



Docsis 3

The HFC Pipe to the Home is Huge!



Maximum and (Maximum Usable)DownStream Speeds

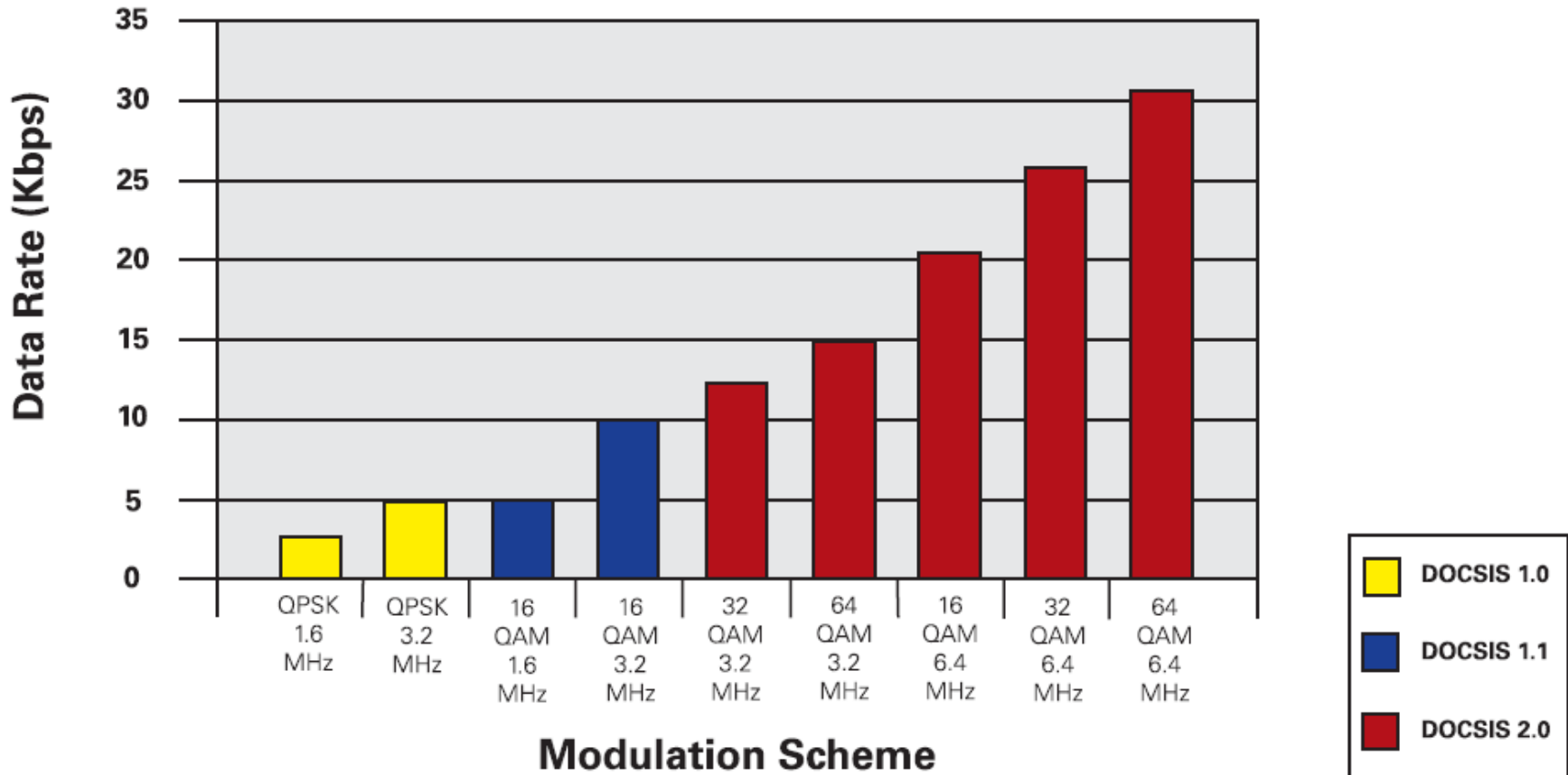
	Downstream	
Version	DOCSIS	EuroDOCSIS
1.x	42.88 (38) Mbit/s	55.62 (50) Mbit/s
2.0	42.88 (38) Mbit/s	55.62 (50) Mbit/s
3.0 ----- 4 channel	171.52 (+152) Mbit/s	+222.48 (+200) Mbit/s
3.0 ----- 8 channel	+343.04 (+304) Mbit/s	+444.96 (+400) Mbit/s

DOCSIS® 3.0 Overview

- New Specifications
 - DOCSIS 3.0 Interface Specifications (released December 2006)
 - CPE equipment in development stages(Bronze, Silver, Full)
 - Downstream data rates of **160 Mbps** or higher
 - Channel Bonding **1 x 256QAM => “up to” ~40Mbps**
 - 4 or more channels **4 x 256QAM => “up to” ~160 Mbps**
 - Upstream data rates of **120 Mbps** or higher
 - Channel Bonding **1 x 64QAM => “up to” ~30Mbps**
 - 4 or more channels **4 x 64QAM => “up to” ~120 Mbps**
 - Internet Protocol version 6 (IPv6)
 - IPv6 greatly expands the number of IP addresses
 - Expands IP address space from 32 bits to 128 bits
 - IPv6 supports 3.4×10^{38} addresses;
 - Colon-Hexadecimal Format
- 4923:2A1C:0DB8:04F3:AEB5:96F0:E08C:FFEC**
- **100% backward compatible with DOCSIS 1.0/1.1/2.0**

Un-Bonded Upstream Data rates

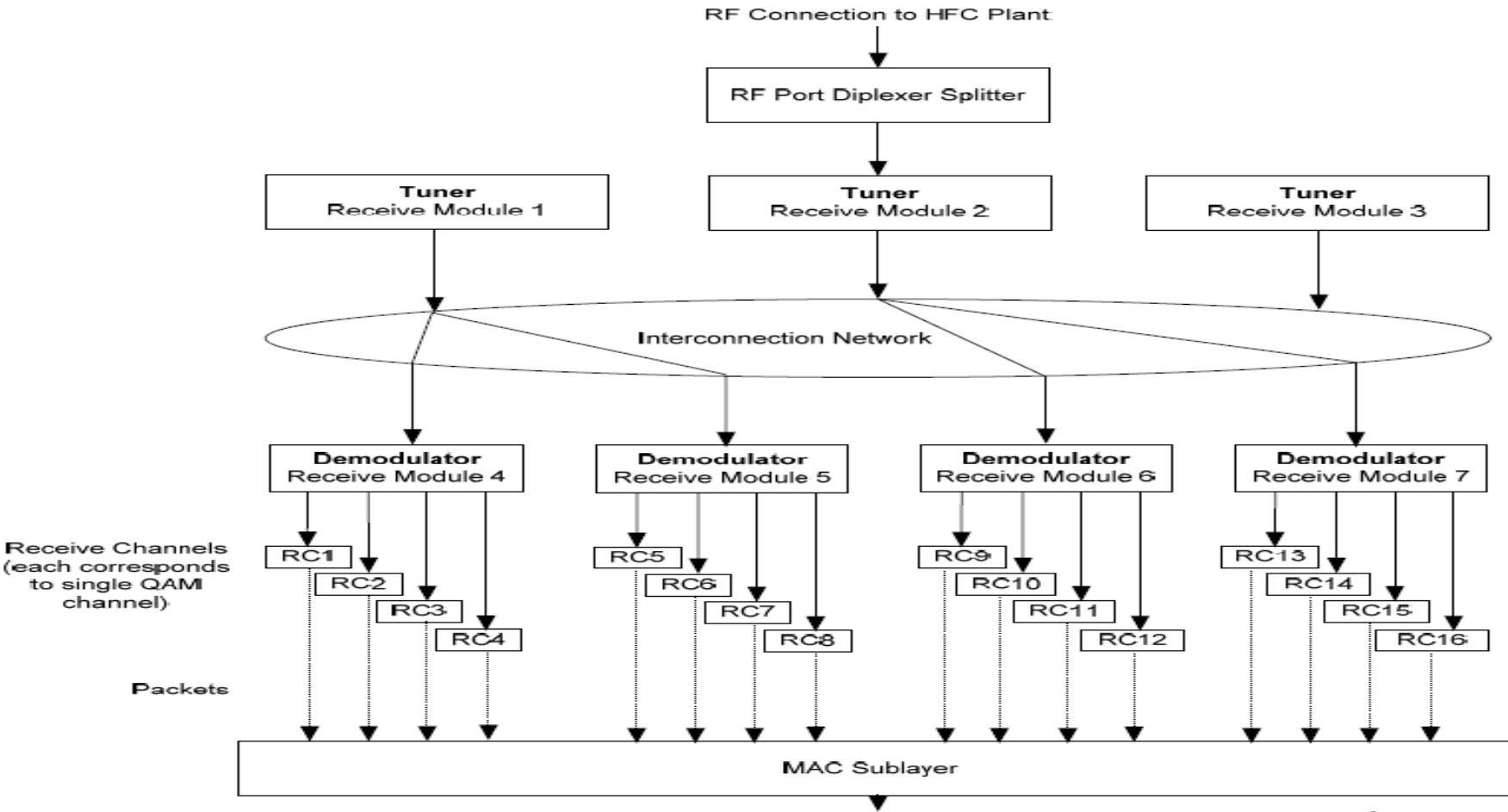
Data Rates by Modulation and Channel Width



Courtesy Motorola

- DOCSIS 1.0 had BPI (Baseline Privacy Interface)
 - Did not hardware authenticate Cable Modems
- DOCSIS 1.1 and 2.0 have BPI+
 - Digital Certificate based security
 - No more spoofing MAC addresses
- DOCSIS 3.0 adds more enhancements – and the specification is now named “Security”, or BPI/SEC
- BPI/SEC encrypts data flows between the CPE and the CMTS
 - BPI/BPI+ use 56 bit encryption – SEC uses 128 bit encryption

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 μ s -15 dBc @ ≤ 1.0 μ s -20 dBc @ ≤ 1.5 μ s -30 dBc @ > 1.5 μ s ¹
Carrier hum modulation	Not greater than -26 dBc (5%) ¹
Burst noise	Not longer than 25 μ s 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



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

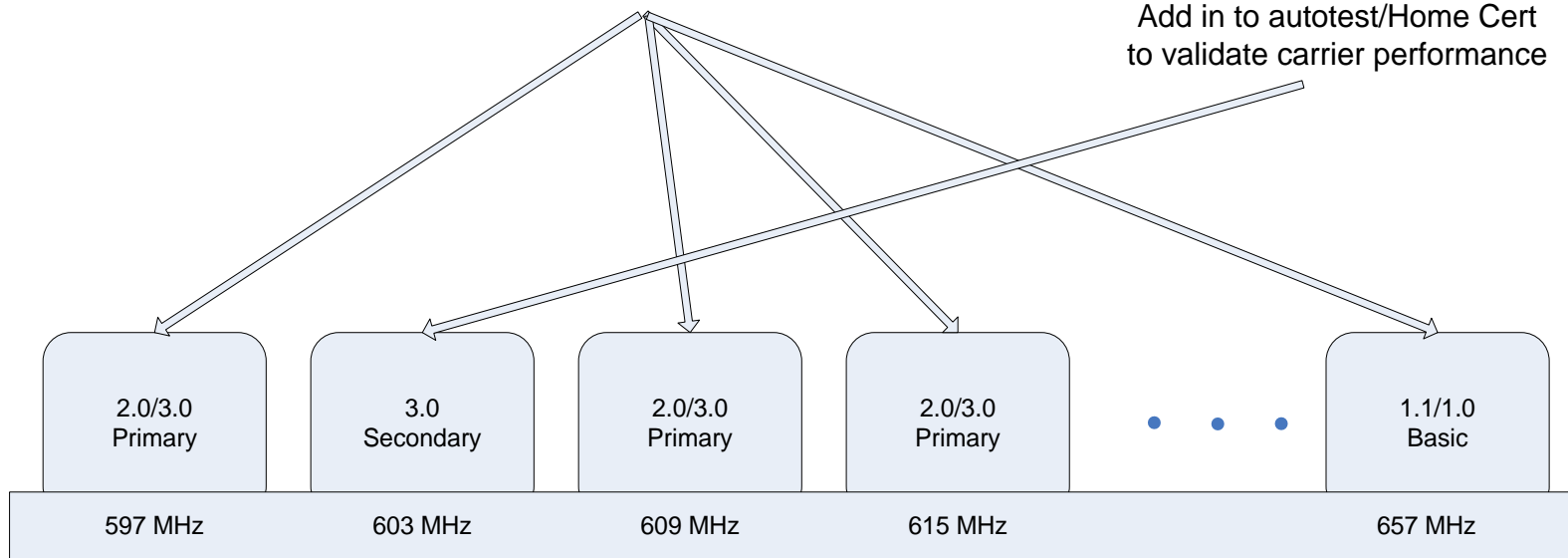
¹ Ingress avoidance or tolerance techniques may be used to ensure operation in the presence of time-varying discrete ingress signals that could be as high as 10 dBc. The ratios are guaranteed only within the digital carrier channels.
² Amplitude and frequency characteristics sufficiently strong to partially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

Source: SCTE

DOCSIS 3.0 Downstreams

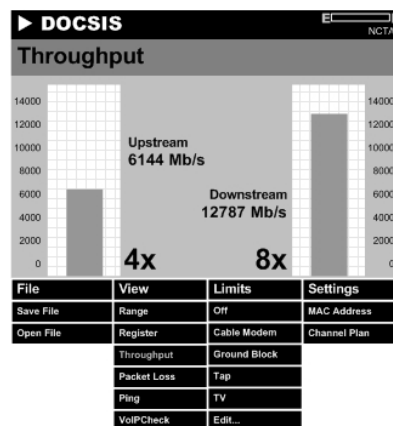
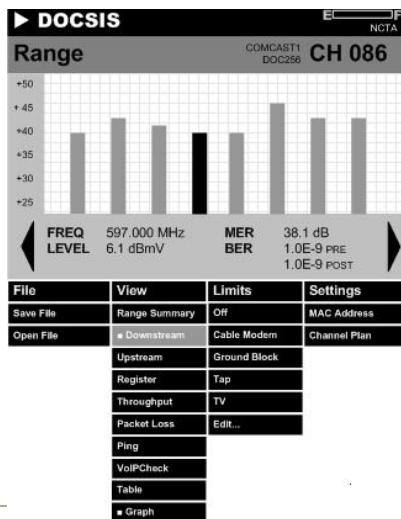
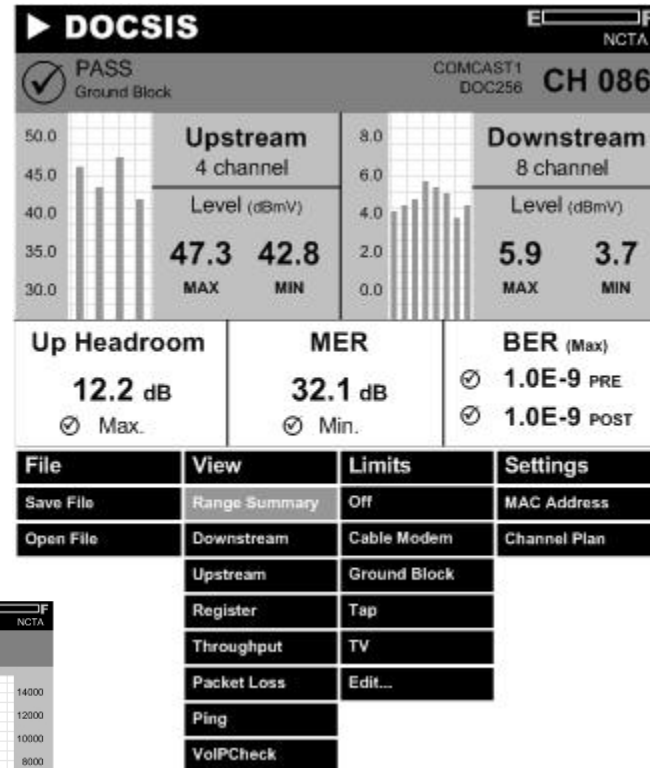
Add to Channel plan as DOCSIS carriers
Add in to autotest/Home Cert to validate
DOCSIS performance

Add to Channel Plan as
Video Carrier
secondary carriers do not
contain channel descriptors or
ranging information
Add in to autotest/Home Cert
to validate carrier performance



DSAM 3.0 Bonded Carrier testing – coming soon

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



BER Example

- A 256QAM channel transmits at a symbol rate of 5M symbols per second
- Bit rate = 8 bits per symbol X 5M symbol per second =40M bits per second
- Error Incident = Bit rate X BER = Errors Per Second

BER	Error Frequency	Error Incident
10^{-12}	1 in 1 Trillion bits	25000 secs between errs (6.94 hrs)
10^{-11}	1 in 100 Billion bits	2500 secs between errs (41.67 mins)
10^{-10}	1 in 10 Billion bits	250 secs between errs (4.167 mins)
10^{-9}	1 in 1 Billion bits	25 seconds between errors
10^{-8}	1 in 100 Million bits	2.5 seconds between errors
10^{-7}	1 in 10 Million bits	4 errors per second
10^{-6}	1 in 1 Million bits	40 errors per second
10^{-5}	1 in 100 Thousand bits	400 errors per second
10^{-4}	1 in 10 Thousand Bits	4000 errors per second
10^{-3}	1 in 1 Thousand bits	40000 errors per second