Multicast Business Models

SANOG 7 Meeting 2006

Multicast Applications

- Multicasting is how the Internet broadcasts
  - Multicast delivers packets from one or more sources to one or more receivers without unnecessary duplication.

- While the original idea of “every man a broadcaster” (that is, universal deployment) is nearly stalled, Multicast is slowly becoming ubiquitous “behind the scenes” in network applications

- Multicast applications are focused around the
  - Timely distribution of data
  - Distribution to large numbers
  - Distribution from unknown sources

Agenda

- What is Multicast ?
  - A (brief) guide for the perplexed
    - Including the history of multicast !
- Multicast Business Models
  - The timely distribution of data
    - Financial Services
  - Cost effective distribution of data
    - Video Distribution
  - Group Communications
    - Push to talk
  - Robust communications
  - Short cuts to Global deployment
- Will not talk about Network equipment potential
  - Such sales require a business case

Thanks

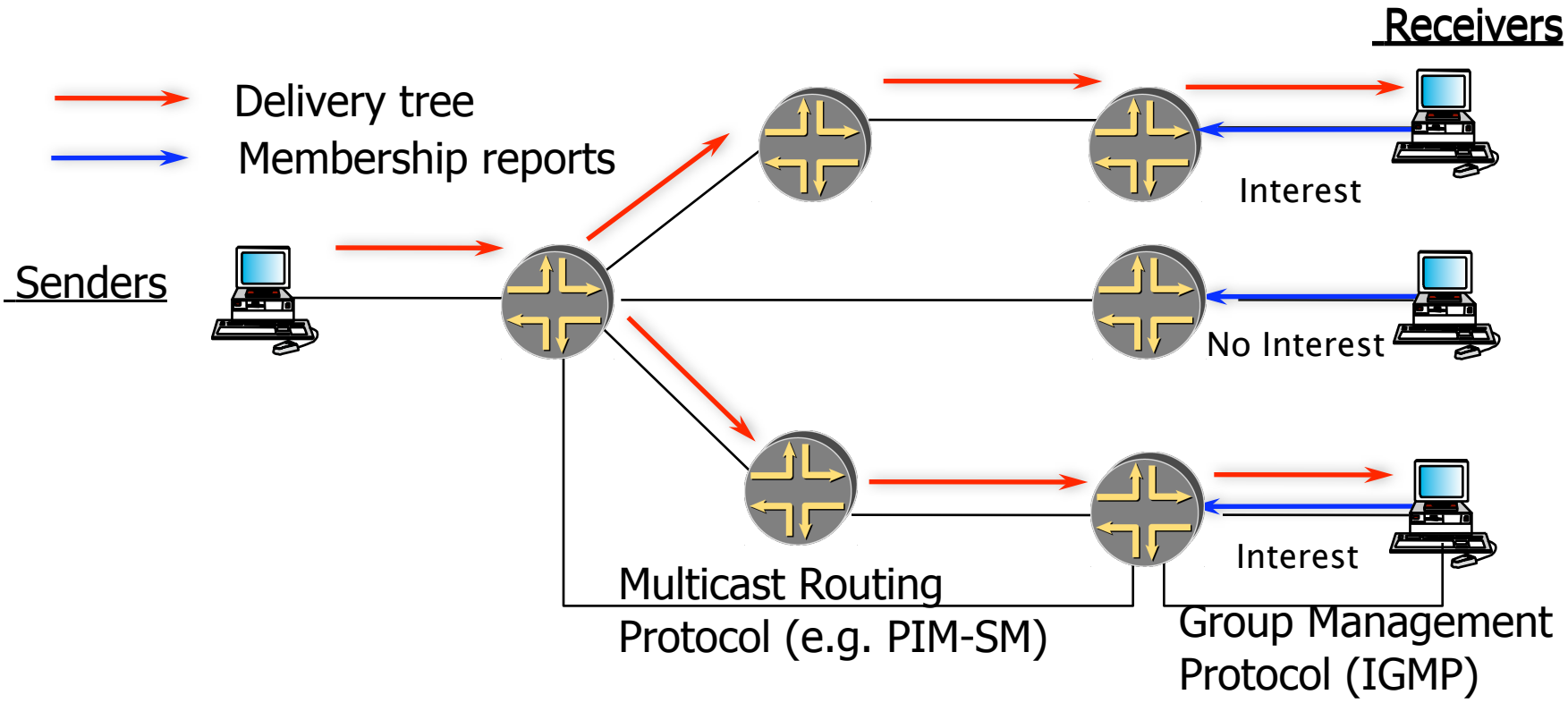
- Thanks to
  - The Internet 2 Multicast Workshop team and the Multicast Working Group
  - Gurvinder Singh, Cisco Systems
  - Toerless Eckert, Cisco Systems
  - Leonard Giuliano, Juniper Networks
  - Michael Luby, Digital Fountain
  - John Kristoff and Tim Ward, Northwestern U.
  - Brandon Butterworth, BBC.

The Basic Idea

Rather than sending a separate copy of the data for each recipient, the source sends the data only once, and routers along the way to the destinations make copies as needed.

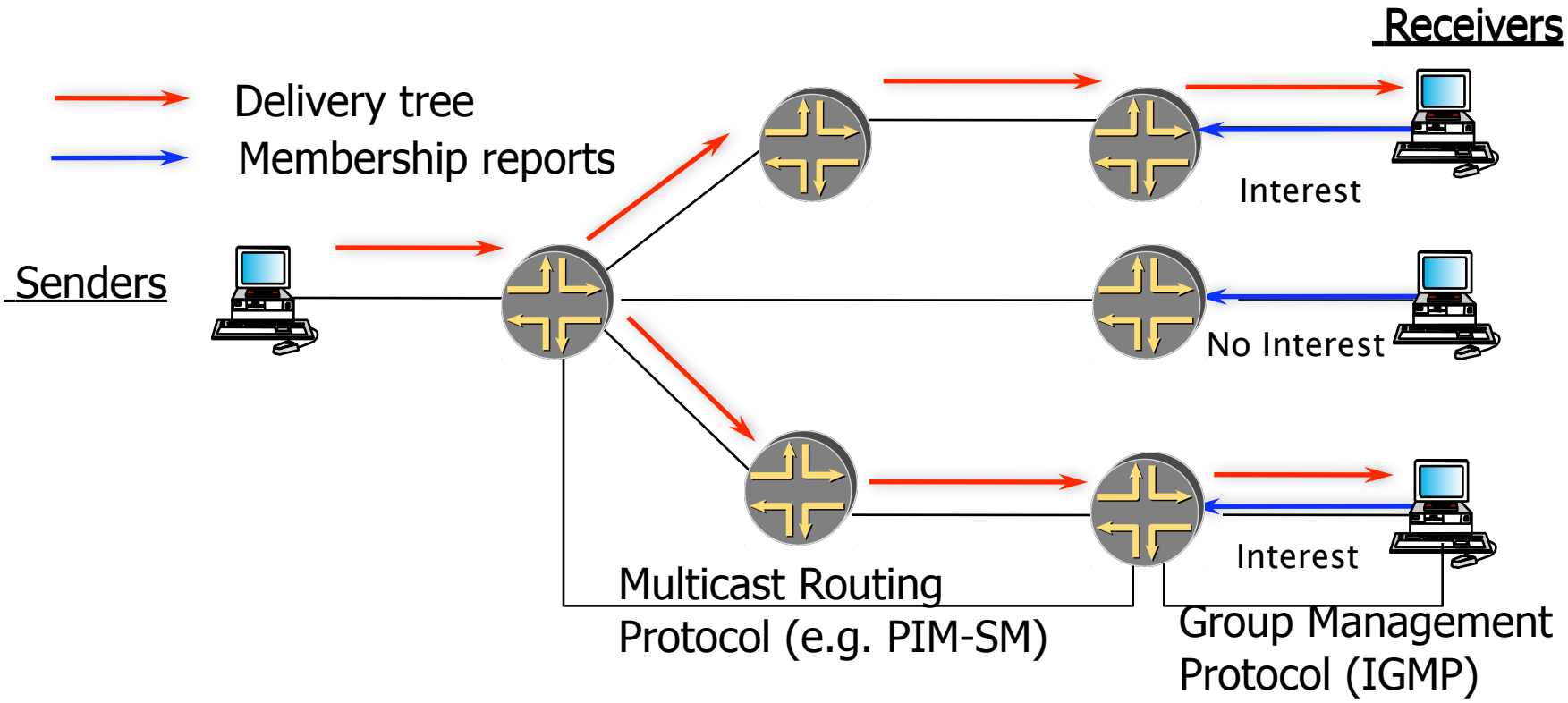
In Unicast, you worry about where the packet is going to, in Multicast, where it came from.

The Essence of IP Multicast



- Sources send data, receivers express interest, the network (routers) get the data from the source to the receiver
  - And, equally important, the network keeps data from those that don't want it
- The Data flow along one unique path from the source (or a Rendezvous Point) to each receiver, with no loops – the Multicast Tree.

The Essence of IP Multicast



- Users are kept isolated from the routing protocol in use
  - Group Management Protocol – enables hosts to dynamically join/leave multicast groups. Receivers send group membership reports to the nearest router.
  - Multicast Routing Protocol – enables routers to build a delivery tree between the sender(s) and receivers of a multicast group.

A Brief History of Multicast

- My first rule of technology is that really good engineering only comes after the first iteration.
  - By that criteria, Multicast should be good indeed…
- My second rule of technology is that anything that takes too long will be superceded, no matter how cool it is.
  - Has multicast escaped this trap ?

What Happened to Multicast?

- By 1995, multicast seemed well on its way to universal adoption.
  - The MBone (Multicast backBone) had been set up and was growing.
  - Audiocasts and Videocasts of meetings, seminars, etc., were fairly routine.
  - Serious interest was coming from industry.
- So why isn't it ubiquitous now ?
  - The hype got ahead of the technology!
  - The original technology was not suitable for adoption throughout the Internet. Basic parts had to be re-engineered on the basis of experience (see the first rule).
  - This took from ~ 1997 to early 2001.

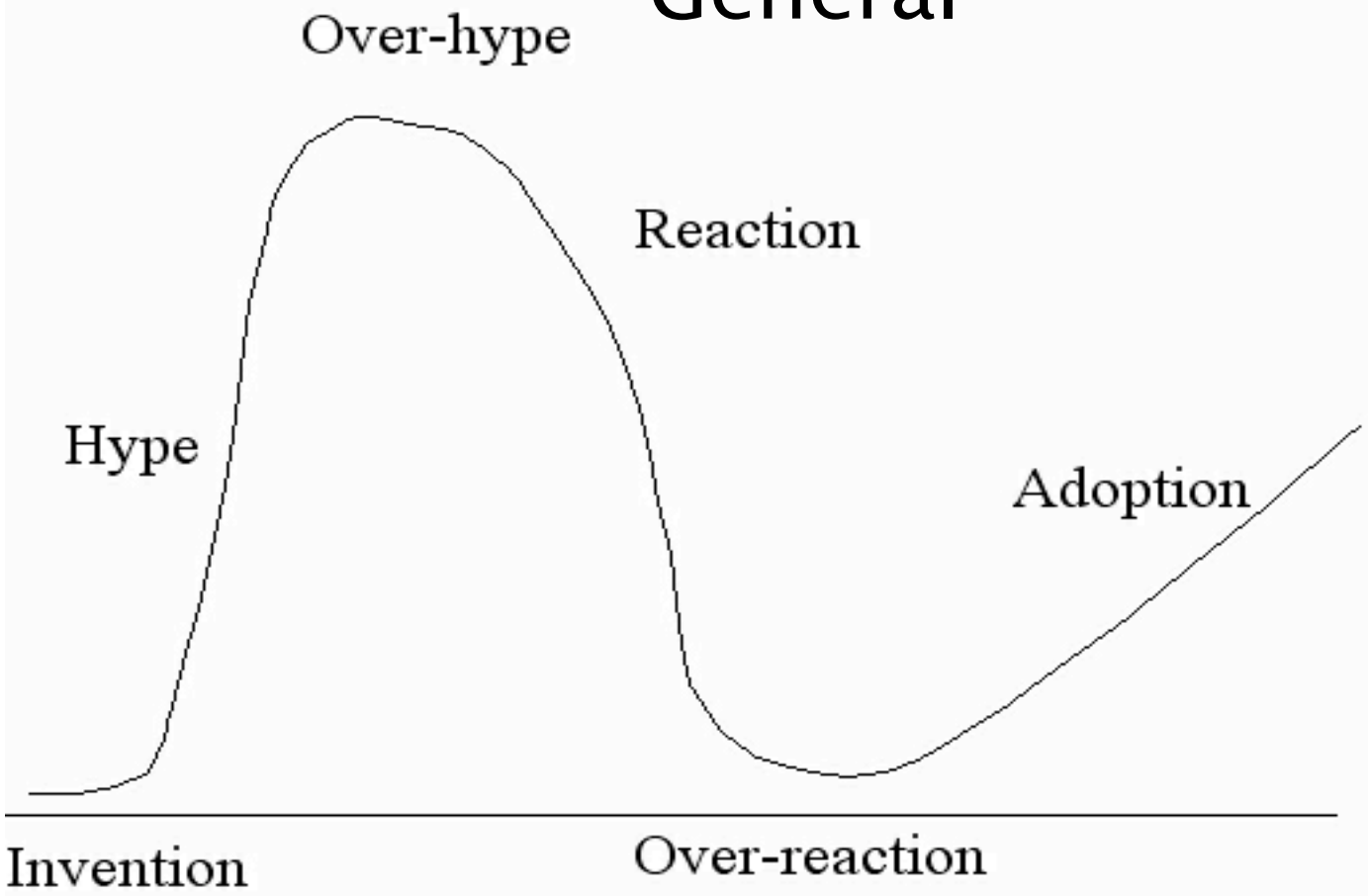
The MBone

- The original multicast network was called the MBone. It used a simple routing protocol called DVMRP (Distance Vector Multicast Routing Protocol).
  - DVMRP is Dense Mode
    - floods multicast traffic to all receivers, until they ask it to stop
- As there were only isolated sub-networks that wanted to deal with DVMRP, the old MBone used tunnels to get multicast traffic between DVMRP sub-networks.
  - i.e., the multicast traffic was hidden and sent between sub-networks via unicast.
- This mechanism was simple, but required manual administration and absolutely could not scale to the entire Internet.
- Worse, DVMRP creates its own routing table, and that requires substantial routing traffic behind the scenes and this grew combinatorially with the size of the MBone.
  - Thus, the legend grew that multicast was a bandwidth hog.

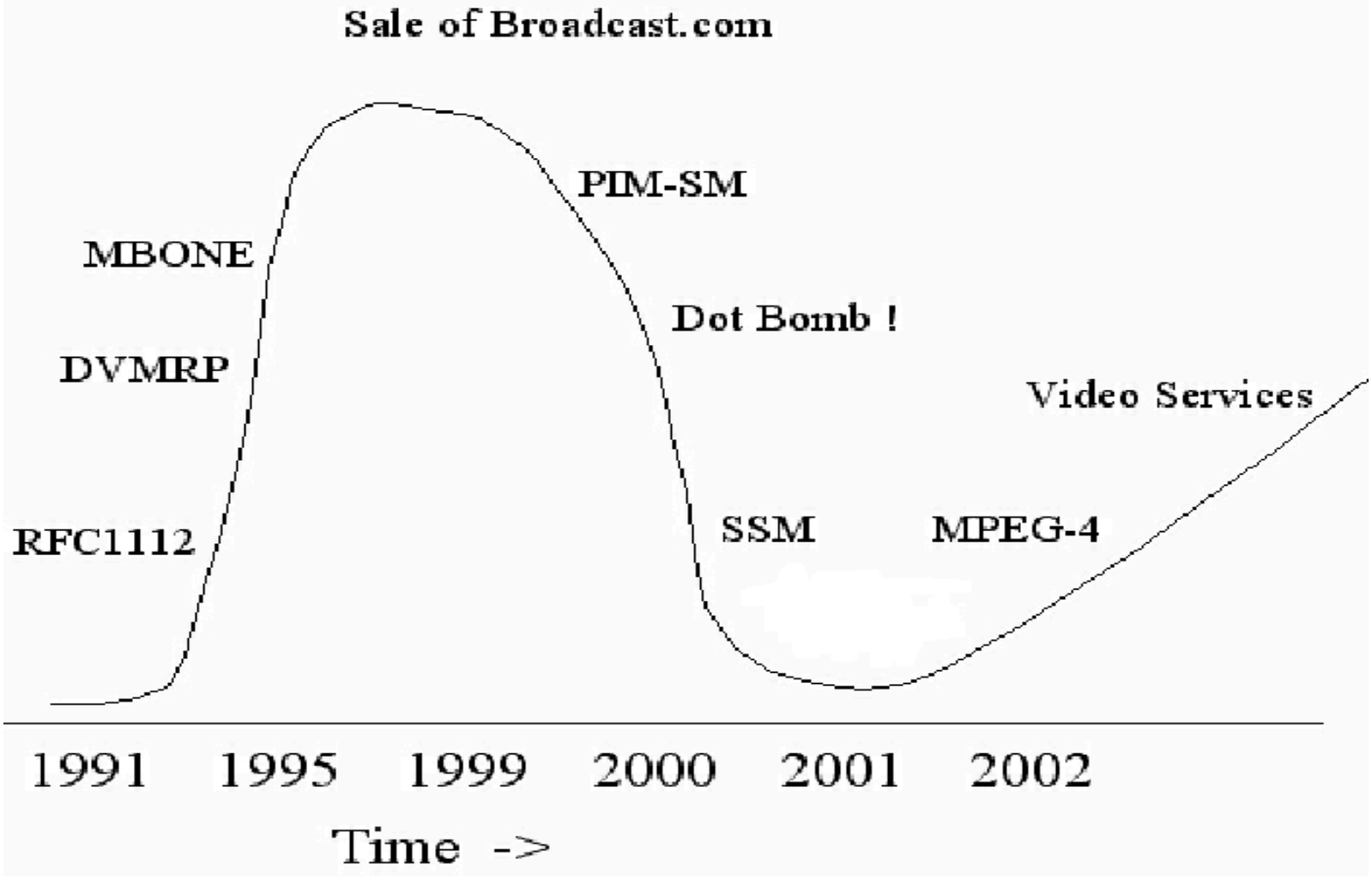
Multicast Grows Up

- Starting about 1997, the building blocks for a multicast-enabled Internet were put into place.
  - An efficient modern multicast routing protocol, Protocol Independent Multicast – Sparse Mode (PIM-SM), was deployed.
  - The mechanisms for multicast peering were established, using an extension to BGP called Multiprotocol BGP (MBGP), and peering became routine.
  - The service model was split into:
    - a many-to-many part (e.g., for videoconferencing): Any-Source Multicast (ASM), and
    - a one-to-many (or "broadcast") part: Source-Specific Multicast (SSM).
- By 2001, these had completely replaced the old MBone.
- This path is not unusual for new technology...

The Life Cycle of New Technologies in General



The Life Cycle of Multicast in Particular



Multicast Protocol Support : The View from Cisco

• 10 Years Cisco IOS IP Multicast	
• 1994	• PIMv1 SM/DM, IGMPv1/v2, DVMRP interoperatability
• 1995	• Fast-switching, SAP/SDR, PIM/IGMP/CISCO-IPMROUTE MIB, mtrace, NBMA mode
• 1996	• AutoRP, CGMP, CMF
• 1997	• MDFS, RFC2337 ATM MPS
• 1998	• PIMv2 SM/DM, BSR, IPMROUTE MIB, MBGP, MSDP
• 1999	• MMLS, MRM, PGM router assist, IGMP/Tunnel UDLR, NTP multicast, multicast NAT, multicast TAG • switching, UDPTN
• 2000	• SSM (IGMPv3, IGMPv3lite, URD), Bidir-PIM, MSDP MIB, PIM-DM SR, Heartbeat, RGMP, MVoIP, HW IGMP Snooping, IGMP mroute proxy
• 2001	• Cisco PIM traps, MSDP SA limits, IGMP-STD MIB
• 2002	• MVPN/VRF-lite (PIM-DM/SM/Bidir, AutoRP/BSR, IGMPv3, MSDP, Default/Data-MDT), multicast/PIM scalable convergence, IGMP limits, MROUTE-STD MIB
• 2003	• IPv6 Multicast (MRIB/MFIB,PIMv2 SM, SSM, MLDv2) SSM Mapping, Netflow v9 Multicast, Mobile-IP + Multicast, PIM Snooping
• 2004	• RPF-Vector, Inter-AS MVPN, MVPN MIBS, RFC3618 MSDP, MSDP MD5, IPv6 BSR, IPv6 Bi-Dir-PIM, SSM Filtering

Courtesy Cisco Systems

What capabilities does IP Multicast provide ?

- Timely distribution of data
- Cost-efficient distribution of data
- Robust distribution of data

"Data" here could be

- Files
- Streamed Audio or Video

Multicast Applications as seen by Cisco

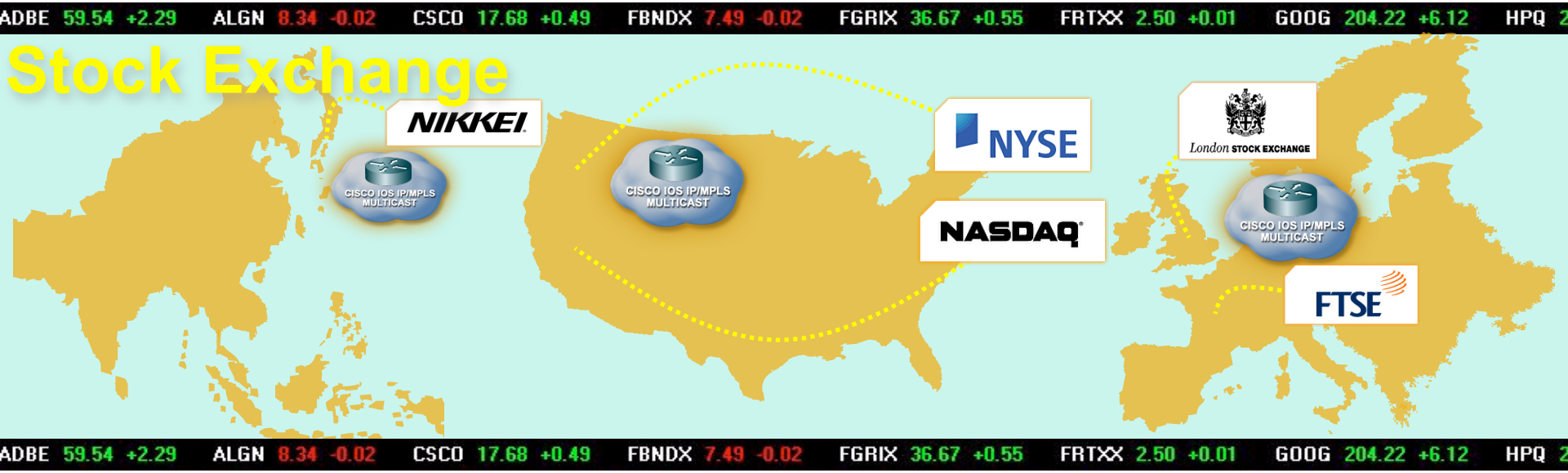
	Real Time	Non-Real Time
Multimedia	•Live Video •Video conferencing •Live Internet Audio •Hoot & Holler	Replication Video, Web servers Kiosks •Content delivery
Data-only	•Stock Quotes •News Feeds •Whiteboarding •Interactive Gaming	•Information Delivery Server to Serve, Server to Desktop •Database replication •Software distribution

Courtesy Cisco Systems

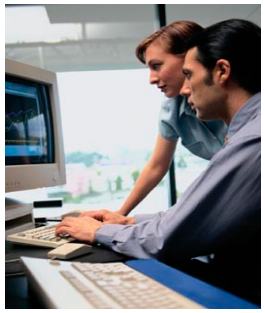
Timely Distribution of Data

- This is the argument for multicasting financial data.
  - Until very recently, "pushing" financial information was the largest business use of multicast
- In unicast, it takes time to send packets separately to each receiver.
  - Even if the cost is not an object, the time may be.
  - Example: A DS3 would take 2 days to distribute a 100 megabyte file to 10,000 desktops. Gigabit Ethernet would take ~ 2 hours
    - And, during that time, the network is clogged up !
  - With Multicast, this would take seconds.
  - Multicasting is compelling here if timely distribution is important (as it is with, say, stockbrokers)
- Simple in principle, can be complicated in

Finance Demands Timely Data Delivery



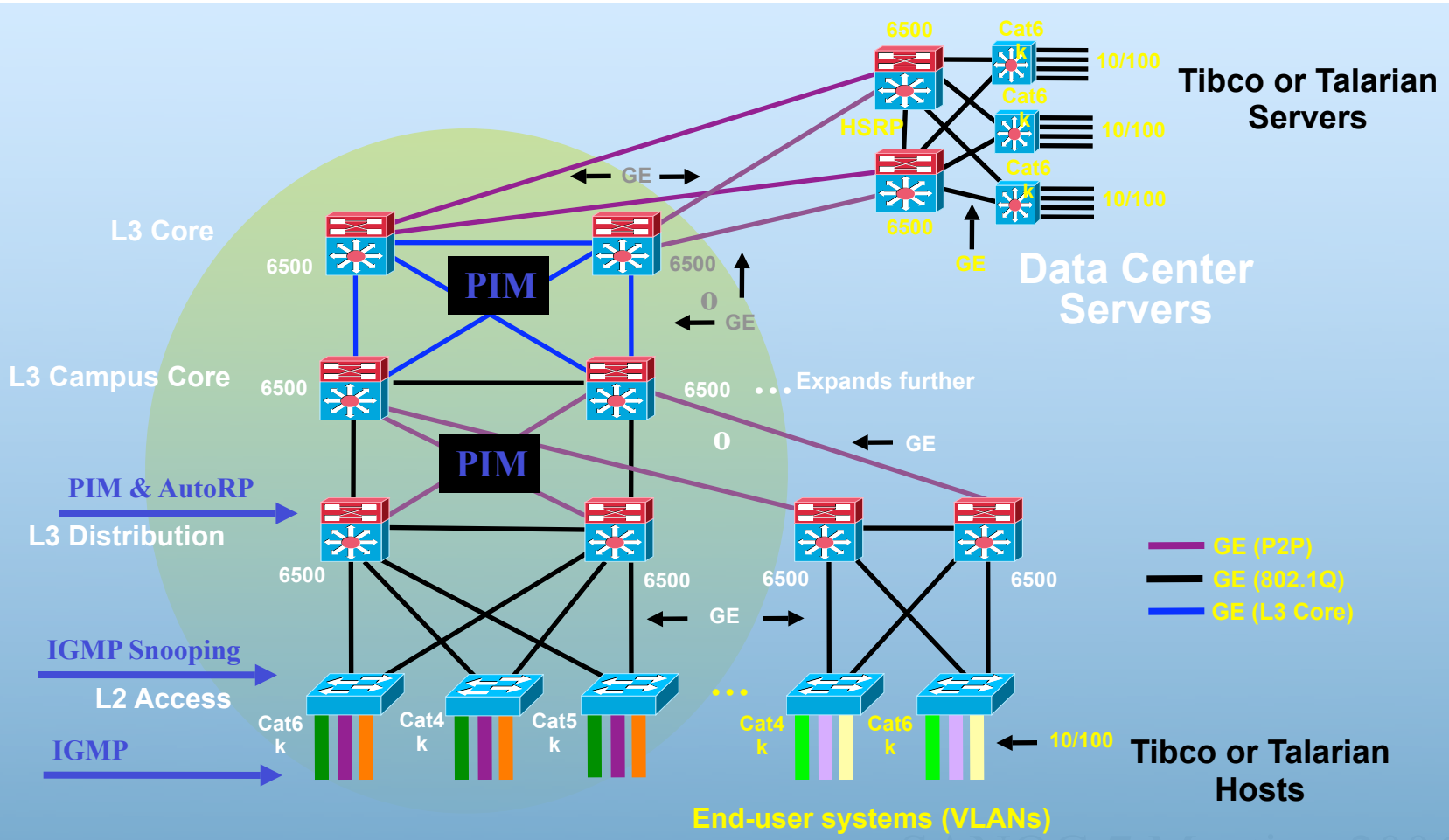
Trading Floor



Courtesy Cisco Systems

Finance : End to End Architecture

Typical Trading Floor



Courtesy Cisco Systems

Cost Efficient Data Distribution

- This is the core of the streaming case.
  - Unicast streaming to millions is just too expensive.
  - This is true either on the commodity Internet or on the Intranet.
  - Multicast is especially compelling for video.
- At $ 100 Mbps / month, a 2 Mbps unicast video channel would cost $ 200 per month per user for IP transit.
  - At a CPM of $ 25 (USA Superbowl), advertising could bring in $ 60 to $ 120 per viewer per month.
    - Not counting cost of content, cost of acquiring ads, etc.
  - Multicasting is still needed to make Internet video make economic sense.

Multicast Streaming : Walled Garden or Global Utility

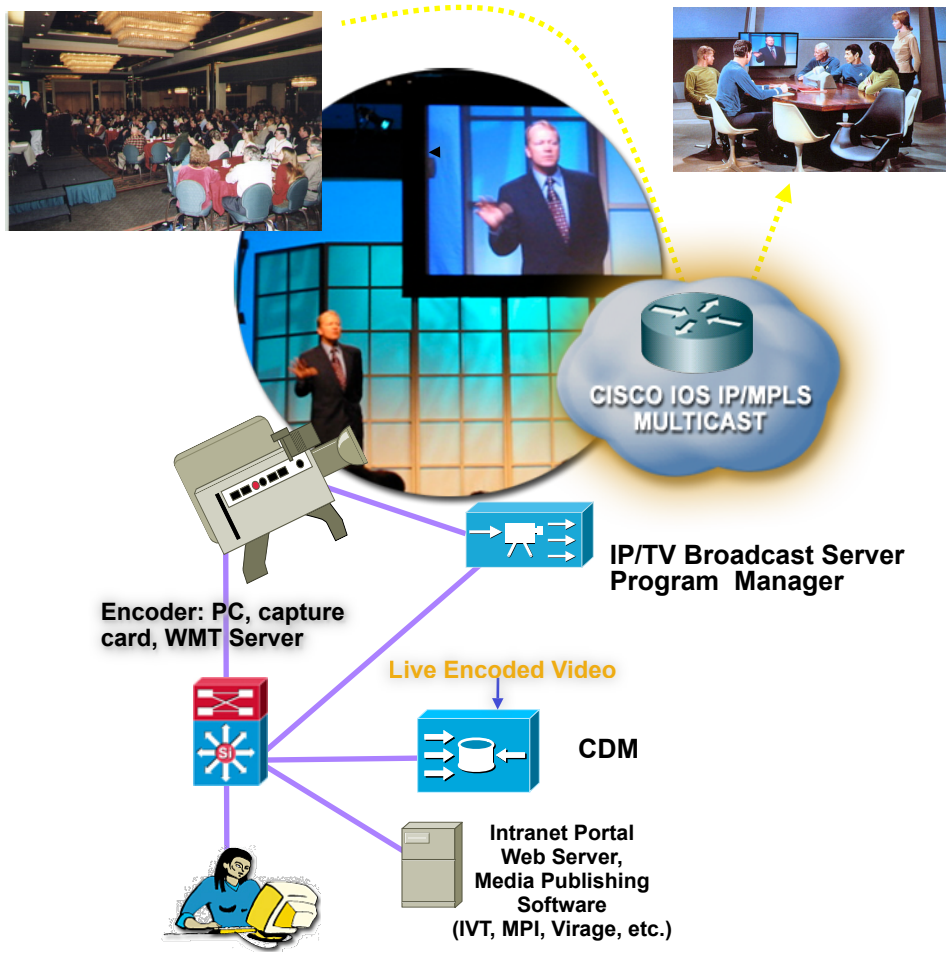
- Most current plans for multicast streaming is entirely behind the scenes.
  - The “walled garden” approach.
    - Video packets and user packets never touch
- The real question is whether Zipf’s Law will allow the walls to stand.
  - Or, how many channels will there be ?
  - It’s hard to see how the walled garden can be extended to encompass 10,000’s of channels
- Will examine some case studies, in the US, UK and Japan.

Case Studies: Enterprise Streaming

- Bandwidth is limited on enterprise networks.
- A typical business quality video stream uses 300 Kbps, while a high quality stream might be 1 Mbps.
- On a typical 100BaseT Ethernet, 300 unicast viewers would completely saturate the network.
- 100 unicast viewers would saturate a point-to-point DS3 link between corporate campuses; five would saturate a point to point DS1.
- The case for multicast is compelling for corporations with more than a few hundred desktops.
- Multicast has made substantial inroads into the corporate video distribution market.

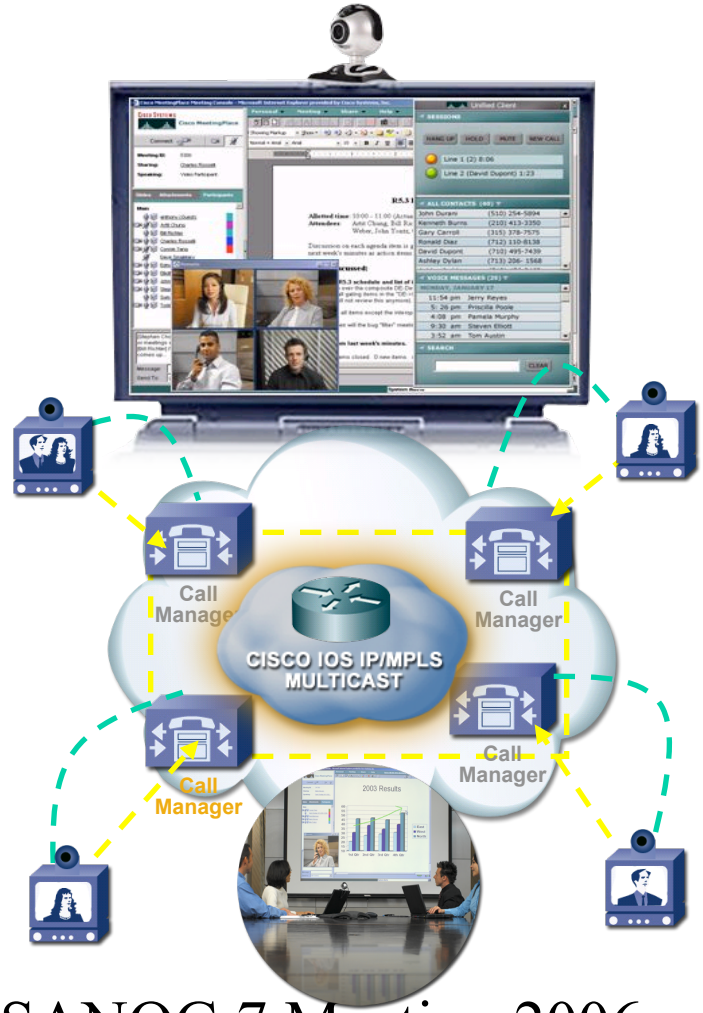
Enterprise

Corporate Communication



Courtesy Cisco Systems

Video Conferencing



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Multicast Video Distribution

- Multicast is becoming the preferred means of distribution for video (TV) to Set Top Boxes (STB) over IP Networks (i.e. IPTV).
- I will cover 4 test cases :
  - Northwestern University (NUTV)

    http://www.i2-multicast.northwestern.edu/
  - University of Wisconsin (DATN)

    http://datn.wisc.edu/about/
  - Hong Kong Broadband Networks (HKBN)

http://www.cisco.com/application/pdf/en/us/guest/netsol/ns610/c647/cdccont_0900aecd80375b69.pdf

  - MTN Triple Play Network

    http://www.netinsight.net/pdf/040616_Case_study_MWT.pdf

Multicast Video Distribution

- Why is Multicast and IPTV becoming the best common practice ?
- It saves money.
  - Northwestern NUTV estimated they saved about $ 3 million USD from not having to do a Coaxial cable install.
- It uses the IP Infrastructure
  - The Buzzword of the day is “Triple Play”
  - Data, VOIP, and Video on the same network is the Triple Play
    - And this requires Multicast

Northwestern's Experience

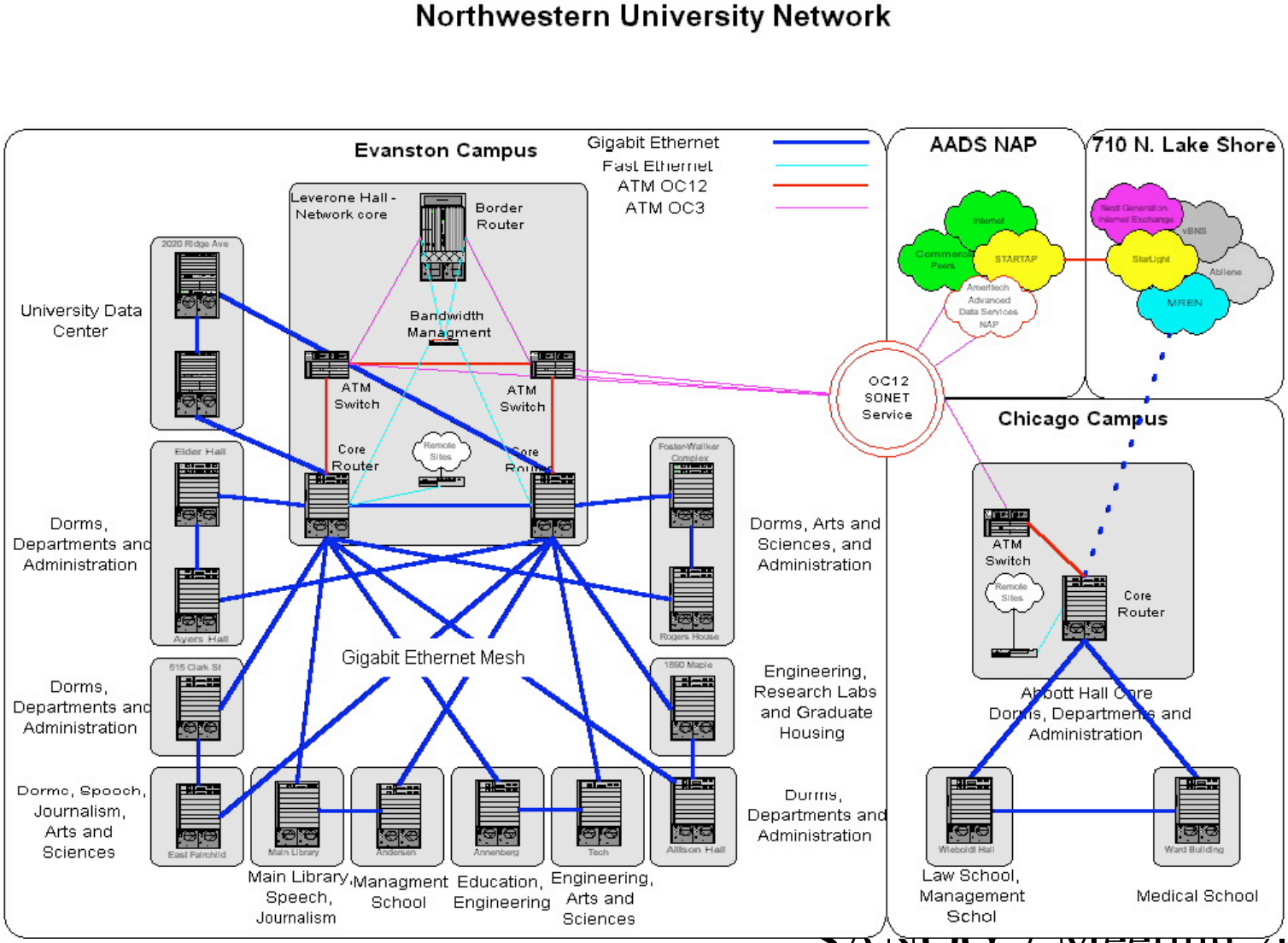
- Effectively, Northwestern University is running a medium sized "cable" company, except entirely through IP Multicast.
- Northwestern uses video broadcast solutions from Video Furnace, Inc.
  - http://www.videofurnace.com/
    - "The Video Furnace solution handles all the heavy tasks of capturing and encoding live video to standards based MPEG streams with quality from VHS to full D1 broadcast, while seamlessly managing the distribution of client viewers to your Windows, Mac and Linux users."

What Has Been Deployed?

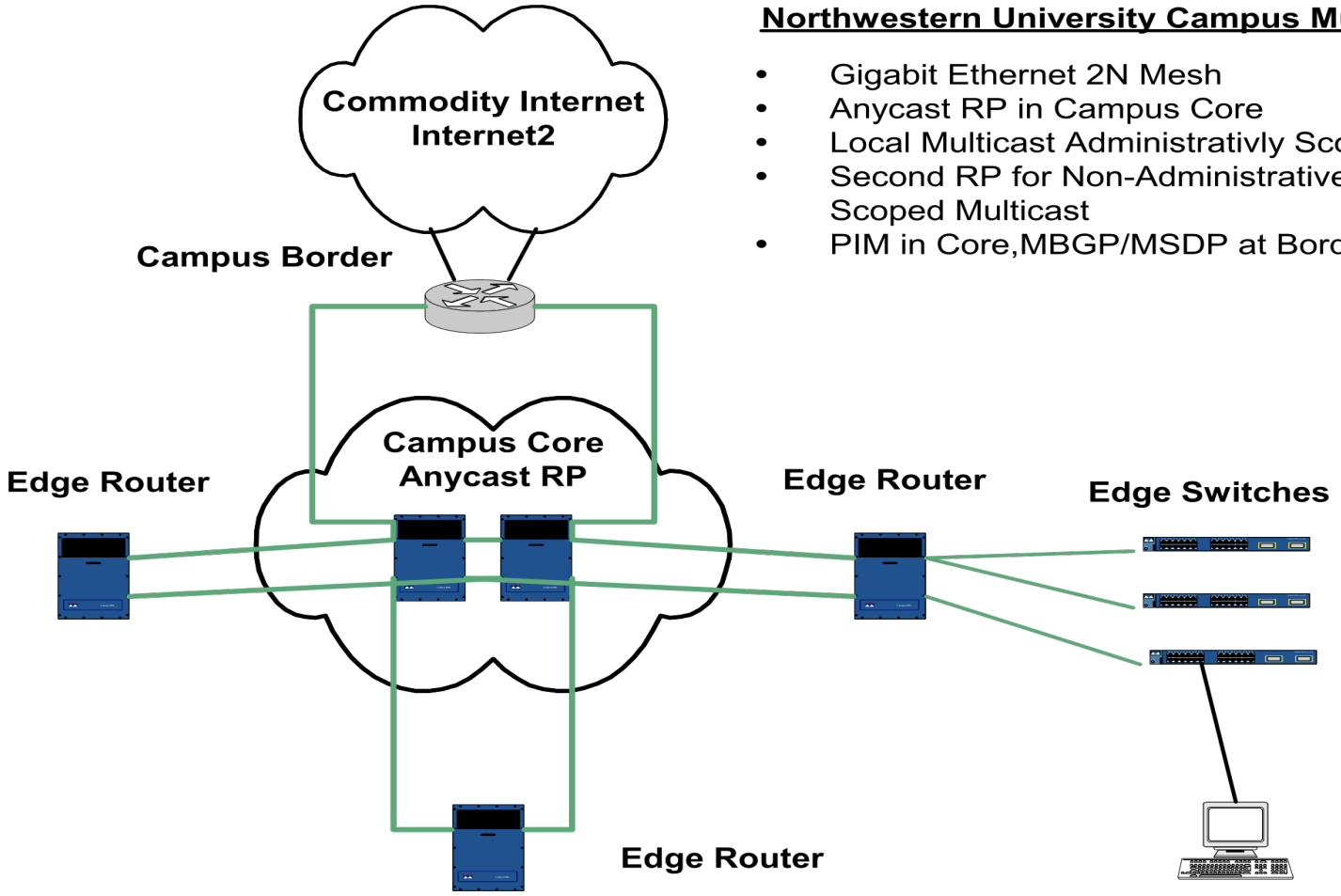
- 20 channels of entertainment television
  - Combination of off-air and CATV channels
- Multicasted to all undergraduate dormitories (4350 unique locations)
- MPEG2 encoding, 29.97 FPS, ~2Mbps per stream (128Kbps mono audio)

Why Deploy This Type of System?

- No CATV in student dormitory rooms
  - Only in common areas/lounges
- Over 60 residence halls
  - Cost to wire with coax very high ($2-$5 Million)
  - Estimated time of completion: ~4 years
- CATV major issue for the student population



Courtesy Northwestern University

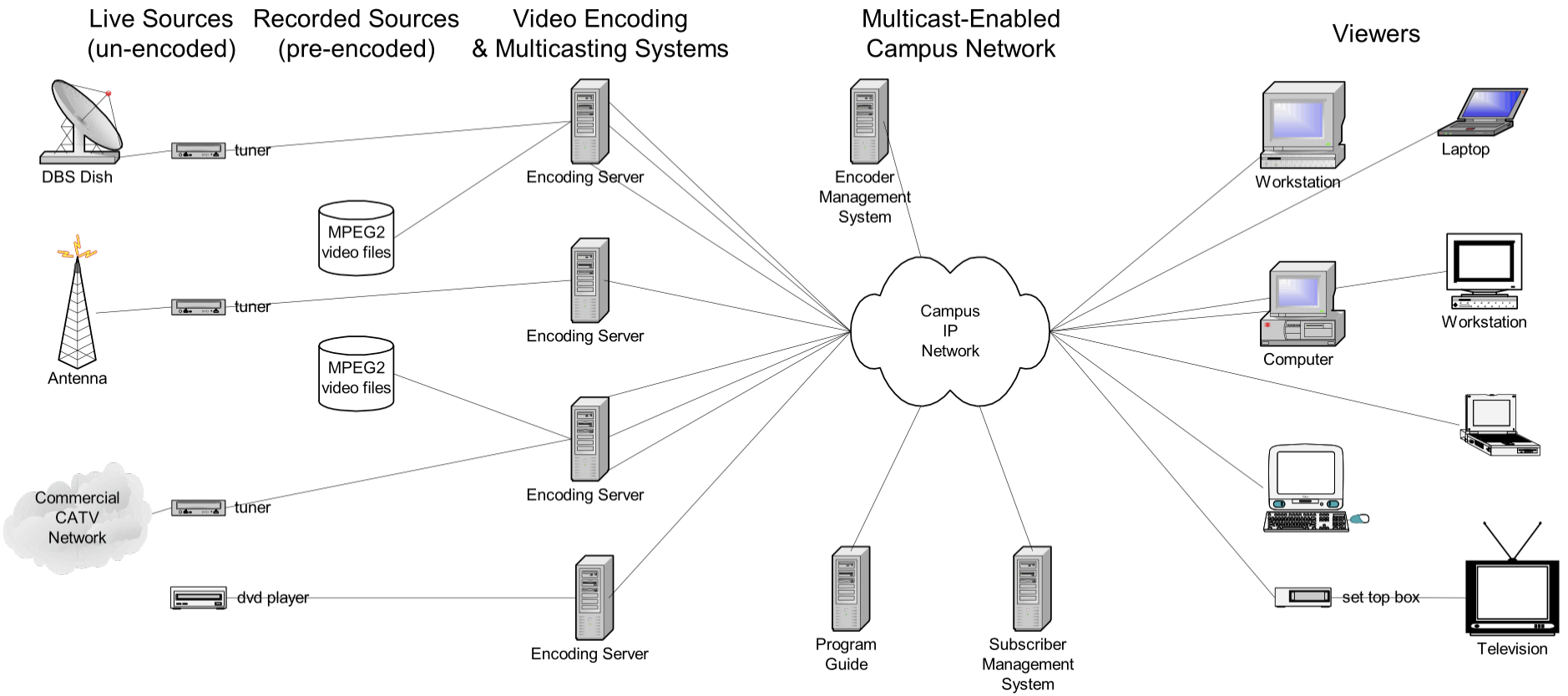


Northwestern University Campus Multicast

- Gigabit Ethernet 2N Mesh
- Anycast RP in Campus Core
- Local Multicast Administrativly Scoped
- Second RP for Non-Administratively Scoped Multicast
- PIM in Core,MBGP/MSDP at Border

Courtesy Northwestern University

System Components



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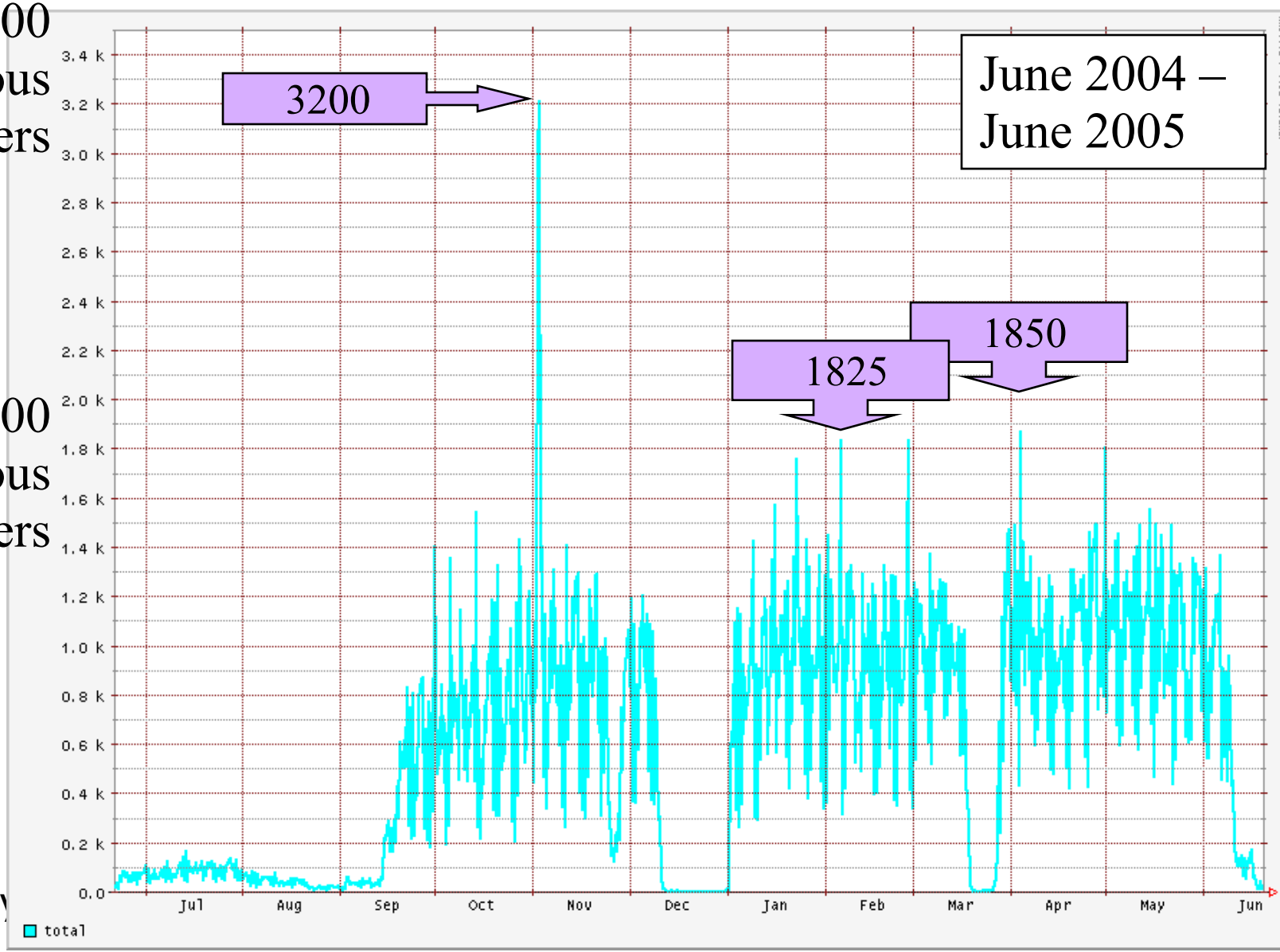
Courtesy Northwestern University

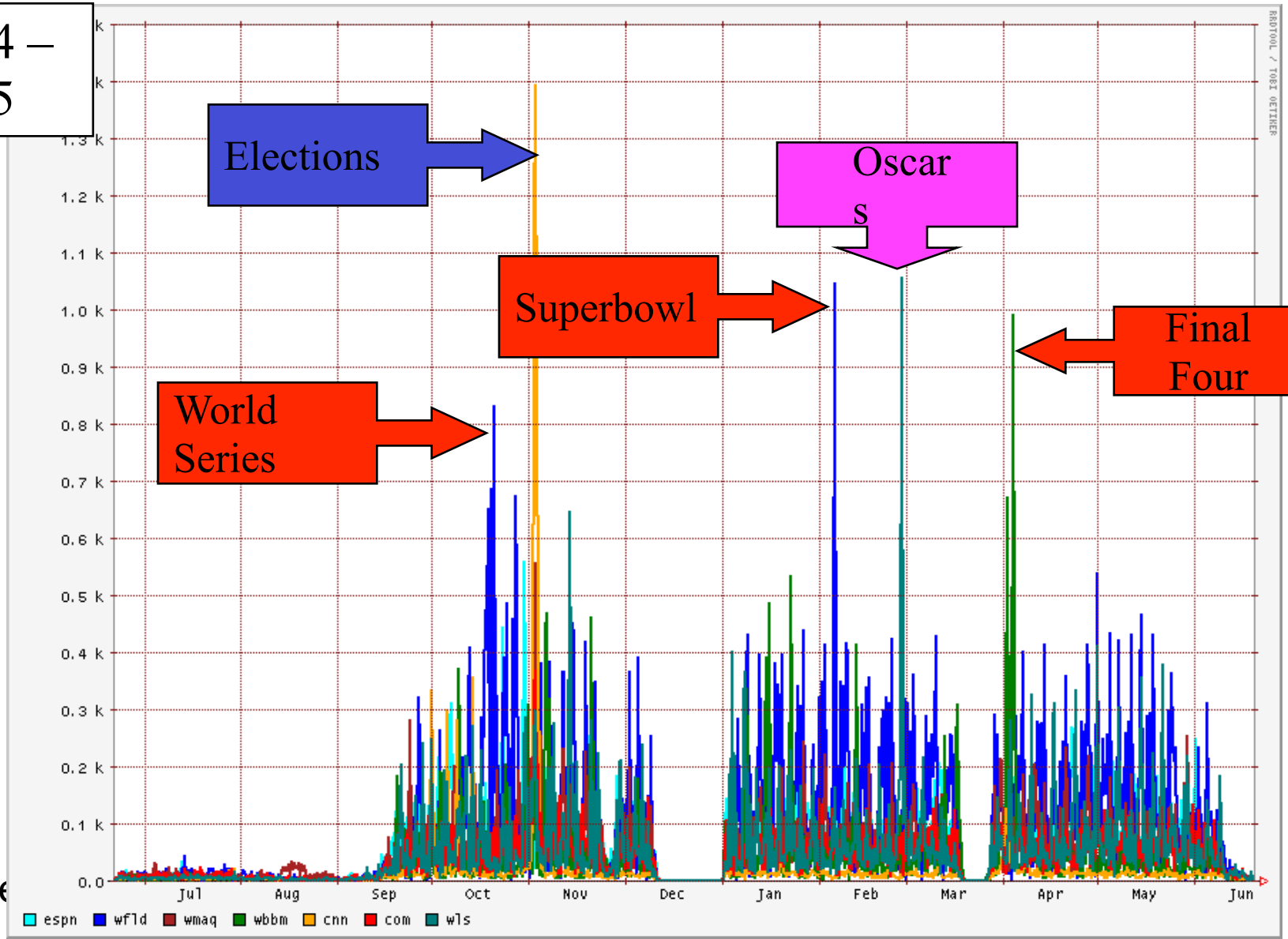
3400 Simultaneous Viewers

1700 Simultaneous Viewers



Courtesy

June 2004 – June 2005



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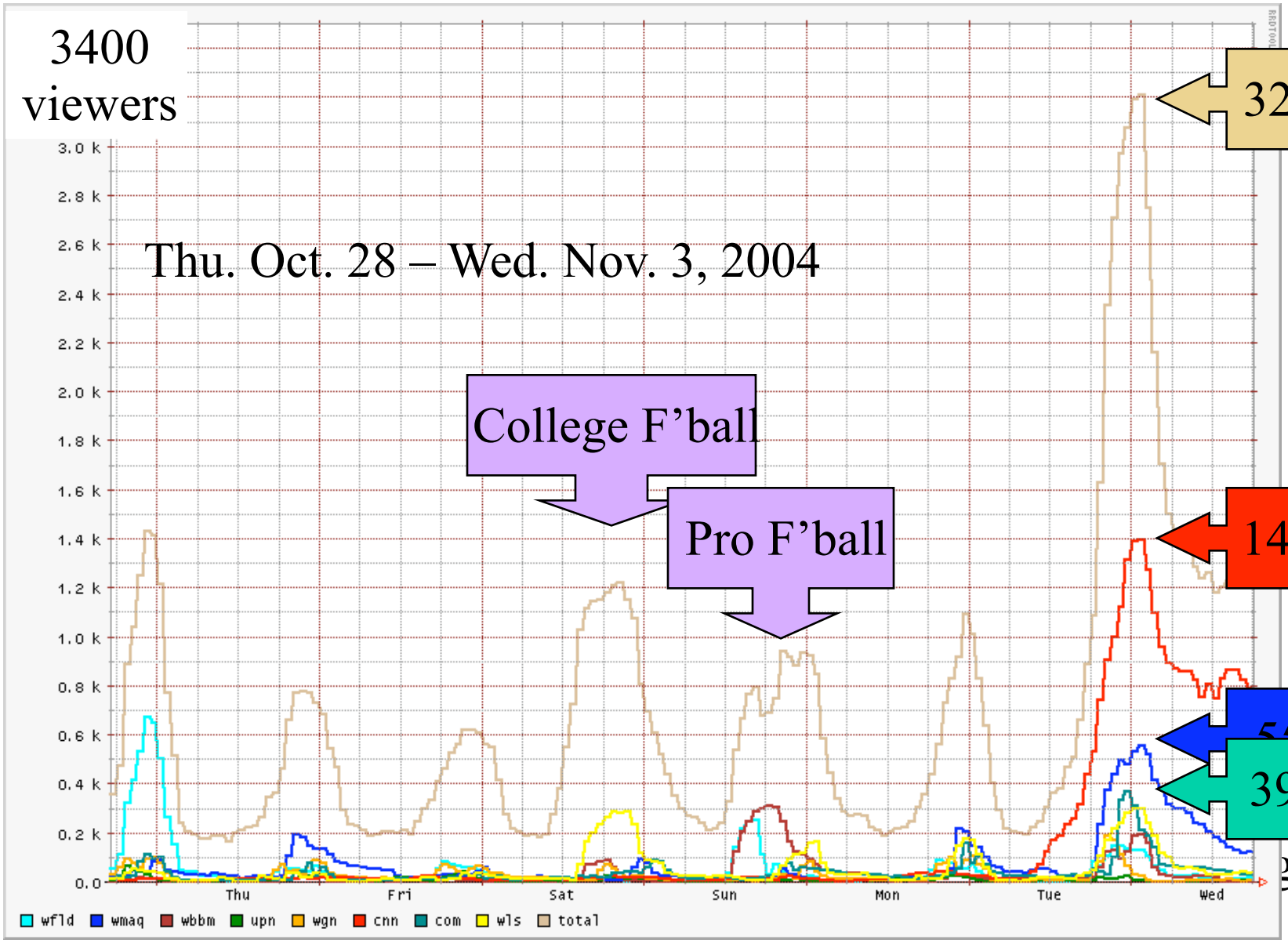
3400 viewers
Thu. Oct. 28 – Wed. Nov. 3, 2004
3200 Total
College F'ball
Pro F'ball
1400 CNN
390 COM
3.0 k
2.8 k
2.6 k
2.4 k
2.2 k
2.0 k
1.8 k
1.6 k
1.4 k
1.2 k
1.0 k
0.8 k
0.6 k
0.4 k
0.2 k
0.0
Thu
Fri
Sat
Sun
Mon
Tue
Wed
wfld wmaq wbbm upn wgn cnn com wls total

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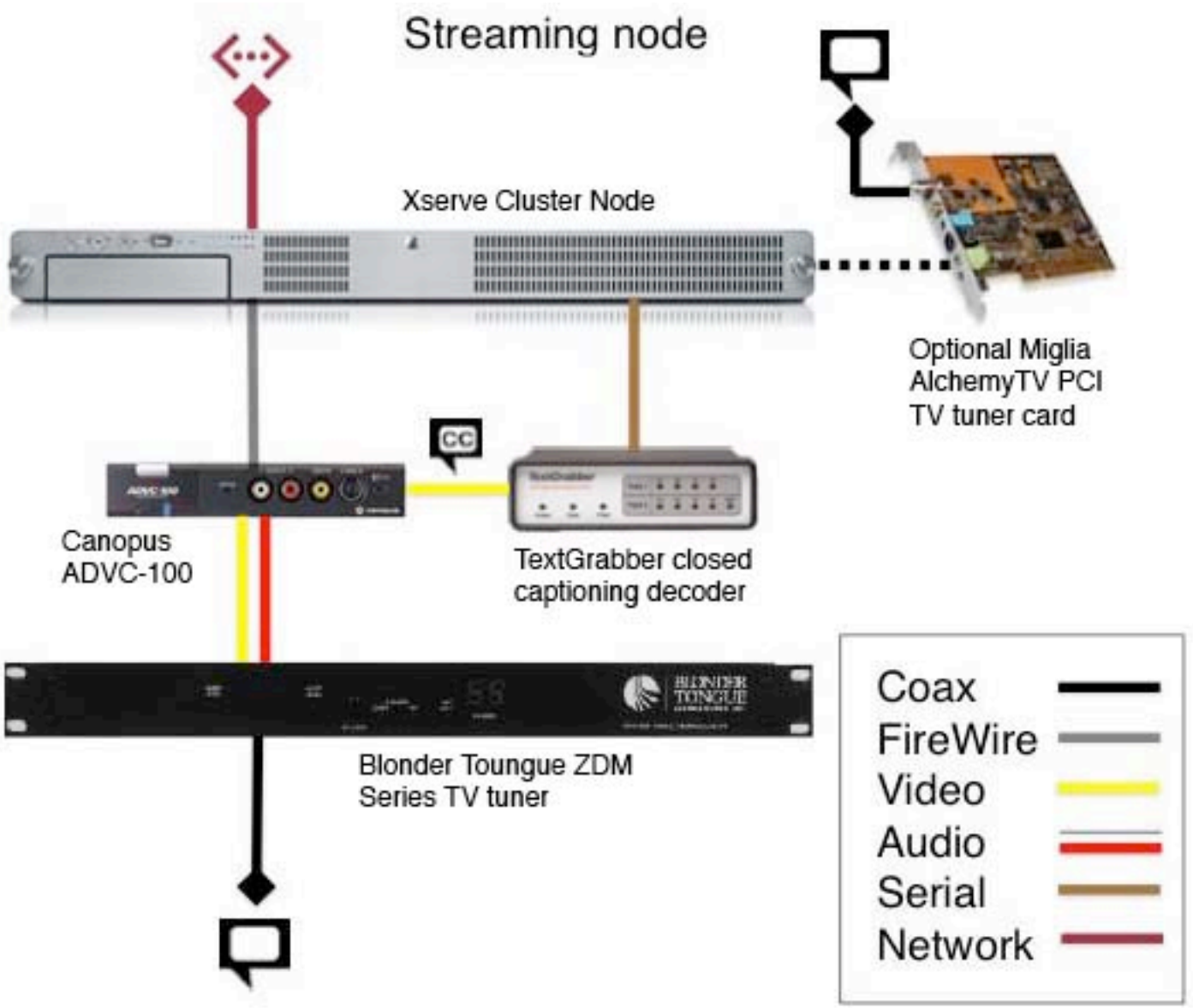
Wisconsin DATN

- Wisconsin has chosen a more open system.
  - Digital Academic Television Network or DATN
  - At University of Wisconsin – Madison
  - Based on Apple Quicktime
    - Quicktime 7 or VLC is the player
    - Server is Apple Xserve (1 per channel)
      - Mac OS X Server
      - QuickTime Broadcaster*
      - QuickTime Streaming Server*
      - Apache
      - Tongue ZDM Series (TV tuner)•
      - TextGrabber GP500 closed captioning decoder•
      - Canopus ADVC-100 analog to FireWire AV converter


DATN00
DATN01
DATN02
DATN03
DATN04
BLONDER TONGUE

DATN Channel Architecture



2006

DATN Video

- DATN
  - Streams 78 channels of live local television
  - via multicast over a 10-GigE backbone network
  - to a 65000-person research campus.
  - No DRM (Digital Rights Management)
    - They don't want it
  - No EPG (Electronic Program Guide)
    - This is an issue with Multicast Video
    - A standard is needed

DATN Video : Why Quicktime

- Why did DATN pick Apple Quicktime and QTB and QTSS ?
  - Support of open standards
    - MPEG-4 and H.264 (MPEG-4 version 10)
  - Support of common OS's
  - Cost
    - Quicktime is free
    - Quicktime Streaming Server is free
    - Quicktime Broadcaster is free

DATN Video : More about why QT

- QuickTime capabilities :
  - QuickTime Text Track allows DATN to stream closed captioning content independent of video
  - QuickTime Skins allows DATN to use flexible approaches for the display of video on the client end
  - Because of the granularity of the system, other uses of the content can be explored
    - Closed captioning search database
    - Video archival
    - Custom players and other applications
    - Computer “set top box” configurations
    - See http://datn.wisc.edu/about/DATN_WWDC_2005.pdf for more details

DATN Video : Future Plans

- QuickTime 7!
  - H.264
    - Requires about twice the processing power of MPEG-4
    - Delivers about twice the image quality at same data rate
    - Standard-definition TV quality streams are possible in under 1.5 Mbps
  - QuickTime Broadcaster 1.5 with QuickTime 7 now supports full frame (720 x 480) DV
  - QuickTime Broadcaster 1.5 with QuickTime 7 now supports full frame (640 x 480) from Miglia AlchemyTV card

What DATN Looks Like :

- DATN Developed its own player skin

Other Educational Multicast Video

- Northwestern University and UW-Madison are hardly alone
  - Many schools are running trials or initial deployments of multicast video
  - Dartmouth announced it will use Video Furnace equipment on May 18th, 2005
    - 62 channels and wireless. -
  - Cornell University is rolling out service "soon."
  - AHECTA - American Higher Education Cable TV Association - is interested
- Then there is also the Open Student Television Network (OSTN.tv)
  - Focused on student produced content

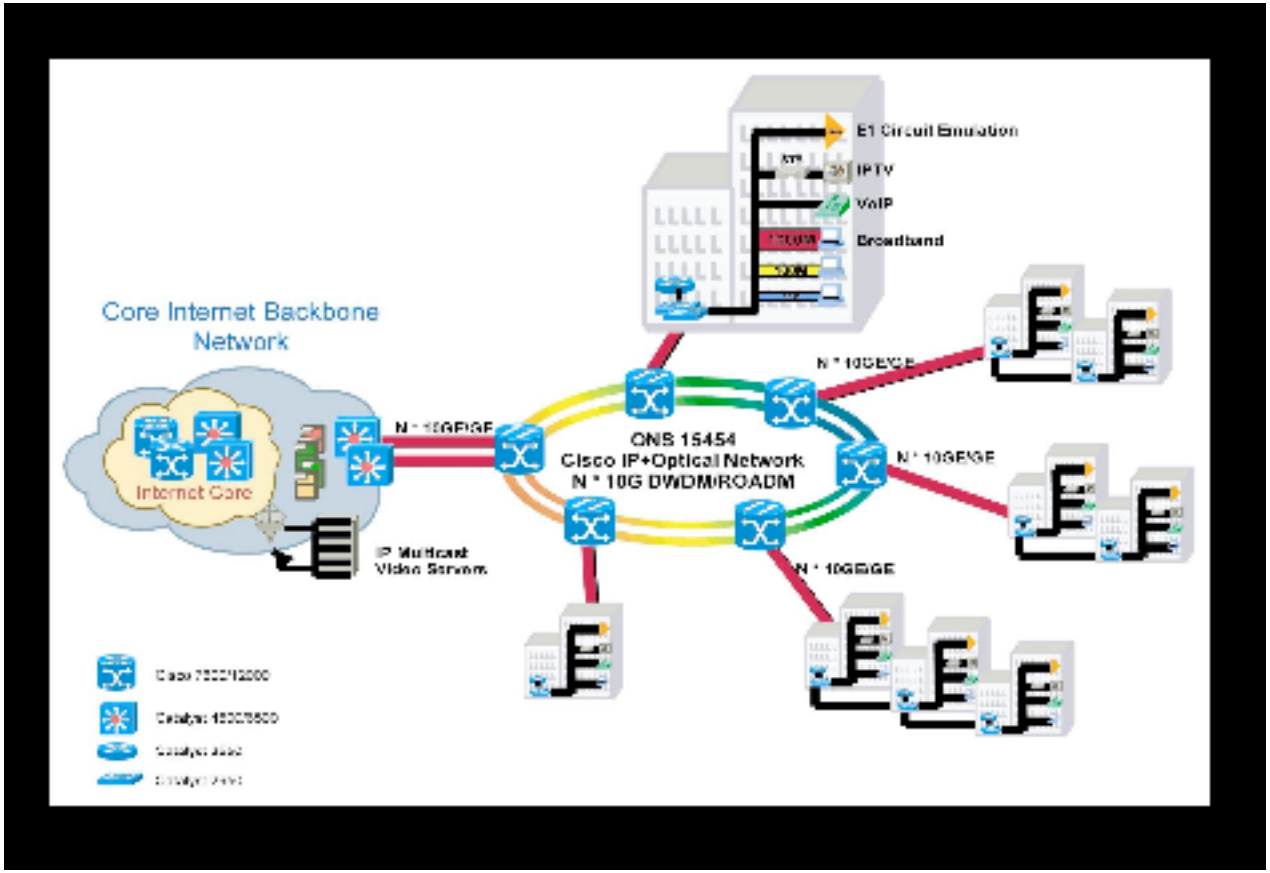
Hong Kong Broadband Networks LTD.

- A commercial video deployment
  - All Cisco based solution
- They want to compete with DSL by using Ethernet deployments
- Customer Charges :
  - 10 BaseT is “below dialup” cost
  - 100 BaseT is $ 27 USD / month
  - 1 GigE is $ 172 USD / month

HKBN Business Model

- HKBN offers (to subscribers)
  - VOIP at $ 6 / month flat rate
  - 60+ channels of IPTV
    - In 10 / 2005 :
    - HKBN has 120,000 subscribers @ $ 16 USD / month
    - Their conventional competitor, HK Cable, has 685,000 subscribers @ $ 39 USD / month
  - Ethernet Cost is $ 130 USD / residence passed
    - Hong Kong is a population dense urban environment

HKBN Network Topology



HKBN Network Architecture

- Multiple 10 Gig DWDM rings
  - Cisco 12000 and 7600's
- 10 GigE to the Internet and video servers
- 10 GigE to Multi Tenet Units (MTU's)
  - Catalyst 4500's switch at the "miniPOP's"
  - Catalyst 3450's at the MTU's
- Convert to Copper and put on risers
  - Catalyst 2950 switch to users at the subscribed rate.

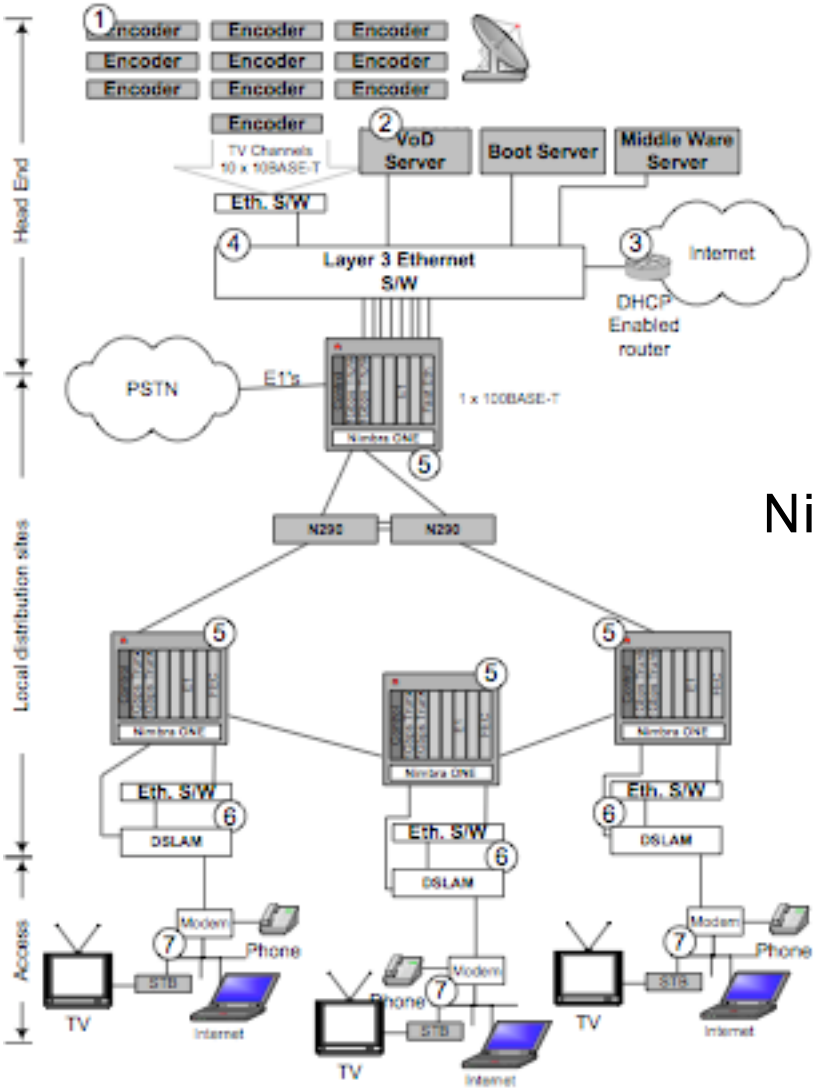
Midwest Tel Net Triple Play Network

- Midwest Tel Net is a small IOC network in Wisconsin
- MWT triple play network is
  - A Multi-vendor solution
  - ADSL to the customer
  - Fiber based Ethernet backbone
  - 100+ channels of Television
  - Plus data and voice
  - To 22,000+ homes
- Video Setup Cost is $ 30 to $ 80 / subscriber
  - Depending on the take up rate.

MWT Video Distribution

- Minvera encoders take video from satellite feeds and convert it to 3.5 Mbps MPEG-2 streams.
  - These are multicast onto the Ethernet backbone.
  - At the edge
    - Net Insight's Nimbra One
    - ATI Rapier 24i Ethernet switch/router
    - Allied Telesyn DSLAM 7000 Series
      - Puts the data onto DSL copper
  - At the customer premises, a Set Top Box (STB) is connected by Ethernet to the ADSL router/gateway.
    - Two channels can be viewed simultaneously

MWT Physical Architecture



Nimbra One 100 Base T Switched Network

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Other Commercial Multicast Video Deployments

- Time Warner is undergoing trials of Multicast Video in San Diego
  - Using Real Networks for back office, encoders, DRM, etc.
  - The encode rate in demonstrations was 700kbps, but is adjustable.
  - DRM is being used, but not clear if this is for multicast or unicast content.
- Comcast is in the process of converting to a multicast enabled national backbone.
- Fox Cable, with TVN Entertainment, is using multicast to pre-cache Video on Demand (VOD).
- There is my very own AmericaFree.TV
  - This is a multicast source
  - 500 Kbps H.264 encoding (multicast & unicast)

BBC Multicast

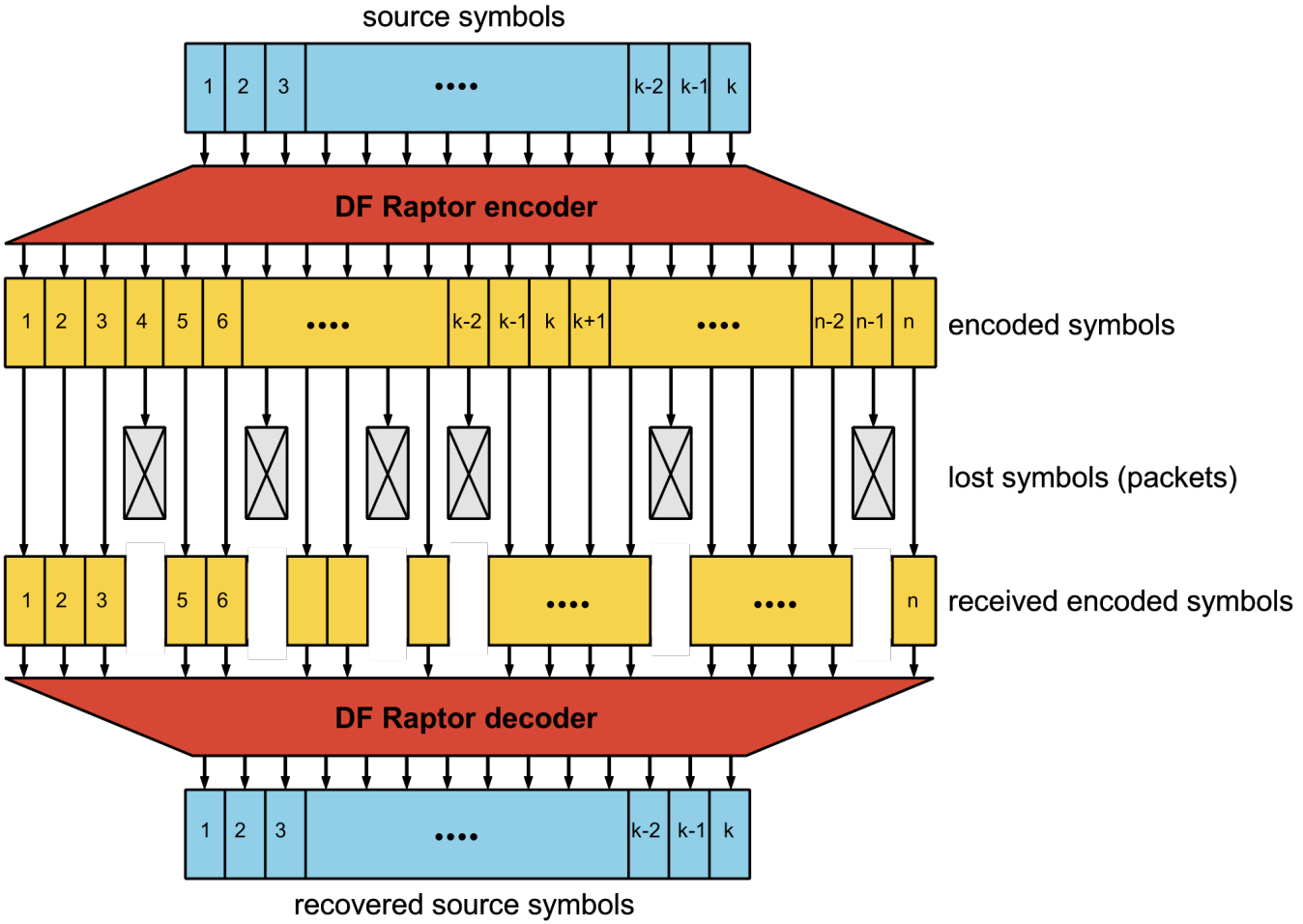
- The BBC has been multicasting for a long time.
  - Licensing issues limit much of their content to the UK
    - ISP's tend to follow national boundaries
      - Being an island has some advantages
  - September 1 they announced that "our multicast trial […] received approval today to use most BBC channels."
    - So far,multicasts are for the UK only.
  - http://support.bbc.co.uk/multicast/
  - http://news.bbc.co.uk/1/hi/entertainment/tv_and_radio/4187036.stm

Digital Fountain

- Digital Fountain is pursuing Multicast content delivery using its “Raptor” erasure protection.
  - Multicast does not use TCP, and does not itself guarantee that packets get delivered.
- Business applications of Multicast are not just in the delivery of packets
  - The entire video distribution model is being re-engineered.

Digital Fountain's DF Raptor Is An Erasure Code

- DF Raptor encodes a block of k source symbols as n>k encoded symbols in order to protect the symbols from loss in transmission
- Once any ~k encoded symbols are received, the original k symbols can be recovered
- A "symbol" is relatively large – several bytes to several hundred bytes
- Often, "symbol" and "packet" are the same (for example, 1 symbol per packet)



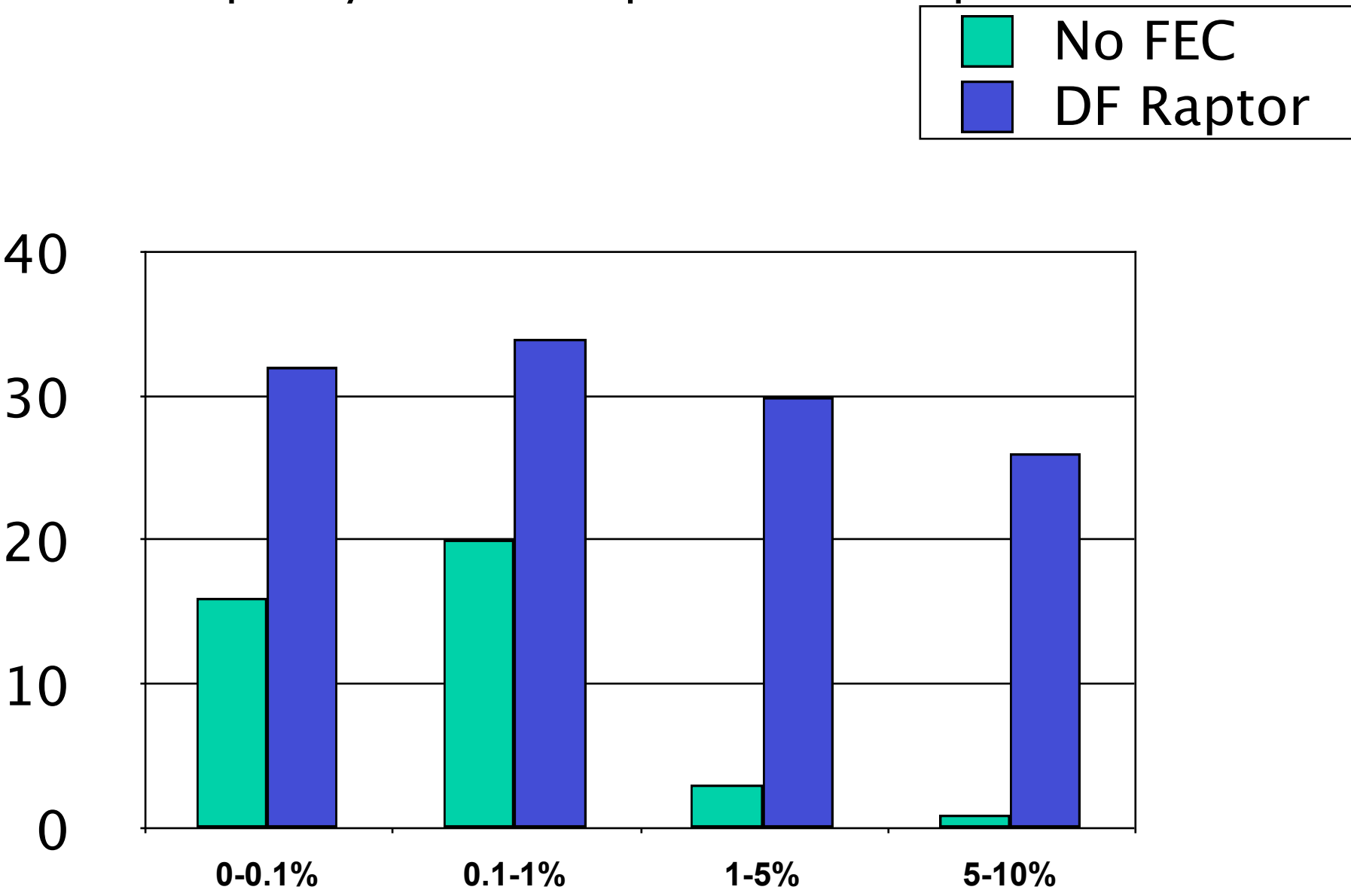
Courtesy Digital Fountain

NTT quality test for Raptor

- Two month trial: December 2003 – January 2004
- 300 subscribers in the Tokyo area
- FTTH (48%), ADSL (52%)
- Service: Video on Demand
  - Commercial service also uses multicast for scheduled/live delivery
- Format: MPEG2 (6 Mbps / 3 Mbps)
- 100 titles: movies, music, animation (30 – 120 minutes)
- Blind test
  - 50% Raptor
  - 50% No-FEC
- User access definition
  - Watched for at least 3 minutes

Courtesy Digital Fountain

NTT quality test for Raptor: Minutes per access



Source: NTT Trials. Blind test over Internet infrastructure.
User accesses of more than 3 minutes only

SANOG 7 Meeting 2006
Courtesy Digital Fountain

More information about Reliable Transport

- www.digitalfountain.com contains a lot of information that is multicast/broadcast related.
- Reliable Multicast Transport Working Group
  - http://www.ietf.org/html.charters/rmt-charter.html

Robust Distribution of Data

- In some streaming or data distribution cases, the problem is handling sudden large increases in load.
- Multicast was designed to handle sudden large increases in usage.
  - In multicast, audience spikes need not translate to load on servers or routers.
- This is leading to increased adaptation of Multicast for surveillance, security, etc.
  - The military has long been interested.

Case Study: 9/11/2001

Internet News "Melt-down": Web Site Performance 9:00 AM to 10:00 AM

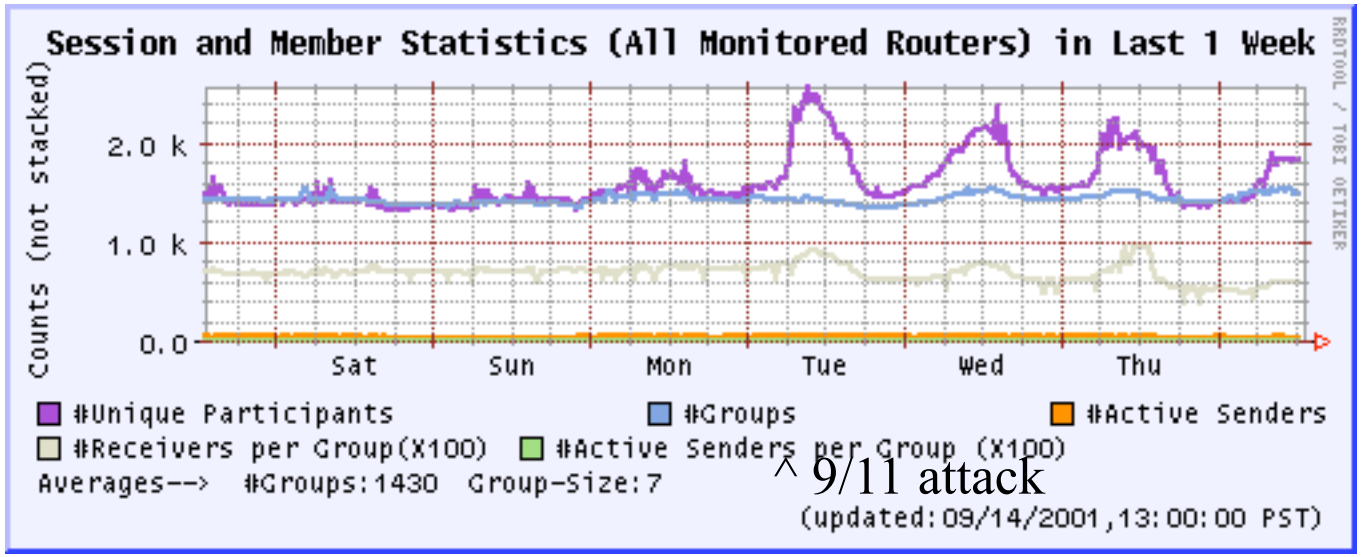
Site	% Users able to access
ABCNews.com	0 %
CNN.com	0 %
NYTimes.com	0 %
USAToday.com	18 %
MSNBC.com	22 %

(source: Keynote's Business Performance / Interactive Week 9/17/2001)

Internet News Performance on 9/11/2001

- Of course, the “melt-down” was caused by the incredible demand for news after the attacks.
- Unicast streaming web sites suffered similar problems, at least from anecdotal evidence
- By contrast, multicast performed well
  - Large increase in traffic
  - Roughly 1 Gigabit per second saved at peak
  - Over time, the multicast peering mesh degraded, but this was NOT due to increased traffic

Multicast Activity at FIX-West / Mantra



^ 9/11 attack

from http://www.caida.org/tools/measurement/Mantra/session-mon/session-mon.html

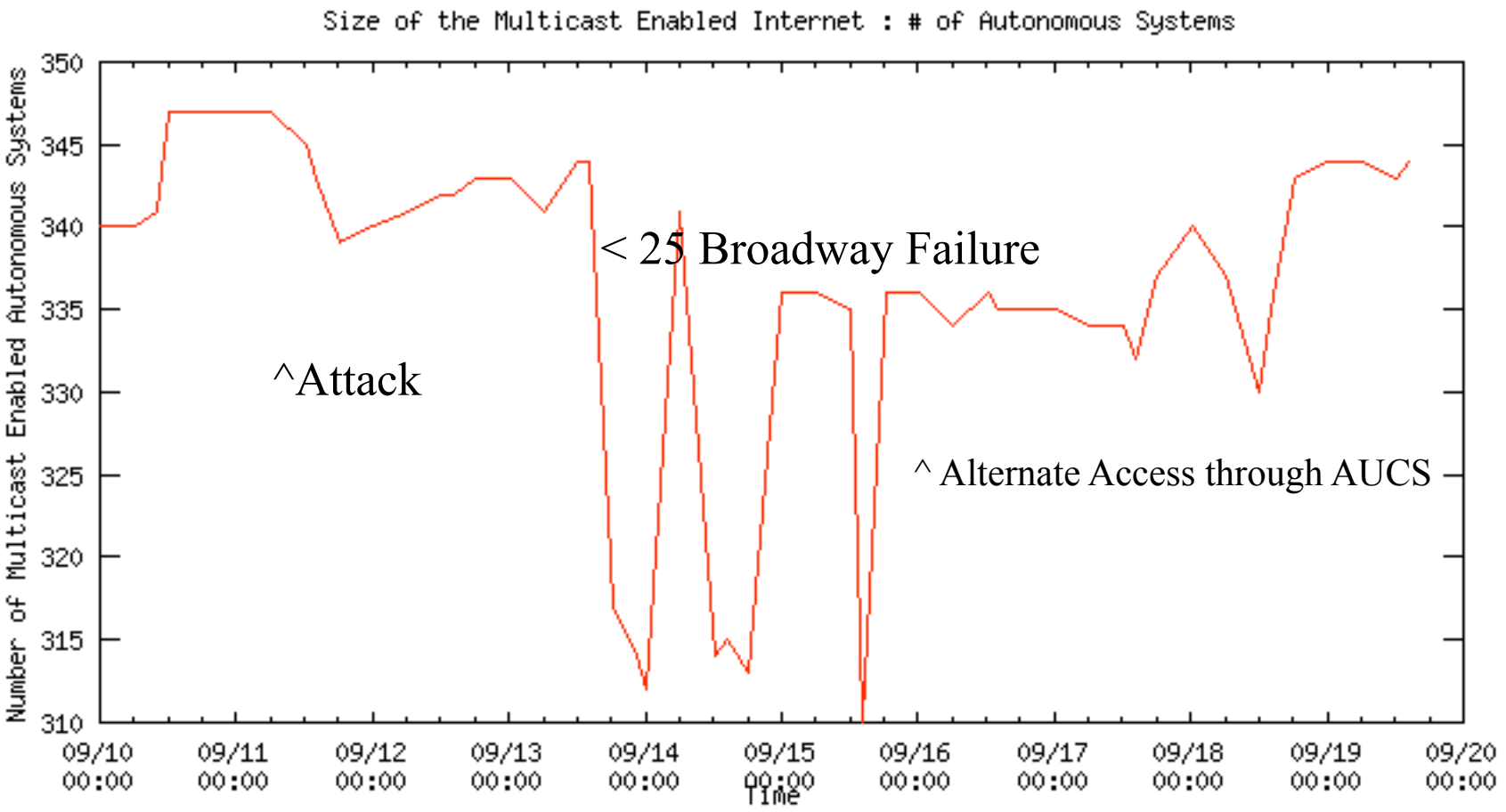
Note that extra traffic seems to be mostly US — also not all multicast traffic is visible to Mantra

Attack traffic spurt was so rapid and unusual that we first thought it was an MSDP storm!

The Stability of Multicast

- How did Multicast connectivity behave under the attack?
- Multicast Technologies monitors multicast connectivity as seen by MBGP from its AS.
- There were no apparent problems on 9/11.
- However, there were problems starting on 9/13 when the backup power for 25 Broadway went down.
- Connectivity suffered from this.

Multicast As the Generators Ran Out…



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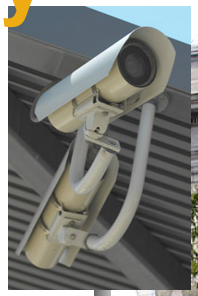
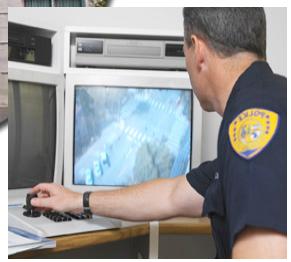
Surveillance

Securit y



School Security



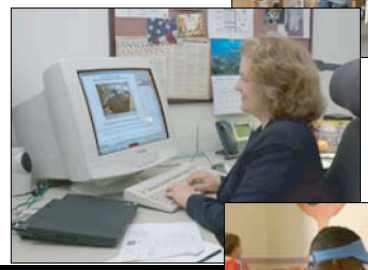
Bank security

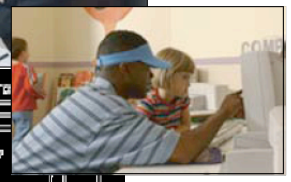
IP Cameras

CISCO IOS IP/MPLS MULTICAST

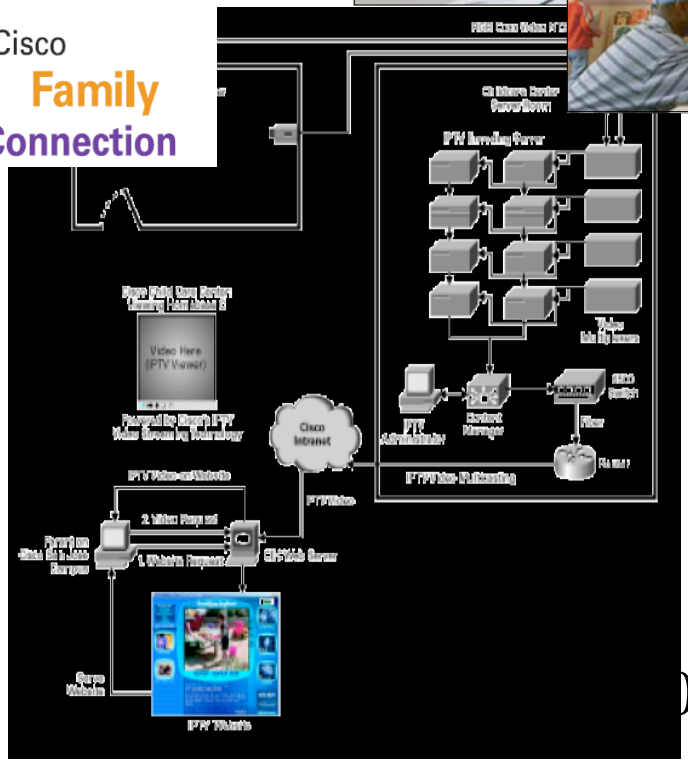
Retail behavior

Childcare





Cisco Family Connection



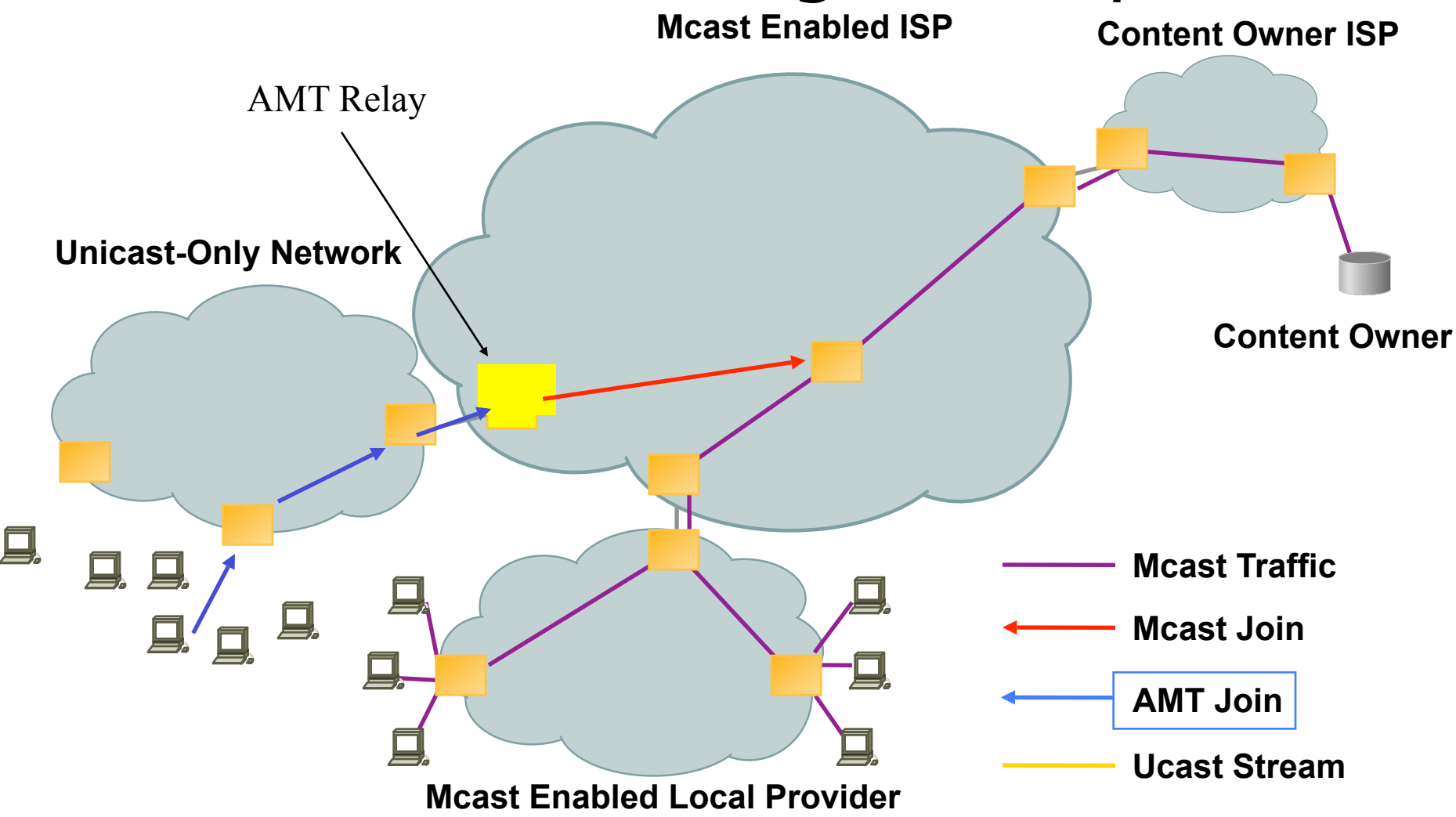
What about global deployment ?

- Most / all of the Multicast applications that are currently generating review are intended for use on the LAN, in an Enterprise WAN, or in some other restricted environment.
- What about global deployment ?
  - This was the original goal, but it seems to be slipping
  - SSM will help, as it is easier to deploy, but it will take years to reach full penetration
  - You can always use unicast, but the overhead this creates in many cases absorbs the savings from Multicast
- Is there a way to jump start the process ?

How to Fix this ?

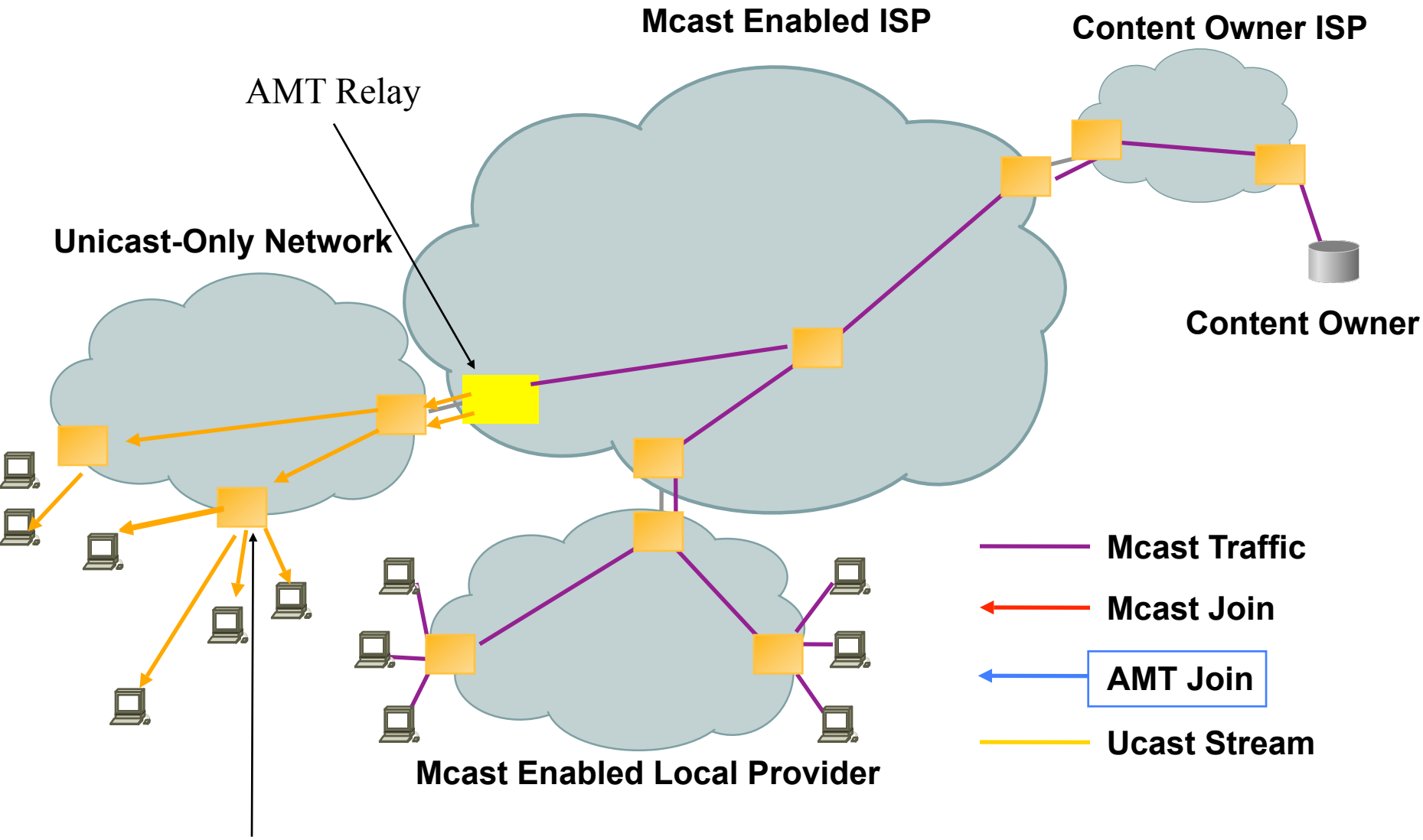
- Universal Deployment, of course !
- But another solution is Automatic Tunnels
  - This idea has been around for years
  - Basic idea is to equip edge routers with the ability to tunnel towards a source
  - SSM makes this much easier
    - You always know where the source is
    - It seems reasonable for the source, or its network and peers, to supply the missing bandwidth if multicast is not enabled.
- Current version is **Automatic Multicast without Explicit Tunnels (AMT)**
  - Encapsulated data with no point to point tunnels
  - For more info :
    - http://www.mountain2sea.com/amt/

AMT : Joining a Group



AMT Join is a UDP encapsulation of IGMPv3

AMT : Getting the Traffic



What is the status of AMT ?

- The Internet draft for AMT is on version 4
  - Hopefully, will last call soon
- There is code now working for
  - BSD Unix
  - Linux
  - Mac OS X
- Windows should be coming soon
- Need content providers to come on board.
  - Will also need players capable of dealing with IGMP v3

What about BiDir ?

- Bi-Dir currently can only be deployed within one domain.
- But in that case it can lead to considerable savings in router state
  - Number of paths is order N, not order N^2
  - This is ideal for cases with many sources, all of home have to “hear” each other
    - One (literal) example is Cisco’s “Hoot and Holler’ push to talk system.

Hoot and Holler

Reliable Transport of TDM Audio over Packet Networks

Traditional Hoot and Holler:

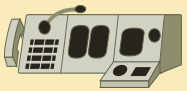
- Broadcast audio network
- Specialized analog 4-wire phones (Hoot phones) and digital turrets
- Used in brokerage houses, publishing / media companies, mass transit

Cisco IP Multicast Value:

1. Eliminate expensive leased-lines by enabling customers to run hoot applications on data networks
2. Continue to use existing Hoot and Holler end user equipment
3. Enable future applications such as IP phones, IP turrets, and multicast clients

Circuit-switched Hoot & Holler Devices

Turrets

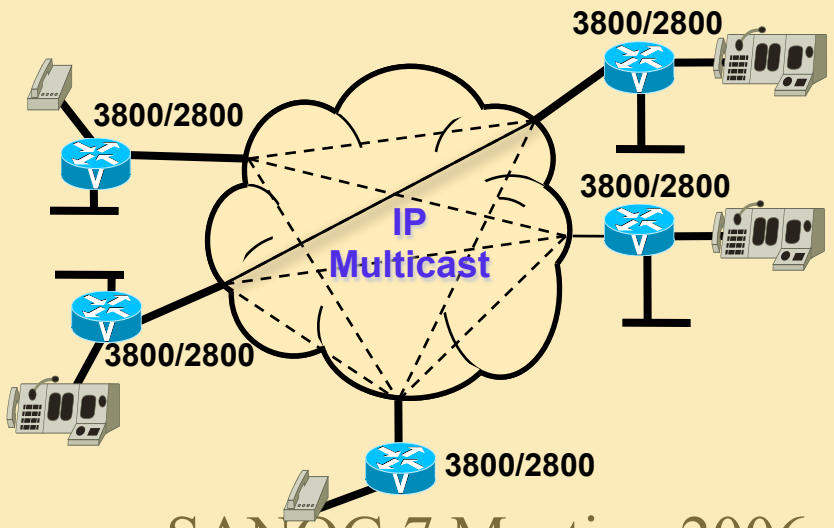


Hoot Phones

Cisco Multi-Service Network

Cisco VoIP, IP Multicast & Audio Mixing

Cisco Hoot and Holler over IP



Multicast-Only Solution

- Successful business models will bring more content
- Unicast edge networks are only pain-point
  - Upgrade or die.
- It's coming...
  - Many proposals
  - Many players
  - Lowest pain-to-deployment may (should) win

Multicast Myths

- "It's too hard."
  - Not really.
  - It just hasn't been a requirement (yet) for many people
- "If it hasn't caught on yet, it never will."
  - It's unfortunately been an all-or-nothing solution
  - Multicast needs an mcast-to-ucast transition technology
- Provider – "If multicast catches on, my customers will stop buying big circuits."
  - WRONG!
- Vendor – "If multicast catches on, no one will need big routers and high-speed interfaces."
  - WRONG!

How Do ISPs Make Money from Multicast ?

- By offering as a value-added part of their basic service.
- Enterprise customers, in particular, will want and need multicast to extend their internal video and data delivery to remote locations.
- Multicast should also be part of every broadband consumer rollout.
  - Multicast enabled consumers will have access to more content.

What are the Costs of Migrating to Multicast ?

- New equipment costs are usually minimal.
  - If you can run IOS 11 on your Cisco routers, you can support multicast.
  - Junipers all support multicast.
  - Most switches now support IGMP snooping. This is necessary for bridged Ethernet networks, which is common in the Enterprise.
    - Need more IPMP v3 snooping switches !

Other Costs of Migrating to Multicast

- Peering Costs
  - Sprint and Verio include multicast peering at no extra costs, as do a number of ISP's.
    - Multicast Peering is available at the LINX in London, and also in Amsterdam.
    - All GigaPoPs offer multicast exchanges / peering.
  - It can be a problem, though, if none of your peers support multicast.
  - On the other hand, offering multicast peering can attract customers.

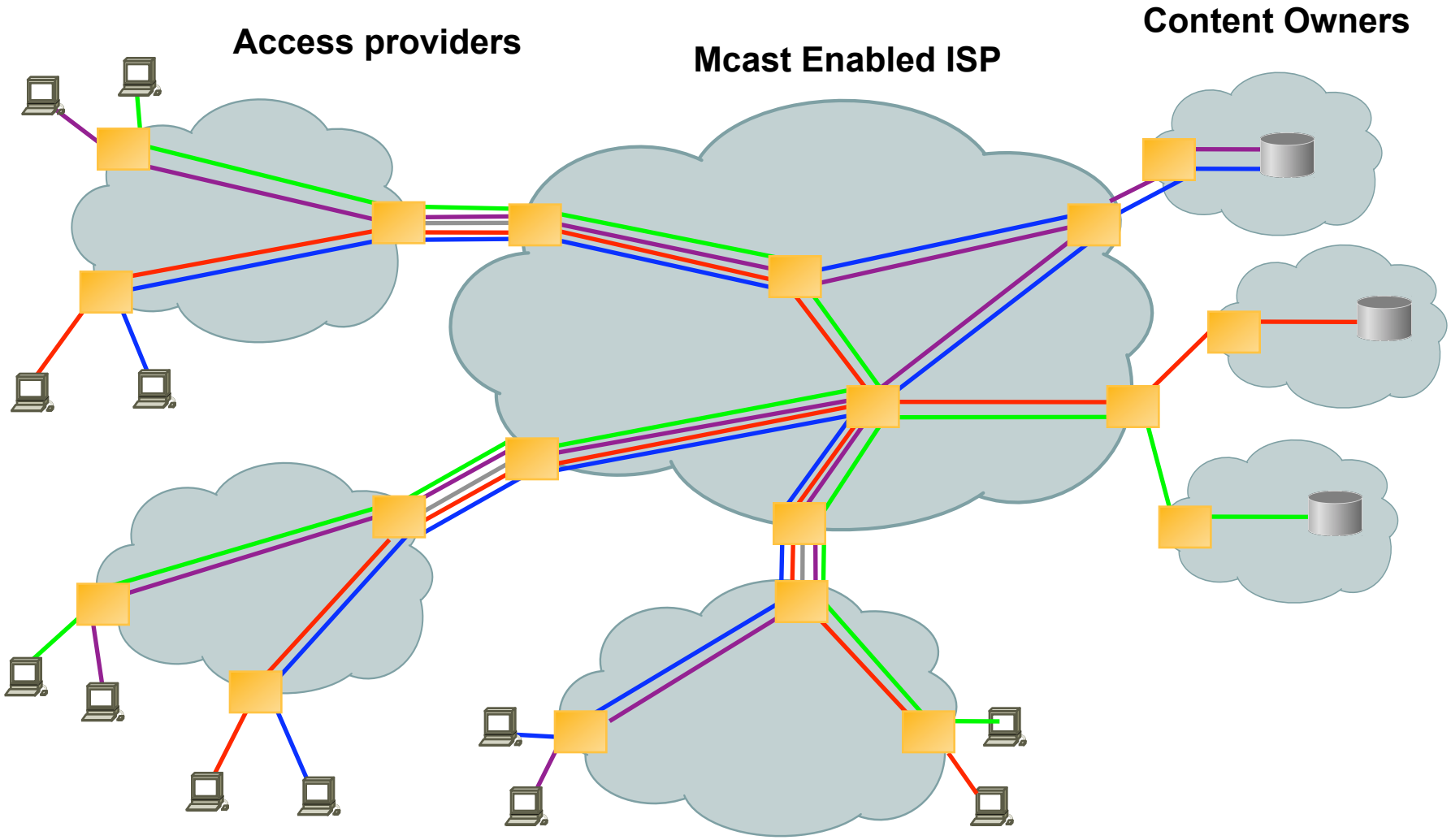
Multicast Debugging Costs

- Multicast Debugging
  - Multicast debugging can be tedious.
  - Setting it up is easy. But, what if it doesn't work ?
  - Most companies do not provide good multicast technical support.
  - You may want to contract for network assistance.

Conclusions

- I have tried to give some flavor of the solutions in place today using Multicast
  - People do make money from Multicast
  - Multicast is becoming widely used behind the scenes
  - The Question is, will it ever come back out into the open ?
- Multicast research and development continues, and there are new applications on the horizon that I didn't have time to cover.
  - Multicast VPN's and the use of Multicast with MPLS are good examples.

When the World Deploys Multicast

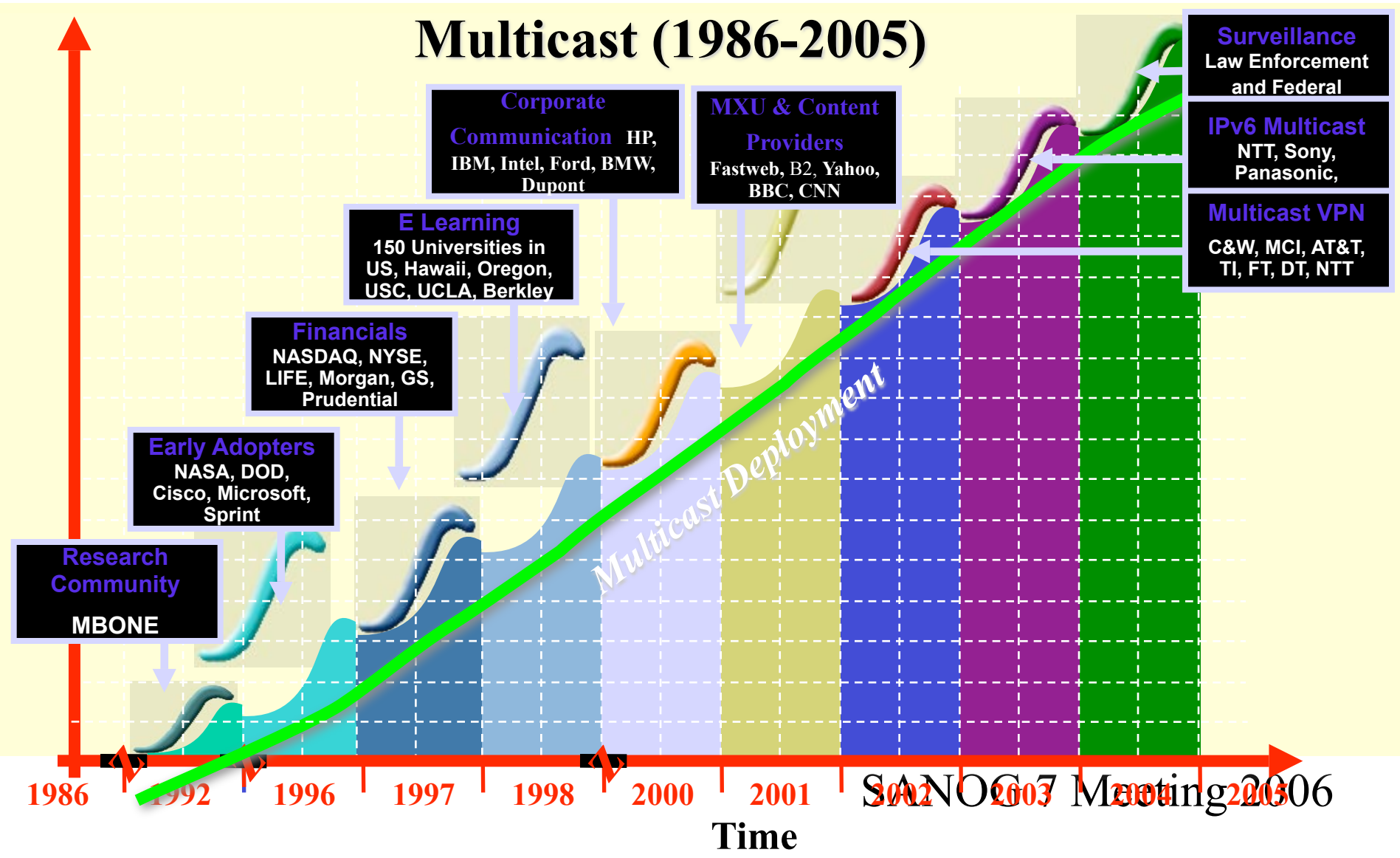


When the World Deploys Multicast

- A successful multicast business model makes IP profitable for content owners
  - Success brings MORE content
- Access networks of tomorrow look like provider networks of today
  - Few large circuits upstream, many small circuits downstream
- Provider revenue model gets flopped
  - Few small circuits from content networks, many large circuits down to access networks

Multicast Adoption (Cisco's Version)

Past, Present & Future



Information Online

- http://multicast.internet2.edu
  especially the tutorial-style paper at http://multicast.internet2.edu/almeroth.pdf
- http://dast.nlanr.net/Projects/Beacon/
- www.multicasttech.com/faq/multicast_faq.html
  and
  www.multicasttech.com/status/
- Greg Shepherd's multicast site: www.shepfarm.com/multicast/
- http://www.cisco.com/en/US/tech/tk828/tsd_technology_support_protocol_home.html and ftp://ftpeng.cisco.com/ipmulticast.html
- www.sprint.net/multicast/faq.html
- http://www.juniper.net/techpubs/software/junos/junos72/swconfig72-multicast/html/ip-multicast-overview.html