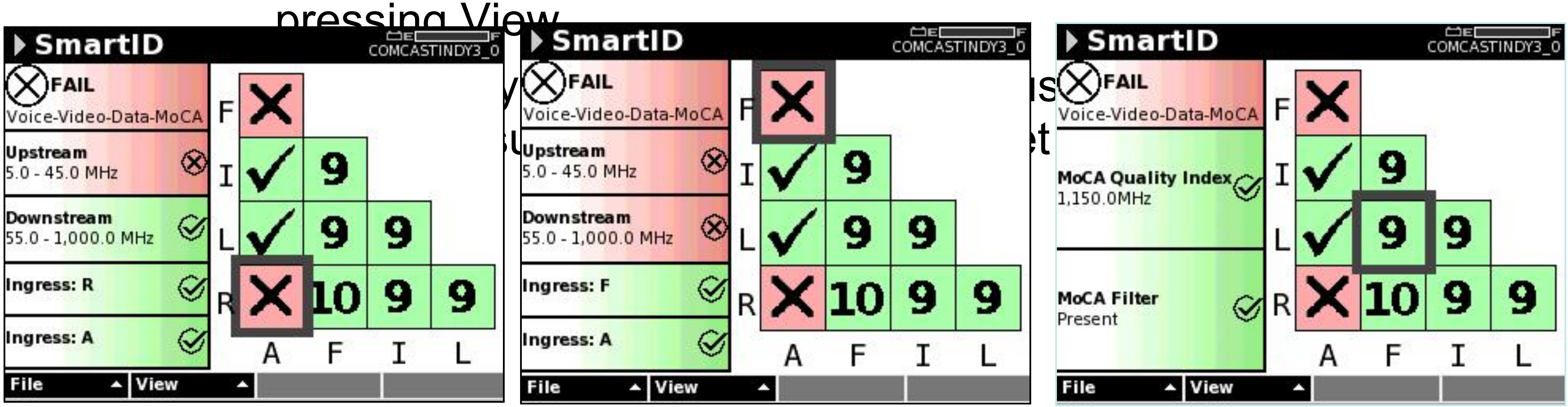


- Put a RF tester at each location inside the home where a Set-top-box or Cable Modem will be located (or is desired to be tested)
- Connect one RF Tester to the DSAM's USB port
- Then Connect that RF Tester to the POE looking into the home toward CPE (ie: drop cable, ground block, or main split)

Certify each Coax Path Independently

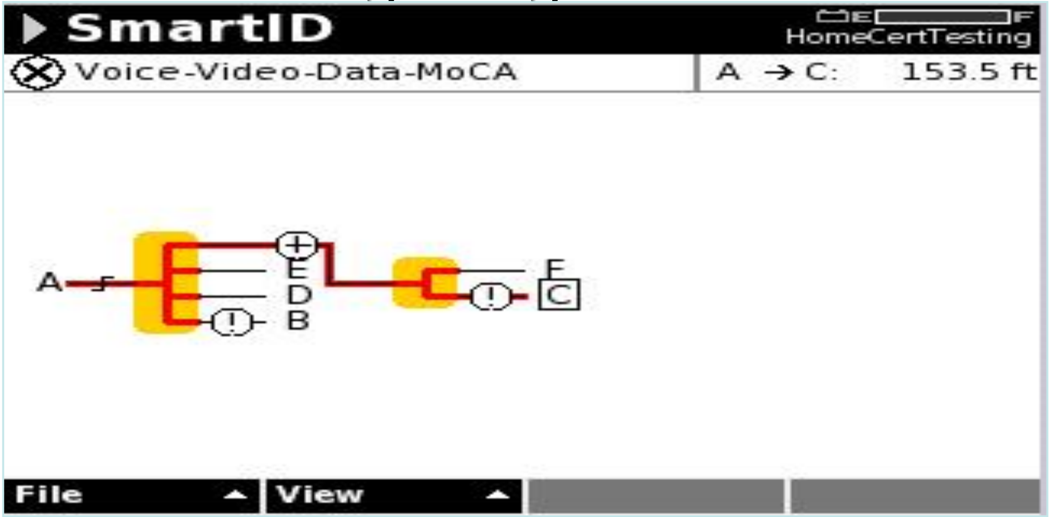
Shortcut: Press #1

- Qualification Screen shows Pass/Fail
  - If all metrics pass the coax paths are good for the services its was tested against
  - If a failure exists then further action is required
    - The columns on the left indicate which parameters failed for the movable bold box – Different paths may have different results
    - Additional detail about the failure can be collected from the Detail and the Network Overview screens – Accessible by pressing View



Seeing how everything is connected

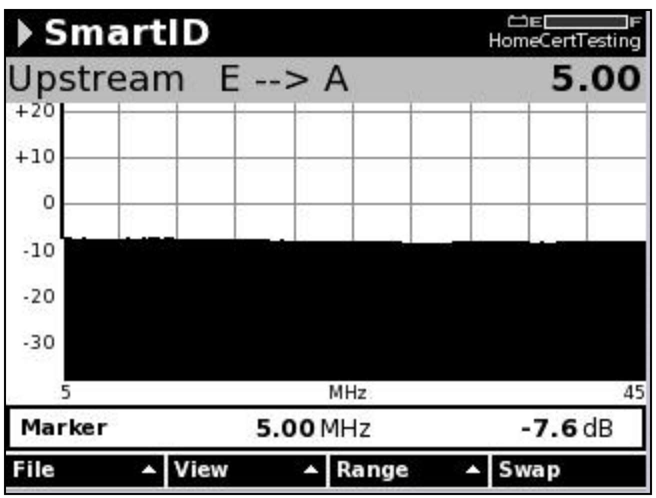
- Network Overview shows what is connected
  - RF Tester can determine what it believes is connected and where those elements have common connections
  - Each element is shown on the topology map including: splitters, filters, amplifiers, and found mismatches
  - Users can easily identify if unexpected elements are discovered and trace where those elements are located before beginning to troubleshoot the coax network



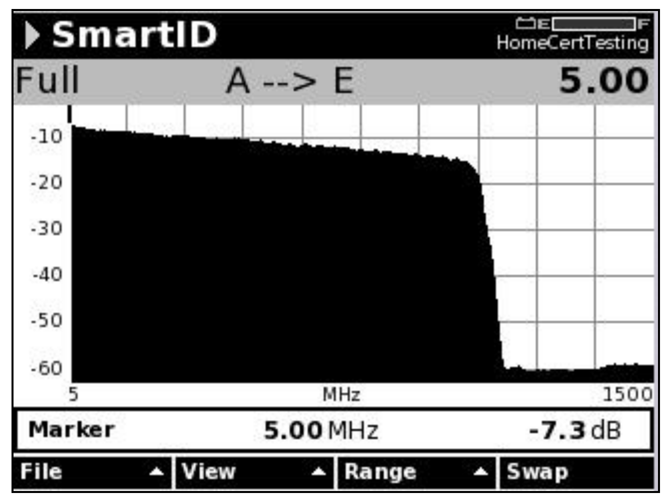
Sweep Trace – Freq Response

Shortcut: Press #4

- Shows POE to CPE for Full and Upstream Sweeps
- User Arrow keys to See amplitude at a specific frequency
- Type in the specific freq on the keypad
- Press cancel button to go back



Upstream Freq Response

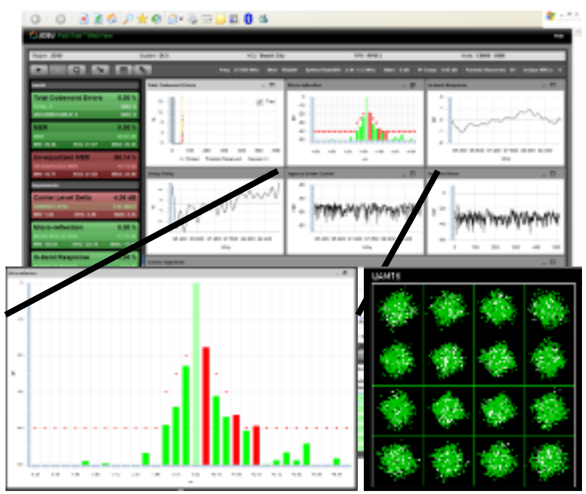


Downstream Freq Response – with MoCA filter in place

Common Linear Distortion Impairment Types

Micro-reflections

- Common Causes
  - Damaged/missing terminators
  - Loose seizure screws
  - Water-filled taps
  - Cheap/damaged splitters or CPE
  - Kinked/damaged cable
  - Install Issues



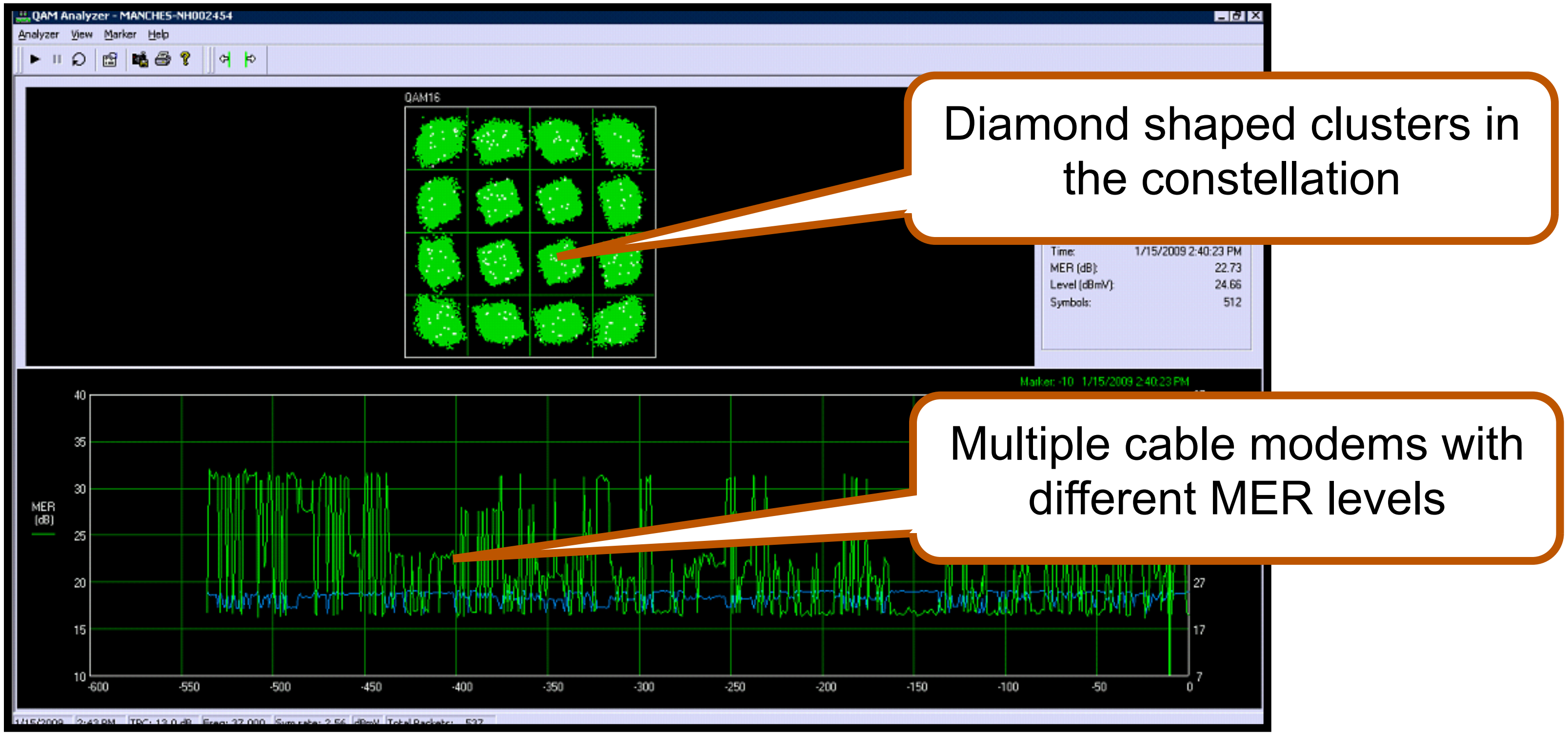
Group Delay

- Common Causes
  - Operation too close to diplex roll-off
  - Defective diplex filters
  - AC power coils/chokes
  - Notch Filters (high-pass, HSD-only, etc)
  - Micro-reflections

In-channel Freq. Response

- Common Causes
  - Misalignment
  - Impedance mismatches

PathTrak QAM Analyzer View – Group Delay & Micro-reflections



Group Delay / Microreflections

If the accumulation takes on a diamond shape, the problem is likely a group delay issue

Constellation may take on a diamond or square shape

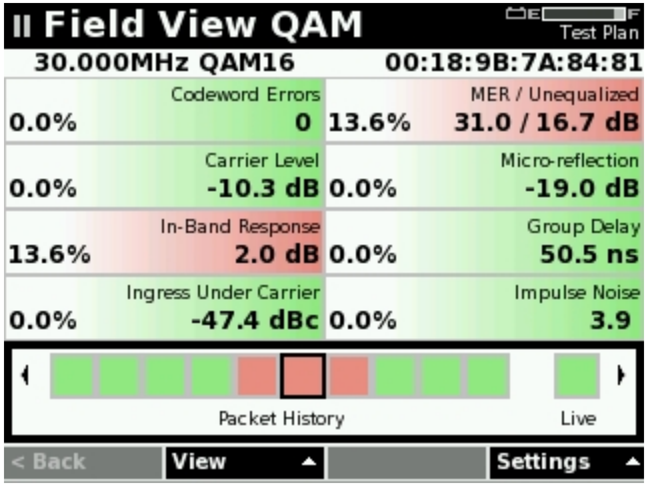
Clarity of diamond shape will vary with percentage of packets affected

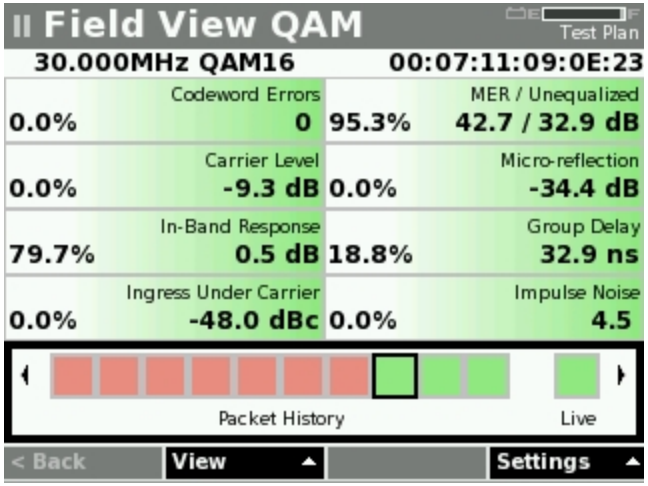
Microreflections are a common cause of group delay

Often caused by unterminated or improperly terminated lines or faulty CPE (cheap TV or VCR)

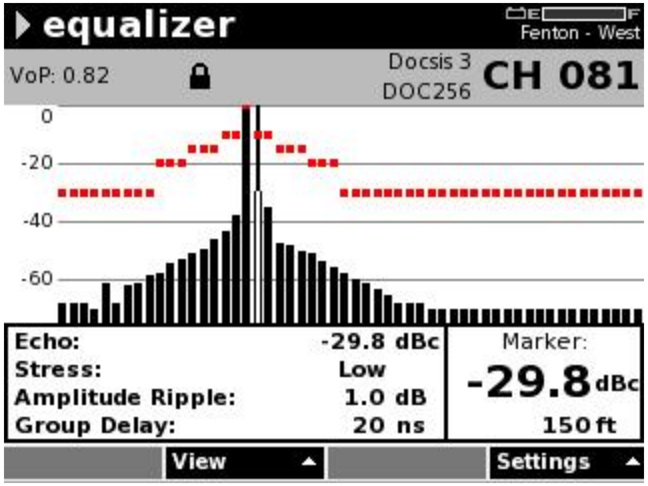
Group delay can also result from a carrier placed too close to the band edge of the diplex filter

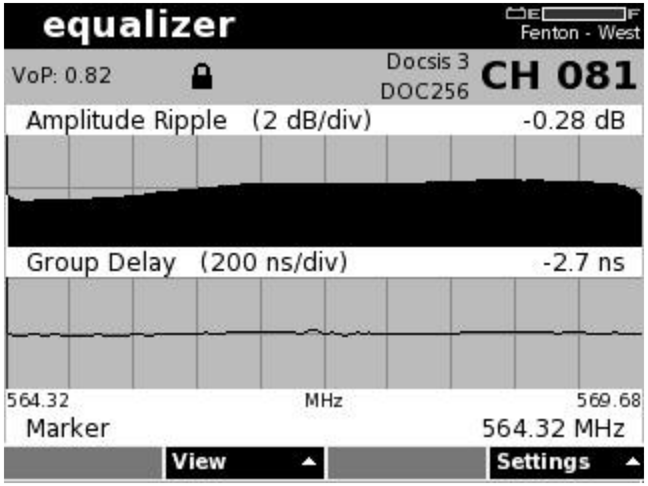
Linear Distortions Tests





Return Path

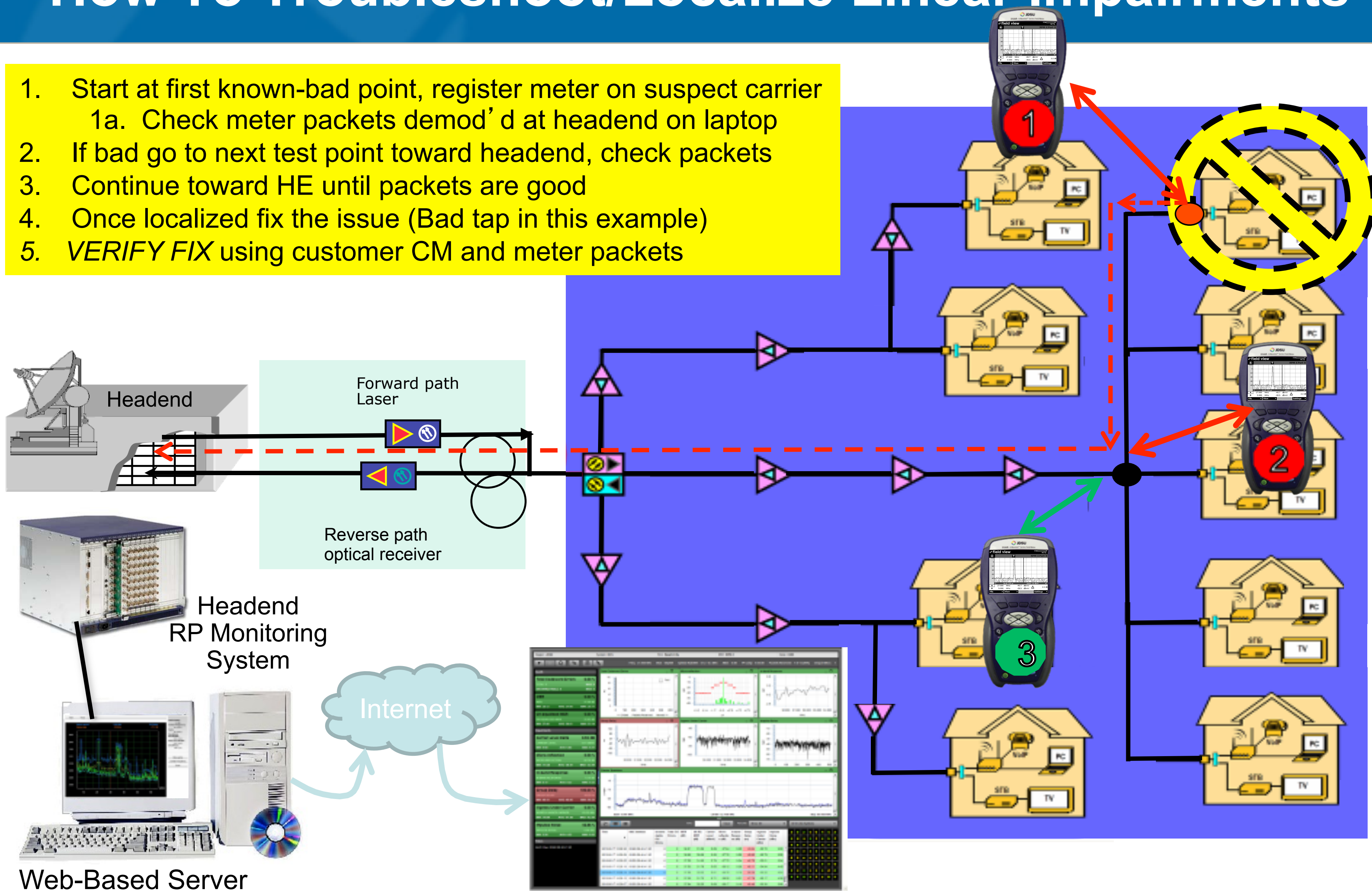




Forward Path

How To Troubleshoot/Localize Linear Impairments

1. Start at first known-bad point, register meter on suspect carrier
   1a. Check meter packets demod'd at headend on laptop
2. If bad go to next test point toward headend, check packets
3. Continue toward HE until packets are good
4. Once localized fix the issue (Bad tap in this example)
5. *VERIFY FIX* using customer CM and meter packets



Summary of In-Home Wiring Options

Service	Typical achievable Data Rate	Distances
MoCA	>100Mb/s typ. 140 MB/s max	>300 ft.
HPNAv3	86-128 Mb/s typ	>400 ft
802.11a/g	~10Mb/s Typical	~90 ft
802.11n	~40Mb/s Typical	~150 ft
HomePlug A/V	150 Mb/s Max published	<300 estimated
Wired Ethernet	100 Mb/s	300 ft

Back to the Basics

- Check for leakage sources
- Check for ingress sources
- Do a visual inspection of cable / connectors / passives
- Replace questionable cable / connectors / passives
- Tighten F-connectors per your company's installation policy
  - Be very careful not to over tighten connectors on CPE (TVs, VCRs, converters etc.) and crack or damage input RFI integrity

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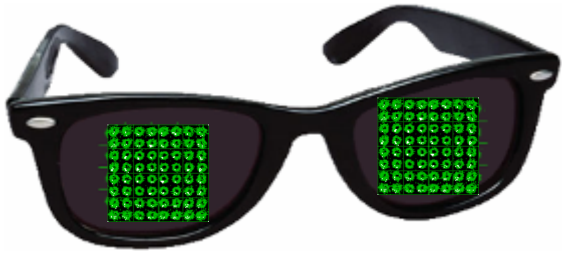
Back to the Basics

- Majority of problems are basic physical layer issues
- Most of the tests remain the same
- Check AC power
- Check forward levels, analog and digital
- Sweep forward & reverse

Training… Training… Training…

- You never have too much training!
  - Learn everything you can about Triple Play & HFC networks
    - Company sponsored training
    - SCTE Chapter Meetings & Certification programs
    - SCTE EXPO & Emerging Technologies
    - CED and Communications Technology magazines
    - Vendor "product specific" training
  - Learn everything you can about the devices in your network, both the physical layer and data layer
    - **Headend:** Modulators, Multiplexers, CMTS etc.
    - **Outside plant:** Nodes, Amps, Passives etc.
    - **Subscriber's drop:** Digital Converter, DVRs, Cable Modems, eMTAs, house amps etc.
  - Learn how to get the most out of your test equipment & CPE diagnostics
    - most vendors will train you
- Be thorough - Take pride in your work!
  - Do the installation right the first time
  - Take the time to properly certify every drop for Triple Play services

JDSU – See Digital in a Whole New Light!



See digital in a whole new light!

Questions?

kelly.watts@jdsu.com

Thank You !

Mark Ortel

Sales Support Engineer

Cable Networks Division

www.jdsu.com

National SCTE Member

Supporter of the National

And Local SCTE Chapters