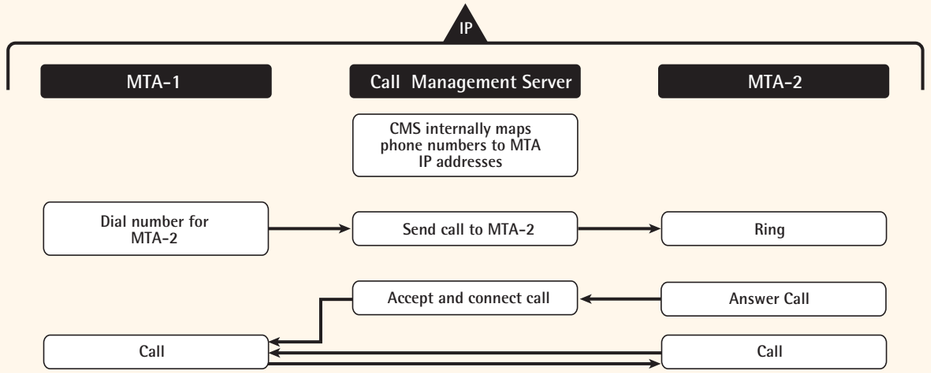
MTA Placing Phone Call



Call Quality using VoIP

Mean Opinion Score (MOS)

- MOS is based on a panel of listeners rating a given call on a scale of 1 to 5
- Corresponded to R-Factor which is computed by various type of metrics during call. Some of those metrics include:
  - SNR of the System
  - Tones and other distortion that occur at the same time as speech
  - Delay and Jitter of the network
  - Frame loss and bit errors

User Opinion	R Factor	MOS Score	ACR Scale
Very satisfied (Toll Grade)	90 – 100	4.3 – 5.0	4.1-5.0
Satisfied	80 – 90	4.0 – 4.3	3.7-4.1
Some users satisfied	70 – 80	3.6 – 4.0	3.4-3.7
Many users dissatisfied	60 - 70	3.1 – 3.6	2.9-3.4
Nearly all users dissatisfied	50 – 60	2.6 – 3.1	2.4-2.9
Not recommended	0 – 50	1.0 – 2.6	1.0-2.4

The Need for and Evolution of DOCSIS

High Speed Internet Access: DOCSIS 1.0
- Specification done in March 1997; First DOCSIS 1.0 CMs appear in 1999
- Best effort IP data service

Voice, Prioritized Traffic, Security and Management: DOCSIS 1.1
- "Quality of Service" and dynamic services, a MUST for PacketCable™
- Service Security: CM authentication and secure software download (BPI / BPI+)
- Operations tools for managing bandwidth service tiers
- CM Account Management
- View-based Access Control and Management (VACM)

Gaming, Streaming: DOCSIS 2.0
- Specification done December 2001; first D2 CMs appear in 2002
- Increase Upstream Bandwidth from 8Mbps with DOCSIS 1.x to 27Mbps
- Improved robustness against interference (A-TDMA and S-CDMA) called advanced PHY

The Need for DOCSIS 3.0

Move from Broadcast to On-demand distribution model

Personalized Video Services
- *"We want to watch what we want, when we want it."*

IPTV

More SD and HD video services

Growing internet appetite
- Video streaming
- Increase in home usage
- Growth of Online Gaming

Increase in business service offerings

Load Balancing

IPv6
- IP addresses running out; IPv6 provides supports 2^128 (about 3.4×10^38) addresses

Features of DOCSIS 3.0

Provides upstream and downstream channel bonding
- Specified as a minimum of 4 Downstream and 4 Upstream channels.
- Most modems will support 8 Downstream and 4 Upstream channels.

Expanded Upstream Frequency Range
- 5-85 MHz
- S-CDMA active code selection

Supports Multicasting
- Switched Digital Video
- IPTV

IPv6 Support

Enhanced Security
- Advanced Encryption Standard

Enhanced Reporting for Management

Sunrise Telecom DOCSIS Products

CM3000 Series

The CM3000 and CM3800 enable operators to deliver quality DOCSIS 3.0 services for business and bundled services. These comprehensive solutions combine a DOCSIS 3.0 cable modem with a best-in-class field spectrum analyzer for identifying impairments faster and with more accuracy. With the CM3000 and CM3800, operators can reduce network outages, improving the customer's experience, and saving time and expenses.

AT2500™

The AT2500 is the best, most versatile spectrum/QAM/Video analyzer for keeping the plant both analog/digital and DOCSIS 3.0 ready. The new web server option provides convenient remote operation through any standard web browser.

Portable and lightweight, the AT2500 covers it all from micro-reflections to mandatory performance testing with full 1.5 GHz spectrum/QAM/Video analysis enhanced by our unique automatic band-pass filtering. All of this in an unbelievably affordable package.

realWORX®

The realWORX WEB, a 24/7 RF monitoring system, facilitates the transition to DOCSIS 3.0 services by providing complete access to information on upstream ingress and downstream channel performance through any standard browser, including smartphones. This "Anywhere, Anytime" access to network information gives service providers a new level of confidence in the reliability of their DOCSIS 2.0 and 3.0 systems without additional capital expenditures.

For more information, please call: 1.800.701.5208 or 1.408.363.8000 or visit www.sunrisetelecom.com

C_0185_DOCSIS_Pocket Expert MKS-22045-001 Rev A00

DOCSIS®
POCKET EXPERT

SUNRISE TELECOM®

DOCSIS 3.0 Impairments

In order to deliver high quality, impairment free business and bundled services, technicians must proactively test and monitor network capabilities, especially the return path.

The five most common impairments associated with DOCSIS 3.0 are ingress, common path distortion, linear distortion, laser clipping and upstream gain and equalization. Any one or combination of these impairments will cause data loss and lower data rates affecting quality of experience. All impairments must be less than -25 dBc below the upstream data signals.

Ingress - The biggest impairment impacting the DOCSIS 3.0 return path is ingress, which may result from a loose or corroded connector, cracked cable, open or damaged housing, faulty or "do it yourself" home wiring. DOCSIS 3.0 will utilize more return path bandwidth, therefore making ingress more critical

Ingress is a fact of life on all cable networks. Users can manage the level of ingress impacting their networks through headend monitoring and field measurement.

In modern DSP analyzers, display rate is not as critical as with older spectrum analyzers. Ingress should be checked out to 200 MHz. It is detected using the peak trace setting combined with peak hold, to capture the maximum level of the impairment.

Common Path Distortion (CPD) – CPD can dramatically affect the DOCSIS 3.0 return path. Upstream signals that mix with downstream signals produce beat signals in the return. Corroded connections, faulty diplexers and improper level can cause CPD.

Sweep the network to ensure levels are set correctly and to locate faults that may create CPD distortions. Diagnose CPD through spectrum analysis, looking for the tell-tale series of beats spaced every 6 MHz. CPD in digital networks appears as an elevated noise floor.

Linear Distortions – Linear impairments include micro-reflections, poor frequency response and group delay. Many older amplifiers may exhibit group delay; which is additive through the cascade, near the higher frequency range, due to diplexer roll-off.

Identify these issues by analyzing the network spectrum or sweeping the network. Not only do these efforts locate linear distortion, they also help discover impairments before they become outages.

Laser Clipping – Laser Clipping is a result of over-driving the laser, causing intermittent or consistently low data throughput.

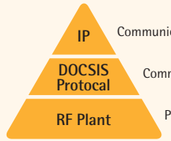
Again, a spectrum analyzer and/or a monitoring system help identify laser clipping. By monitoring the entire return spectrum, typically out to 200 MHz, engineers can identify this typically hard-to-find impairment.

Gain & Equalization – Utilizing more upstream spectrum bandwidth makes upstream pad and equalizer values more critical. Higher transmit levels will overcome ingress and noise, but levels that are too high can create second and third order distortions and CPD.

Sweep is the most effective method to ensure that levels and frequency response are optimized. Because upstream cable modem traffic is multi-point sourced and bursty in nature, it is difficult to use the upstream signals to align the network.

Troubleshooting Methodology

- Troubleshooting any DOCSIS network begins with a BOTTOMS UP approach.
- Never ignore the basics – CNR, CSO, CTB.
- Today, typically 80% of the problems are RF, and 20% are IP/DOCSIS related.



Communications between CMs, MTAs, subscribers & IP servers

Communications between CMTS & CMs only

Physical Layer

DOCSIS Downstream Requirements

Measurements at Cable Modem input

- DOCSIS Carrier level: -15 to +15dBmV; ideal is 0dBmV

	DOCSIS	Euro DOCSIS
• CNR	≥ 35 dB	≥ 44 dB
• CSO	≥ 41 dB	≥ 52 dB
• CTB	≥ 41 dB	≥ 57 dB

- Hum ≤ –26dbc (5%) per DOCSIS specifications
- In Channel Frequency Response ≤ 3dB
- In Channel Group Delay ≤ 75 ns/MHz (in channel)

	Post-BER	64-QAM MER	256-QAM MER
Excellent	1.00E-10	>35	>35
Good	1.00E-08	27-34	31-34
Marginal	1.00E-06	23-26	28-30
Fail	1.00E-05	<23	<28

DOCSIS Upstream Requirements

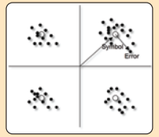
Upstream Transmit Power (a.k.a. Return Signal) Level:

+8 dBmV to +58 dBmV maximum for QPSK (DOCSIS 1.x).
+8 dBmV to +55 dBmV maximum for 8 QAM and 16 QAM (DOCSIS 1.x).
+8 dBmV to +54 dBmV maximum for 32 QAM and 64 QAM (A-TDMA DOCSIS 2.0).
+8 dBmV to +53 dBmV maximum for S-CDMA DOCSIS 2.0 modulation rates.
Recommended upstream transmission levels are +35 dBmV to +52 dBmV.

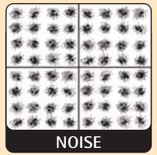
Upstream Performance Specifications:

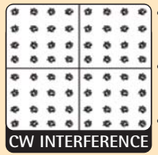
	DOCSIS	Euro DOCSIS
CNR requirement	≤ 25 dBc	≤ 22 dBc
Frequency Response	≤ 0.5 dB/MHz	≤ 2.5 dB in 2 MHz
Group Delay	≤ 200 ns/MHz	≤ 300 ns in 2 MHz

Troubleshoot using Constellation

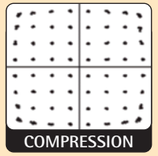


- Modulation Error Ratio (MER) is a measurement of the phase and voltage variation. MER is the best measurement qualifier of digital signals.
- Each point represents one symbol.
- How far the point falls from the center circle is its error magnitude.

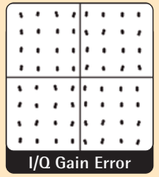

NOISE

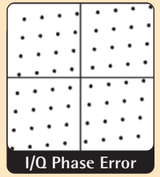

CW INTERFERENCE

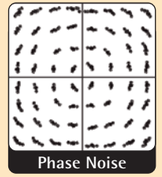
- CW Interference on a constellation is characterized by a donut around ideal.
- CW Interference is often caused by ingress from over-the-air TV.
- Look for:
  - -Faulty connectors
  - -Leaky taps or cables
  - -Signals injected at the headend/hubsite


COMPRESSION

- Compression can occur when the Forward Path Transmitter is faulty or overdriven by RF signals.
- Additionally, fiber node RF receivers, or RF amplifiers may have devices which are over-driven or defective, causing compression of the digital signal.

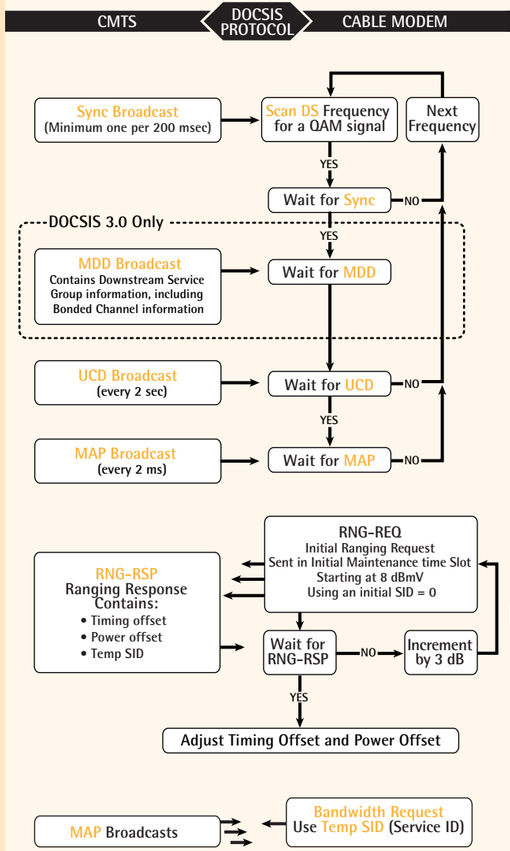

I/Q Gain Error


I/Q Phase Error

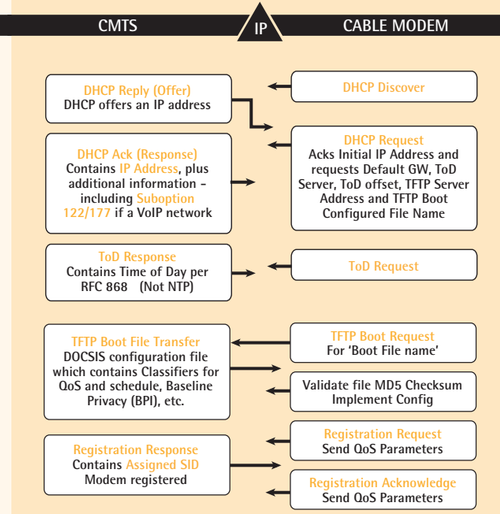

Phase Noise

- I/Q Gain Error, I/Q Phase Error and Phase Noise are impairments that normally occur in the QAM modulator or RF upconverter in the headend or hubsite.

Cable Modem Going Online



Cable Modem Going Online



MTA/CPE Going Online