DOCSIS Futures and the HFC Plant

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Existing HFC Plant Downstream Bandwidth

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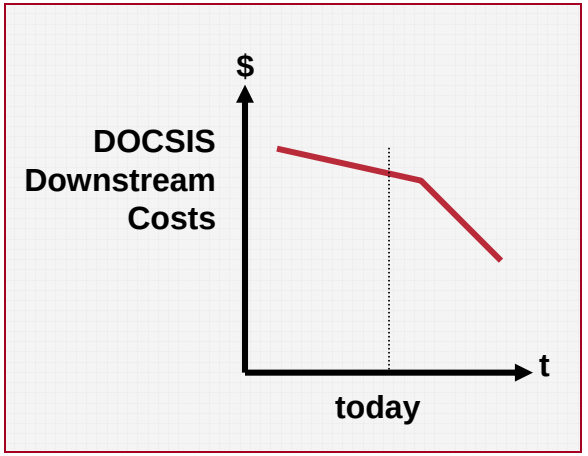
HFC Downstream is ~125 channels. **At 256QAM (~38 Mbps):** 125 channels * 38 Mbps	~ 5 Gbps per FN
This is unique per downstream transmitter. At one optical transmitter per 500 HHP FN: 5 Gbps / 500 HHP	~ 10 Mbps per HHP
MC16, 64 QAM, 1:4 combining 27 Mbps / 4 * 6 FN / 500 HHP **MC28, 256 QAM, 1:1 combining** 38 Mbps / 4 FN / 500 HHP	~ 2 kbps per HHP ~ 20 kbps per HHP
Growth Potential for DOCSIS Downstream: To date: 20 kbps / 2 kbps Future: 10 Mbps / 20 kbps	~ 10 x ~ 500 x

- **There is enough bandwidth in each fiver node for 1.4 HDTV streams to every household passed (JVT @7 Mbps).**

DOCSIS in Perspective



- **What is DOCSIS?**
  - A standardized way of transporting IP and Ethernet over HFC.
- **How cost effectiveness is DOCSIS?**
  - Equipment is increasing in density and decreasing in cost.
    - ✓ uBR 10012 has 40 downstreams and 160 upstreams
  - Up-converter components costs are now dropping dramatically, thanks to the VOD market.
- **DOCSIS technology**
  - Works on the existing two-way HFC plant with no more upgrades
  - Provides QOS and an efficient use of bandwidth (shared bandwidth)
  - Has an established protocol and provisioning infrastructure
  - Is based upon an open standards approach

Enter the DOCSIS STB

Consider a STB which has HFC connectivity with both standard MPEG-TS and DOCSIS

Control Plane:

- **DOCSIS provides an alternative transport to current proprietary OOB channels for one-way and two-way delivery of control information.**
  - OCAP DSG for one-way STB management

Forwarding Plane:

- **DOCSIS provides a complementary transport to MPEG-TS for the delivery of video as well as the delivery of traditional IP services.**
  - JVT video compression could provide 1 Mbps full screen video

Emerging Dual-Transport HFC Network

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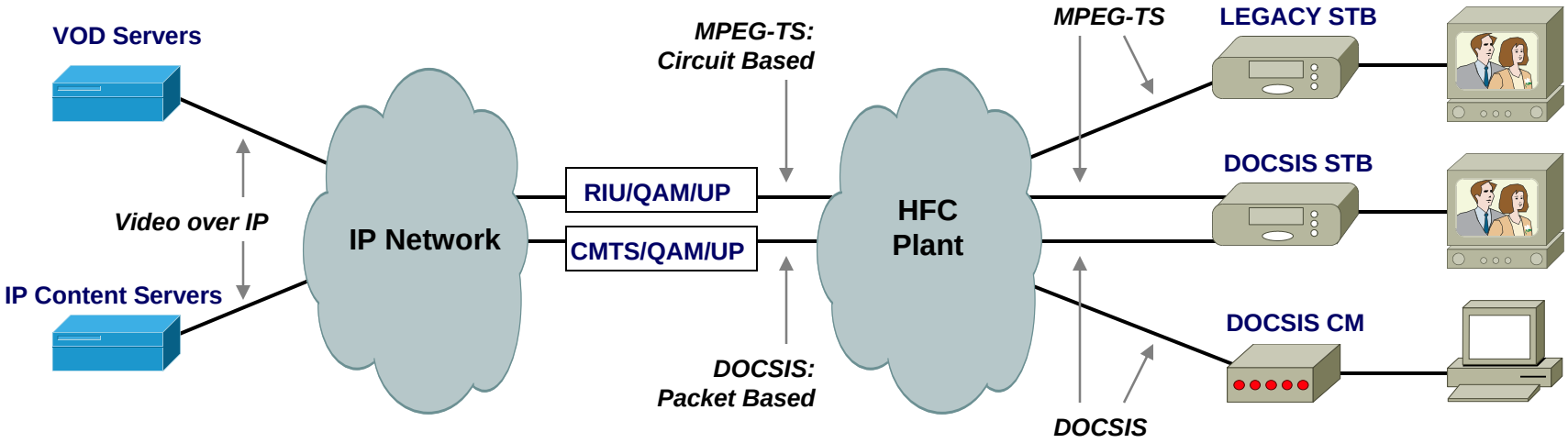

VOD and IP Servers both generate Video over IP/Ethernet.

MPEG-TS is circuit like and is good for real-time, low jitter video.

DOCSIS is packet based and is good for multi-service.

DOCSIS STB can receive video on either MPEG-TS or DOCSIS transport.

MSO makes the transport choice based upon economics and convenience.

Bandwidth Strategy

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- **For the last 5 years, MSOs upgraded the HFC plant.**
  - The capital markets are now forcing plants upgrades to finish
  - 5 Gbps per fiber node is now there on an 862 MHz plant. (downstream)
  - 1 Terabit of bandwidth on a 100K HHP plant. (200 FN * 5 Gbps)
- **For the next 5 years, MSOs need to upgrade the network equipment and backbone infrastructure to take advantage of this bandwidth.**
  - "Bandwidth mining" is required for increased bandwidth efficiency and utilization.
    - ✓ Spectrum recovery with reclaiming of analog channels is inevitable.
    - ✓ Spectrum will move from being scarce to available for a brief period of time as new services, equipment, and vendors move in.
  - New services should be added by making more efficient use of the available bandwidth, rather than adding new bandwidth.
    - ✓ HSD, VoIP, VOD
    - ✓ HDTV, PVR

MSO Rise to IP Pre-Eminence

- **5 years ago, MSOs had no knowledge of IP**
- **Today, MSOs have a good basic understanding of IP and have decent sized networks.**
- **5 years from now, the MSOs should be the dominant Service Provider for IP, and the most knowledgeable and demanding customer for IP networks and integrated data/voice/video services.**
  - Over-builders got washed out.
  - Long Distance providers (AT&T, Sprint, Worldcom) are challenged.
  - RBOCs are not IP Centric and are slow to move.

Trends in Knowledge and Bandwidth

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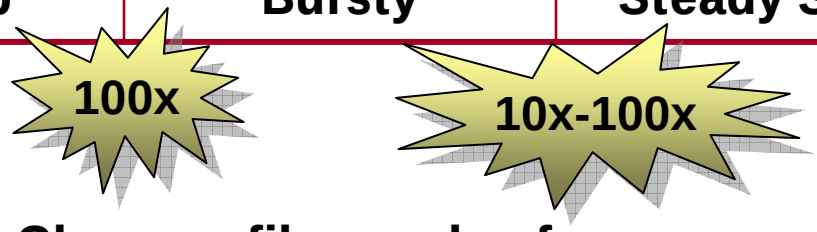
	5 years ago	Today	5 years ahead
MSO IP Knowledge	Nil	Quite Good	Gurus
MSO IP Bandwidth	28.8 kbps/sub Dial-up	2 Mbps /sub Bursty	4 Mbps / sub Steady State



- **Chapman's Challenge: 1 Gbps per fiber node of narrowcast in 5 years (IP/Ethernet/DOCSIS and switched MPEG-TS)**
  - 4 Mbps * 500 HHP * 50% Market Penetration = 1 Gbps per FN
  - GE is a direct match to GE DWDM optics currently being deployed
  - 24 RF channels (@6 MHz) -> only 20% of the fiber node bandwidth
  - This is less bandwidth than what we get at the desktop at work today, and yet we use less bandwidth than the spouses and kids at home.

Closing Remarks

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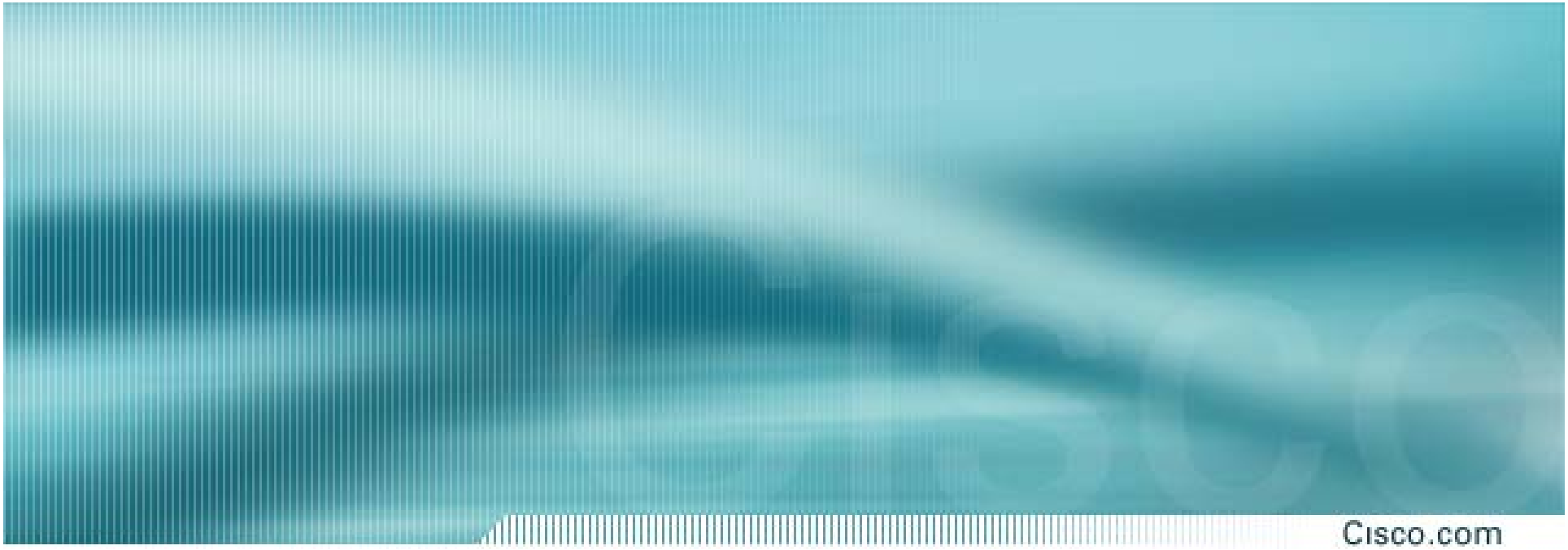
- **There is 5 Gbps of bandwidth per FN, 1 Tbps per 100K HHP.**
  - The bits need to be organized more efficiently.
  - "Bandwidth mining" required.
    - ✓ Bandwidth is a natural resource for the MSO.
- **DOCSIS STB**
  - Will create/provide a dual MPEG-TS & DOCSIS transport network for the delivery of existing and new services.
    - ✓ STBs should be designed to take content from either transport.
- **DOCSIS**
  - DOCSIS is capable of solving your bandwidth requirements incrementally in terms of bandwidth and cost on a as needed basis, one channel at a time, on the existing plant, and based upon open standards.



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