



# DOCSIS 3.0: An Overview



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Cisco

# Agenda

- **What is DOCSIS 3.0?**
- **New Services with DOCSIS 3.0**
- **Deploying DOCSIS 3.0**
- **Conclusions**



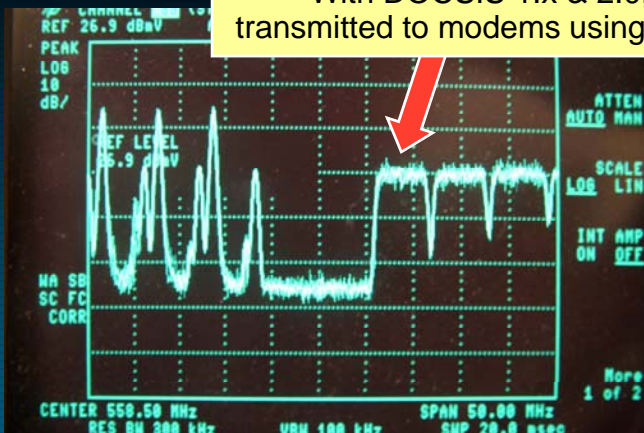
# DOCSIS 1.x and 2.0 Limitations

- Despite the improvements that have occurred as DOCSIS has evolved, maximum data rates to and from cable modems are pretty much topped out. Competition and the desire to provide new services are driving the need for even greater throughput in our DOCSIS networks.
- We're limited by the fact that the maximum raw data rate to or from cable modems is ultimately constrained by what a single 6 MHz wide channel can carry in the downstream, or what a single 6.4 MHz wide channel can carry in the upstream.
- Enter DOCSIS 3.0 and something called **channel bonding**

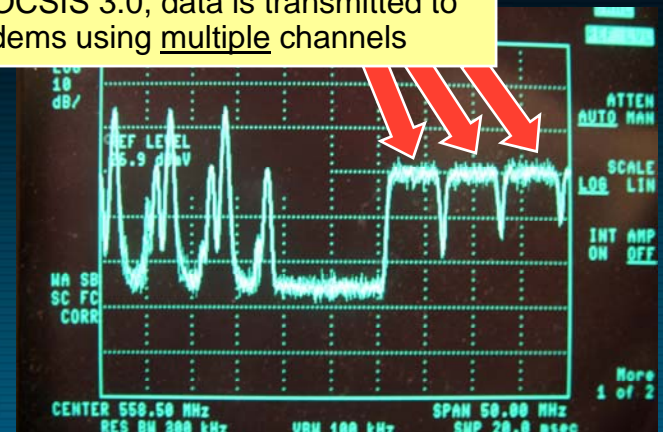
# Channel Bonding

- Channel bonding? What the heck is that?
- In a nutshell, channel bonding means that data is transmitted to or from modems using multiple individual RF channels instead of just one channel. No, the channels aren't physically bonded into a gigantic digitally modulated signal. Rather, the bonding is logical.

With DOCSIS 1.x & 2.0, data is transmitted to modems using one channel



With DOCSIS 3.0, data is transmitted to modems using multiple channels

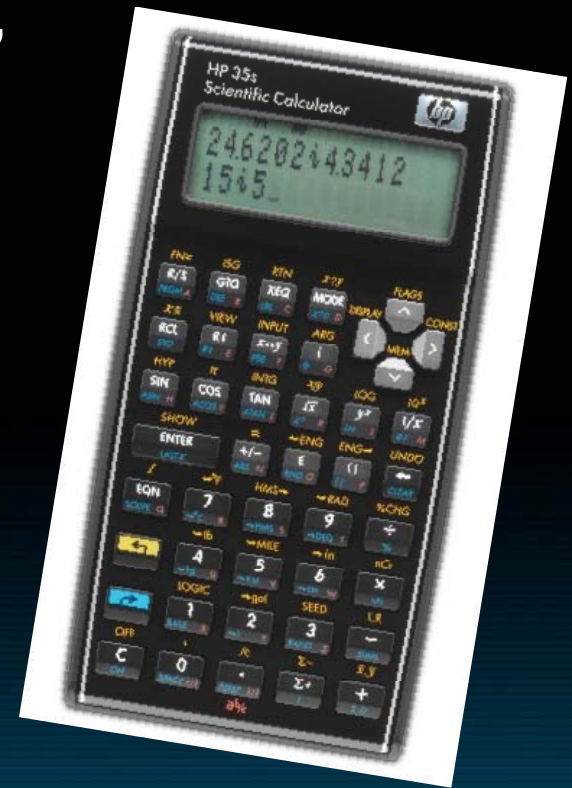


# Channel Bonding

- Let's say you want to increase the downstream data rate between the CMTS and modems from today's single 6 MHz wide channel limit of 42.88 Mbps.
- If you were to spread your downstream data payload across four 6 MHz wide channels, the combined raw data rate using 256-QAM on each channel would be  $42.88 \text{ Mbps} \times 4 = 171.52 \text{ Mbps}$ .
- A DOCSIS 3.0 modem incorporates a special tuner capable of simultaneously receiving data from those four channels. To the modem, the four channels are the logical equivalent of one large bonded channel, even though we're using four physically separate channels. They don't even have to be adjacent channels!

# Channel Bonding

- Want more? Bonding, say, 10 channels, will yield  $42.88 \text{ Mbps} \times 10 = 428.8 \text{ Mbps}$ , and bonding 24 channels works out to  $24 \times 42.88 \text{ Mbps} = 1,029.12 \text{ Mbps}$ , or just over 1 Gbps. Yikes!
- The same channel bonding concept is applicable to the upstream, giving us the ability to go far beyond DOCSIS 2.0's per-channel limit of 30.72 Mbps. How does  $4 \times 30.72 \text{ Mbps} = 122.88 \text{ Mbps}$ —or more—sound?



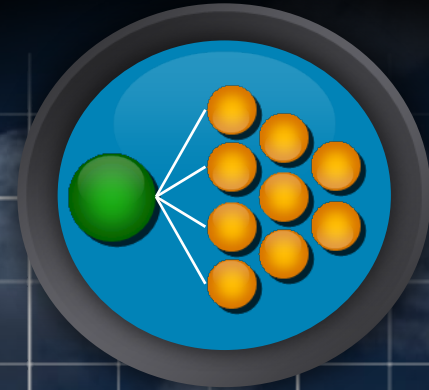
# Why DOCSIS 3.0?



**Faster  
Speeds**



**More  
Devices**



**Better  
Multicast**

# What is DOCSIS 3.0?

## ■ DOCSIS 3.0 CMTS

- DS + US channel bonding
- IPv6 ( $3.4 \times 10^{38}$  addresses versus IPv4's ~4.2 billion)
- IP multicast with IGMPv3 SSM
- DOCSIS DRFI
- AES and other security enhancements
- Network management enhancements
- Integrated or modular CMTS
- Supports DOCSIS 1.x/2.0/3.0 CMs

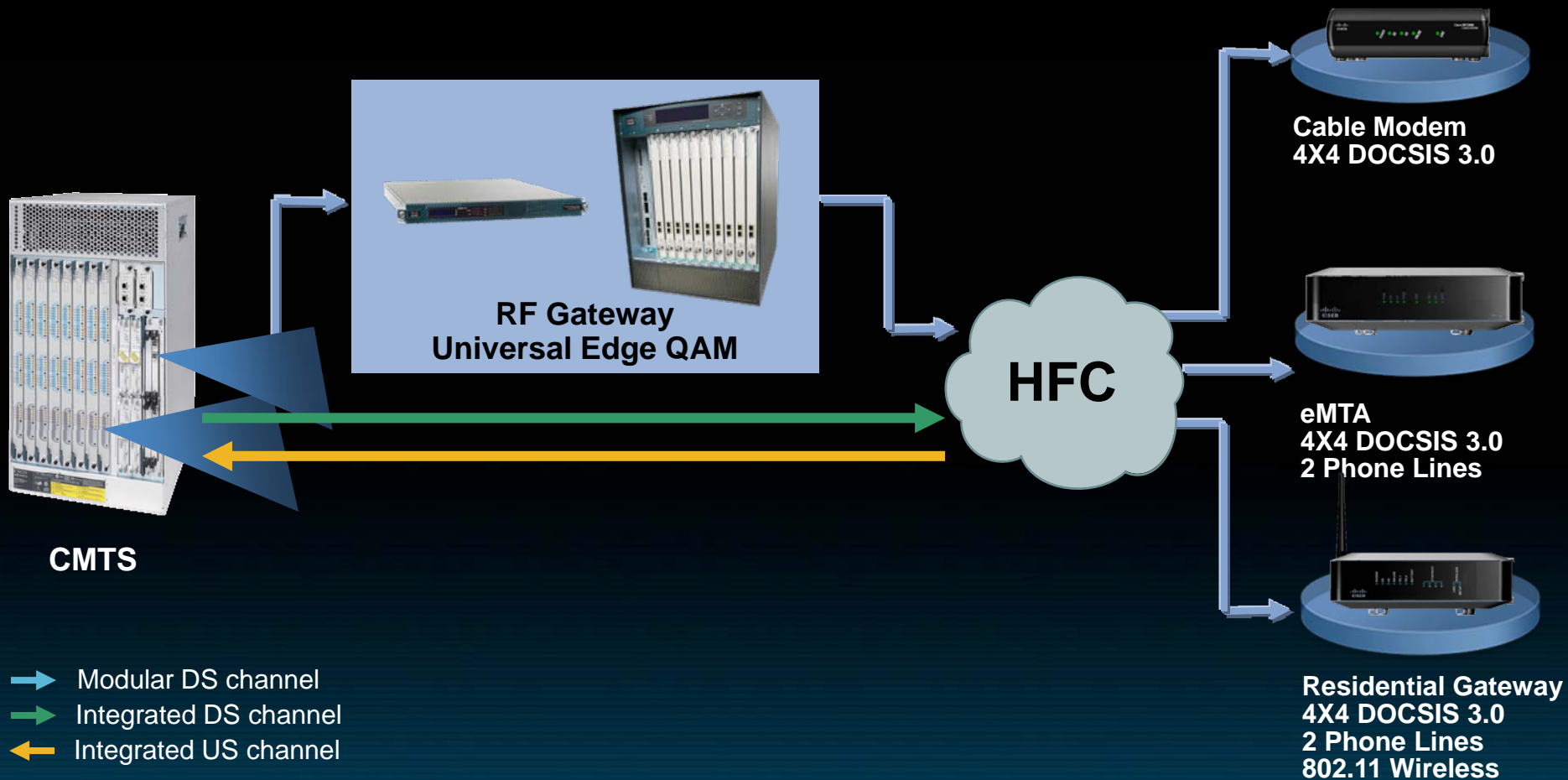


## ■ DOCSIS 3.0 Cable Modem

- Minimum 4 DS + 4 US channels
- DS + US channel bonding
- IPv6
- IP multicast
- Security enhancements
- Works with DOCSIS 1.x/2.0/3.0 CMTS



# Cisco DOCSIS 3.0 Solution



**Phase 1**  
88 DS channels  
160 US channels

**Phase 2**  
184 DS channels  
160 US channels

**Phase 3**  
304 DS channels  
160 US channels

**Phase 4**  
512 DS channels  
480 US channels

# DOCSIS 3.0 Benefits to Cable Operators

- New services to generate more revenue
- Improved bandwidth efficiency
- Increased service velocity
- Enables all-IP converged network
- Lower Capex and Opex
- Targeted upgrades



Connecting Customers with a New Generation of Cable Services

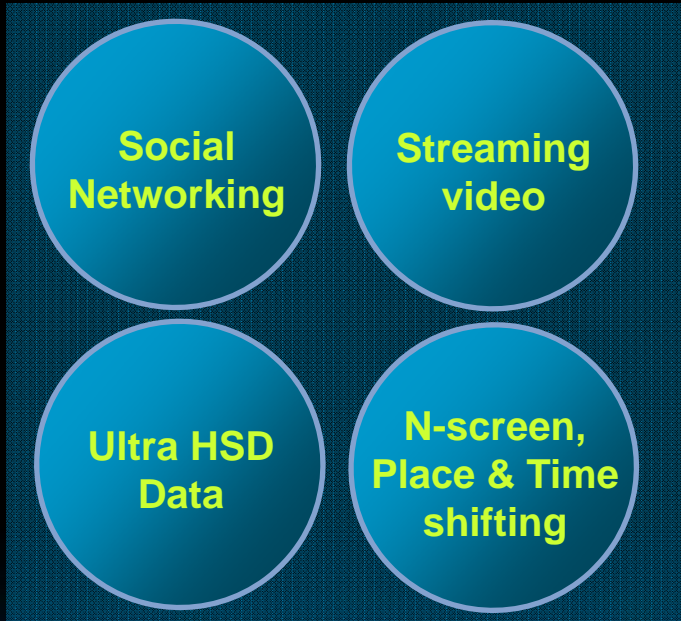
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- What is DOCSIS 3.0?
- New Services with DOCSIS 3.0
- Deploying DOCSIS 3.0
- Conclusions

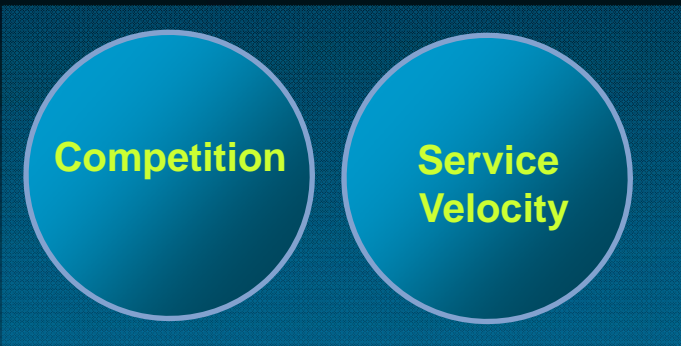


# New services, changes in traffic & consumer trends..

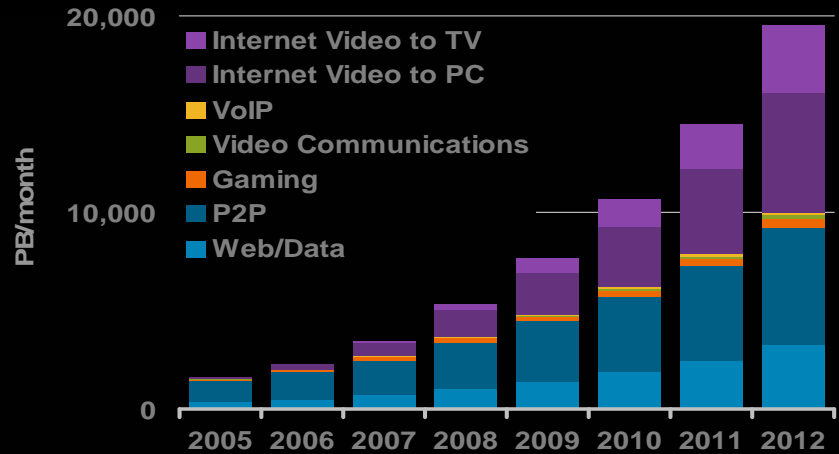
## New Services



## Business Drivers



## Internet Video Growing Rapidly



Video in the Internet is driving data throughput at 41% compound annual growth rate.

By 2012, 50% of internet traffic is expected to be video

Source: Cisco

To address these trends, SPs need a robust IP pipe with more throughput to and from the home – **DOCSIS 3.0 provides the robustness & the needed speeds**

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# Plant Considerations

- Available spectrum for bonded channels

In the downstream, bonded channels don't have to be adjacent, but they must fall within a contiguous "window" (typ. 50~80 MHz wide) that is compatible with the cable modem in use

- Clean plant—downstream and upstream!

- In the upstream, if you plan to deploy more than one or two 64-QAM signals, forget Fabry Perot (FP) lasers. Distributed feedback (DFB) or digital return lasers are a must.

# Recommended Network Performance Specifications

- The first is the technical requirements in Part 76 of the FCC Rules (or equivalent government cable technical regulations)

[www.access.gpo.gov/nara/cfr/waisidx\\_03/47cfr76\\_03.html](http://www.access.gpo.gov/nara/cfr/waisidx_03/47cfr76_03.html)

- The second is the assumed RF channel transmission characteristics outlined in the DOCSIS<sup>®</sup> 3.0 Physical Layer Specification

[www.cablemodem.com/specifications](http://www.cablemodem.com/specifications)

# Plant Considerations

- DOCSIS 3.0 Assumed Downstream RF Channel Transmission Characteristics

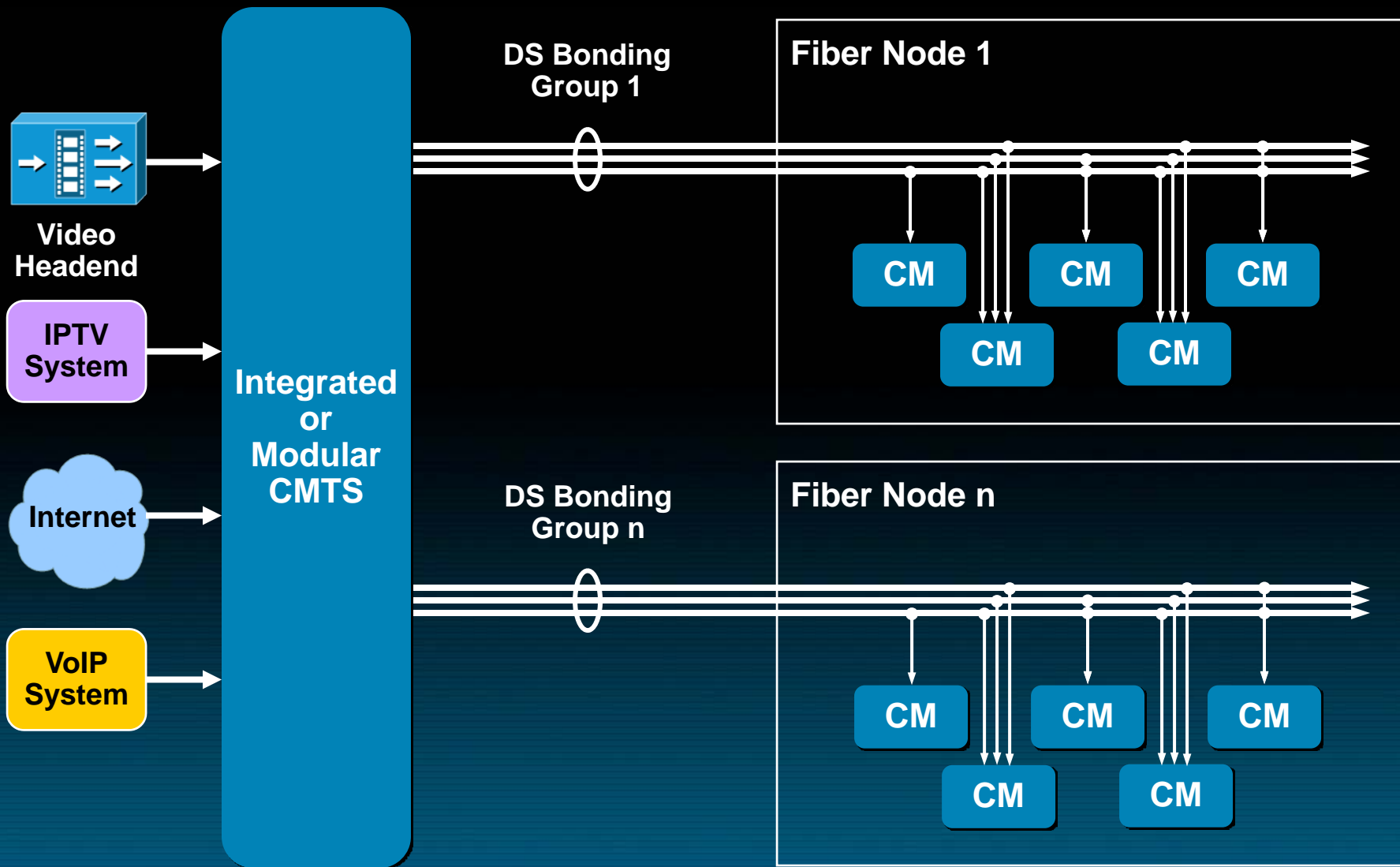
Parameter	Value
Frequency range	Cable system normal downstream operating range is from 50 MHz to 1002 MHz. However, the values in this table apply only at frequencies $\geq 108$ MHz (including Pre-3.0 DOCSIS modes)
RF channel spacing (design bandwidth)	6 MHz
Transit delay from head-end to most distant customer	$\leq 0.800$ ms (typically much less)
Carrier-to-noise ratio in a 6 MHz band	Not less than 35 dB <sup>1,2</sup>
Carrier-to-Composite triple beat distortion ratio	Not less than 41 dB <sup>1,2</sup>
Carrier-to-Composite second order distortion ratio	Not less than 41 dB <sup>1,2</sup>
Carrier-to-Cross-modulation ratio	Not less than 41 dB <sup>1,2</sup>
Carrier-to-any other discrete interference (ingress)	Not less than 41 dB <sup>1,2</sup>
Amplitude ripple	3 dB within the design bandwidth <sup>1</sup>
Group delay ripple in the spectrum occupied by the CMTS	75 ns within the design bandwidth <sup>1</sup>
Micro-reflections bound for dominant echo	-10 dBc @ $\leq 0.5$ $\mu$ s -15 dBc @ $\leq 1.0$ $\mu$ s -20 dBc @ $\leq 1.5$ $\mu$ s -30 dBc @ $> 1.5$ $\mu$ s <sup>1</sup>
Carrier hum modulation	Not greater than -26 dBc (5%) <sup>1</sup>
Burst noise	Not longer than 25 $\mu$ s at a 10 Hz average rate <sup>1</sup>
Maximum analog video carrier level at the CM input	17 dBmV
Maximum number of analog carriers	121
<sup>1</sup> Measurement methods defined in [NCTA] or [CableLabs1].	
<sup>2</sup> Measured relative to a QAM signal that is equal to the nominal video level in the plant.	

# Plant Considerations

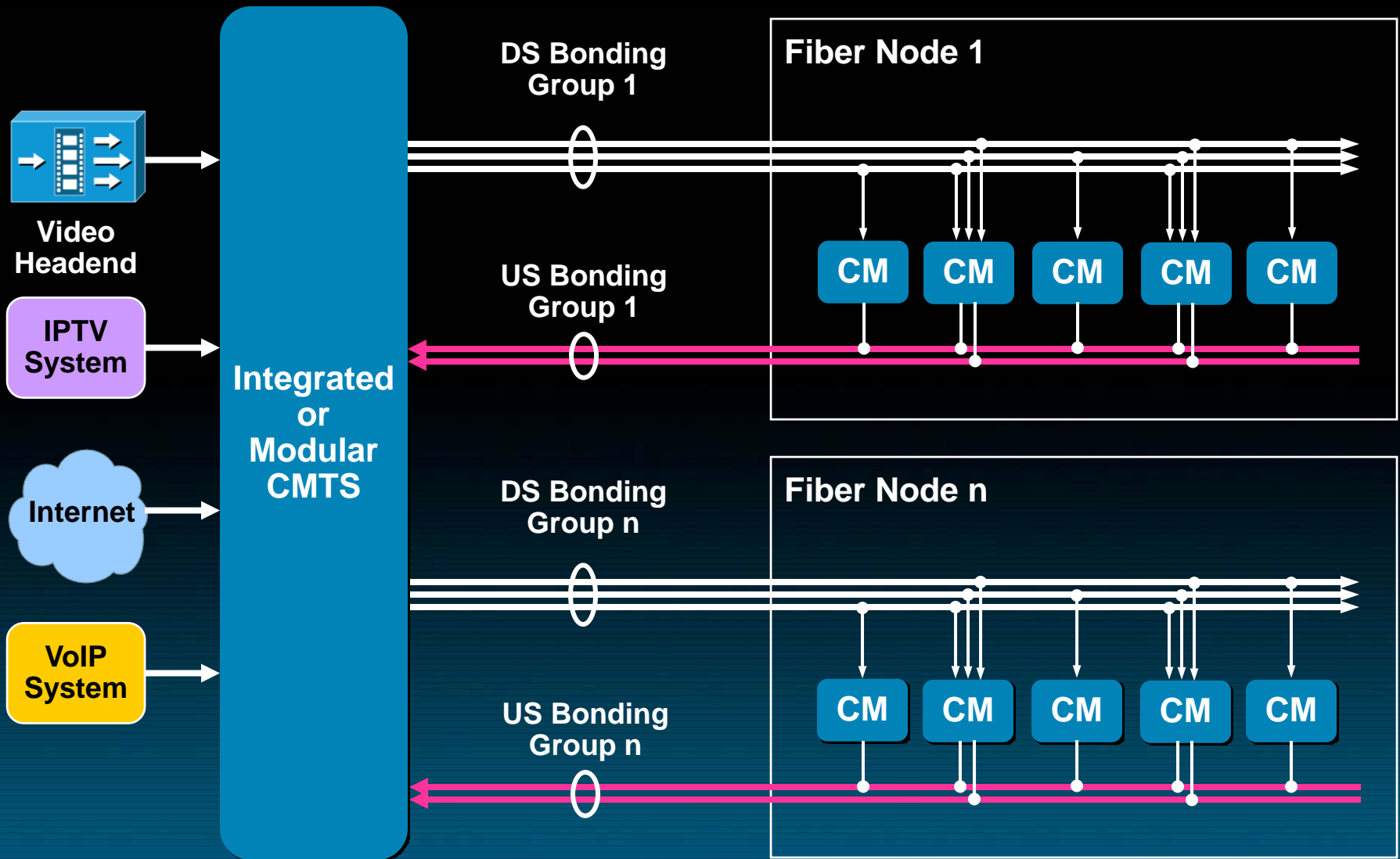
- DOCSIS 3.0 Assumed Upstream RF Channel Transmission Characteristics

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 <sup>1</sup>
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 <sup>2,3</sup>
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
<sup>1</sup> 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. <sup>2</sup> Amplitude and frequency characteristics sufficiently strong to partially or wholly mask the data carrier. <sup>3</sup> Impulse noise levels more prevalent at lower frequencies (<15 MHz)	

# Deploying Downstream Channel Bonding

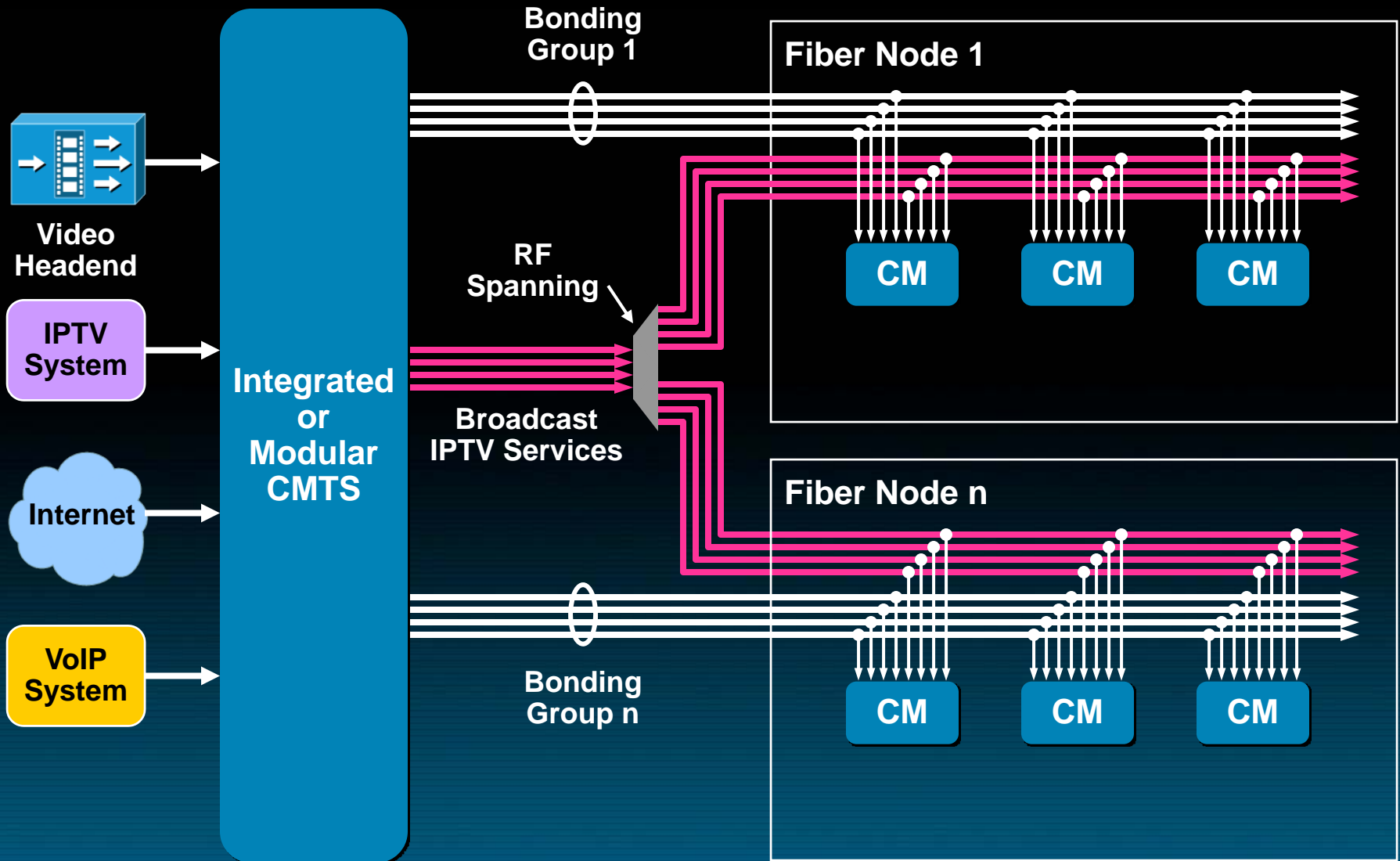


# Deploying Upstream Channel Bonding



# Broadcast IPTV with RF Spanning

## 8-ch Cable Modem



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# Conclusions

- DOCSIS 3.0 enables a media-rich user experience with:
  - Faster speeds
  - More devices
  - Service convergence
- DOCSIS 3.0 provides the tools required to build a scalable, efficient, cost-effective access network
- Cisco DOCSIS 3.0 solutions provide industry-leading scalability, density and cost performance



Connecting Customers with a New Generation of Cable Services

