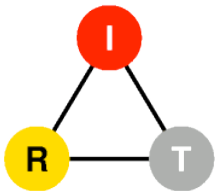


Encouraging bandwidth efficiency for peer-to-peer applications

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May 28, 2008

P2Pi Workshop

Overview

- Video bandwidth consumption
- Cost of providing video content
- Economics
- Mechanisms
 - network topology indication
 - scavenger service
 - indication of charge
- Problem mainly of economics

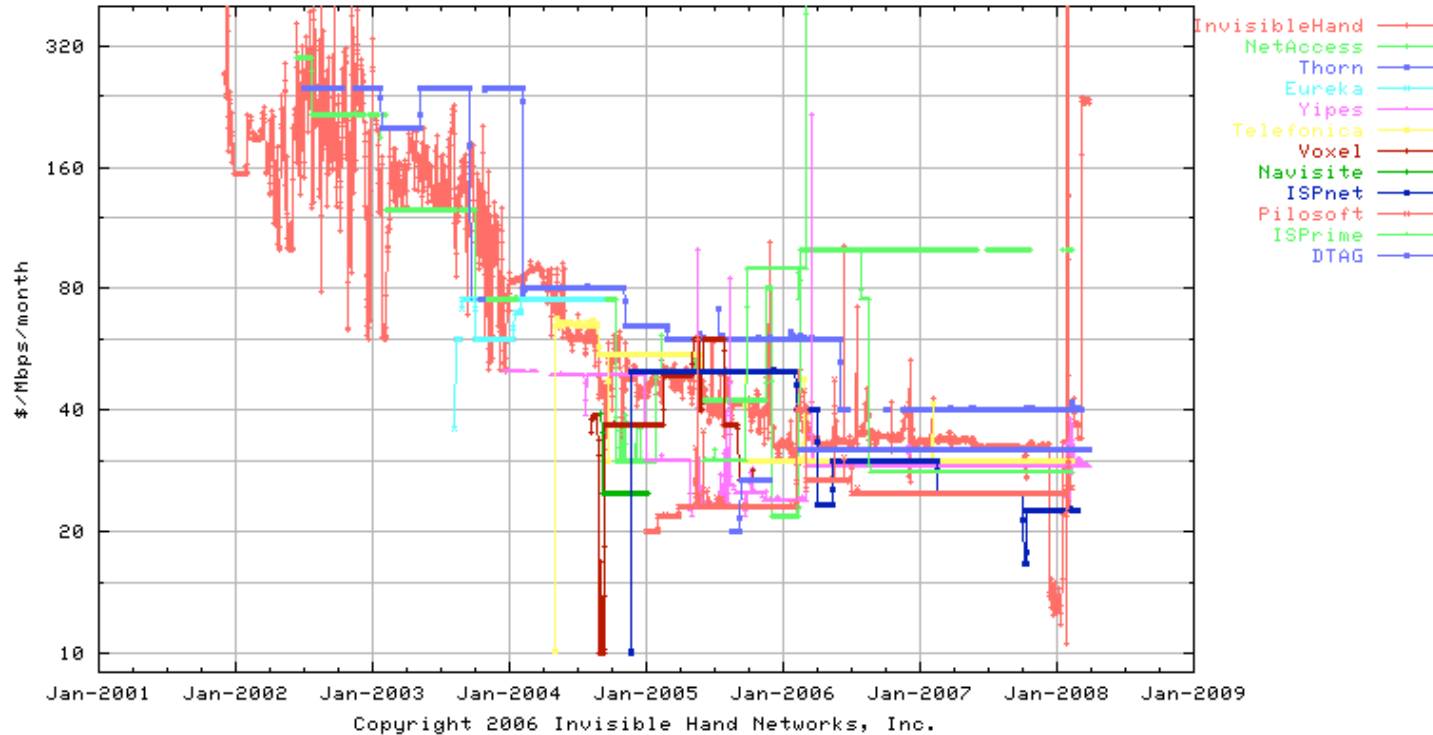
Bandwidth consumption

- 4 hours/day of TV @ 18 Mb/s HDTV \Rightarrow 972 GB/month
- Columbia University caps at 350 MB/hour \approx 252 GB/month

Economics of the eco system

- Long term, minimize **overall** cost of content delivery
 - across end user, provider, ISP
 - thus, focusing only on efficiency of HTTP misses the complete story
- Components
 - media storage
 - media server bandwidth (can't serve whole ISP from one disk)
 - delivery bandwidth (upstream & downstream)
- Re-use of existing components vs. new components
 - e.g., end user DVR storage vs. dedicated cache servers
 - local bandwidth vs. wide-area bandwidth vs. content provider bandwidth
- Allow cost allocation
 - e.g., rentable caches --> both content provider and ISP benefit

Economics of bandwidth

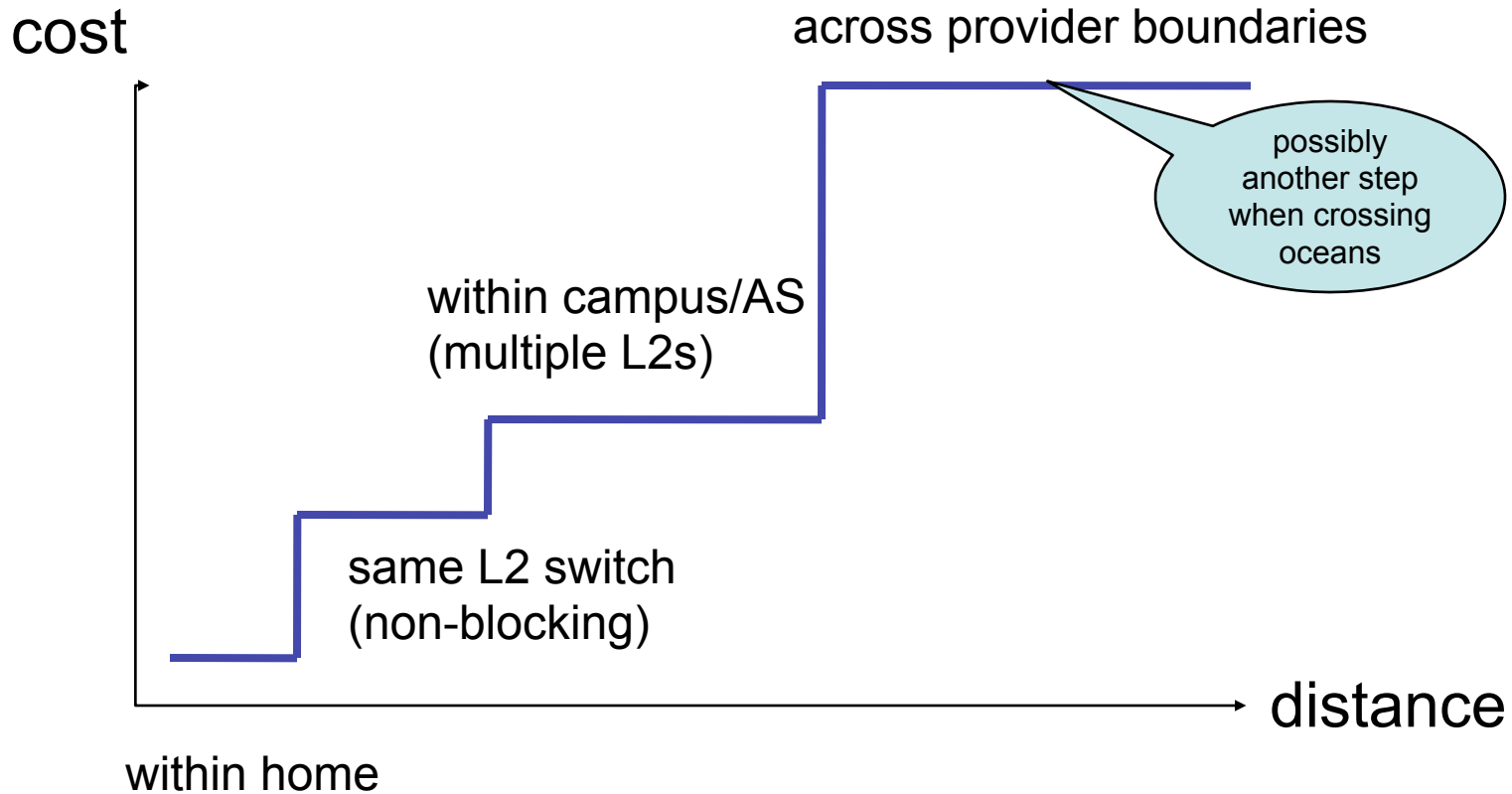


- Transit bandwidth \$40/Mb/s/month ~ \$0.125/GB
- US colocation providers charge \$0.30/GB to \$1.75/GB
 - CDNs: \$0.08 to \$0.19/GB

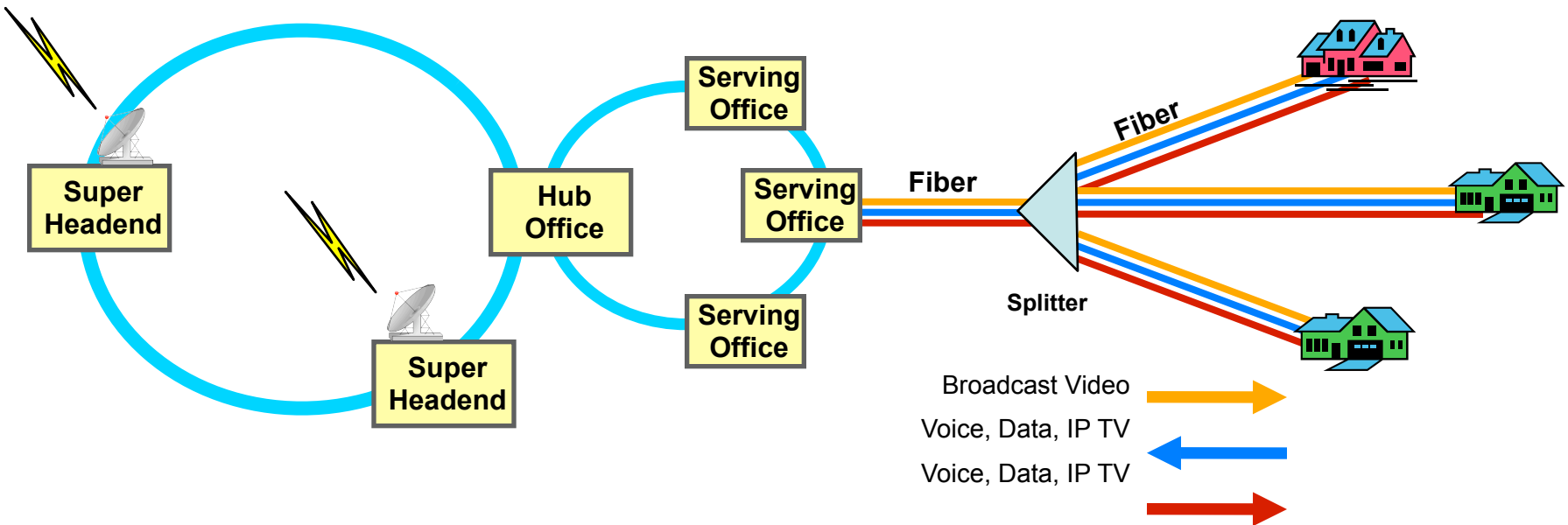
Cost of bandwidth

- Thus, 7 GB DVD → \$1.05
- HDTV viewing ~ \$120/month for WAN bandwidth
- Netflix postage cost: \$0.70 round-trip
- Typical PPV charges: \$4/movie (7 GB)
- Local bandwidth cost is amortization of infrastructure
 - driven by peak load, not average
- Asymmetric vs. symmetric networks

Cost for providing content



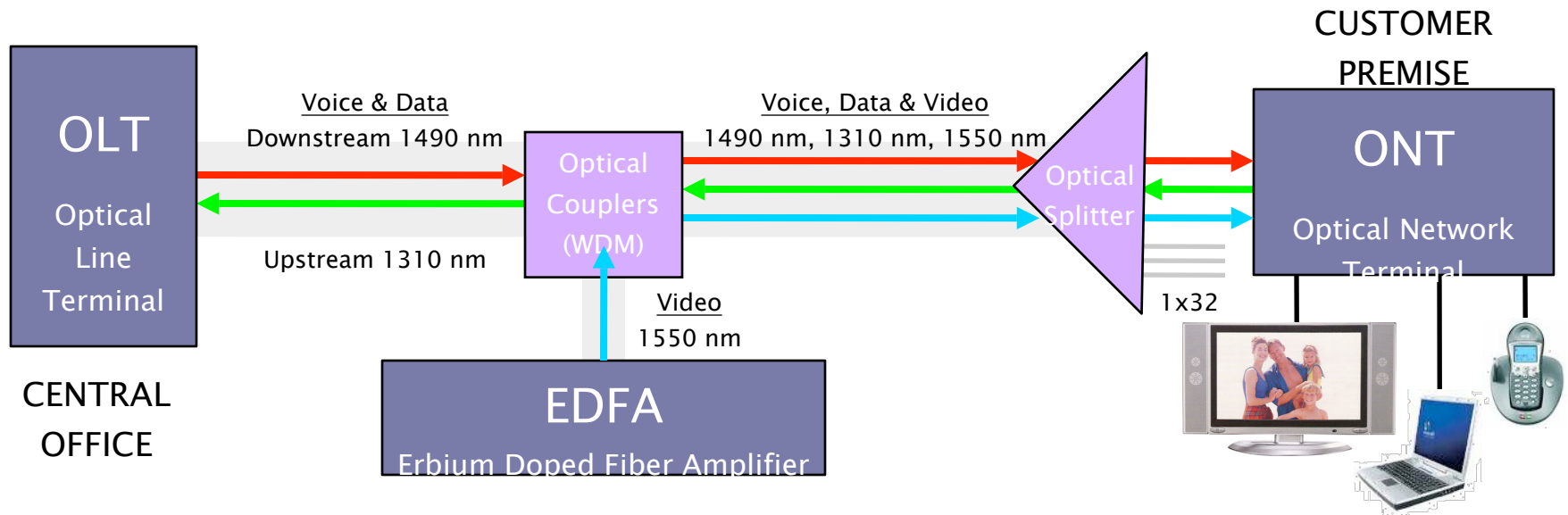
Example: FiOS TV architecture



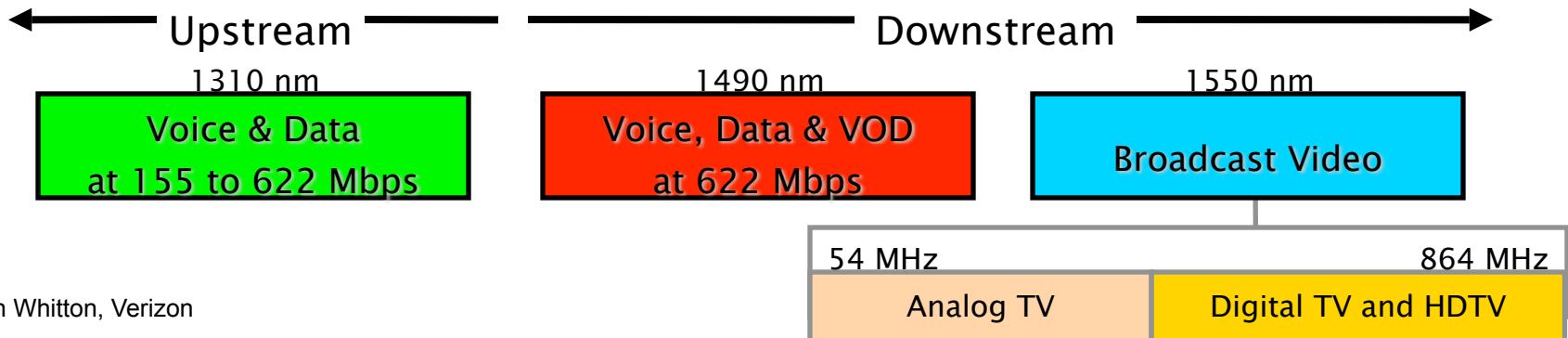
J. Savage (Telecom ThinkTank), Nov. 2006

- 2 national super headends
- 9 video hub offices
- 292 video serving offices

Verizon's FTTP Architecture



Bandwidth & Services



Brian Whitton, Verizon

May 28, 2008

P2Pi workshop

VoD requirements

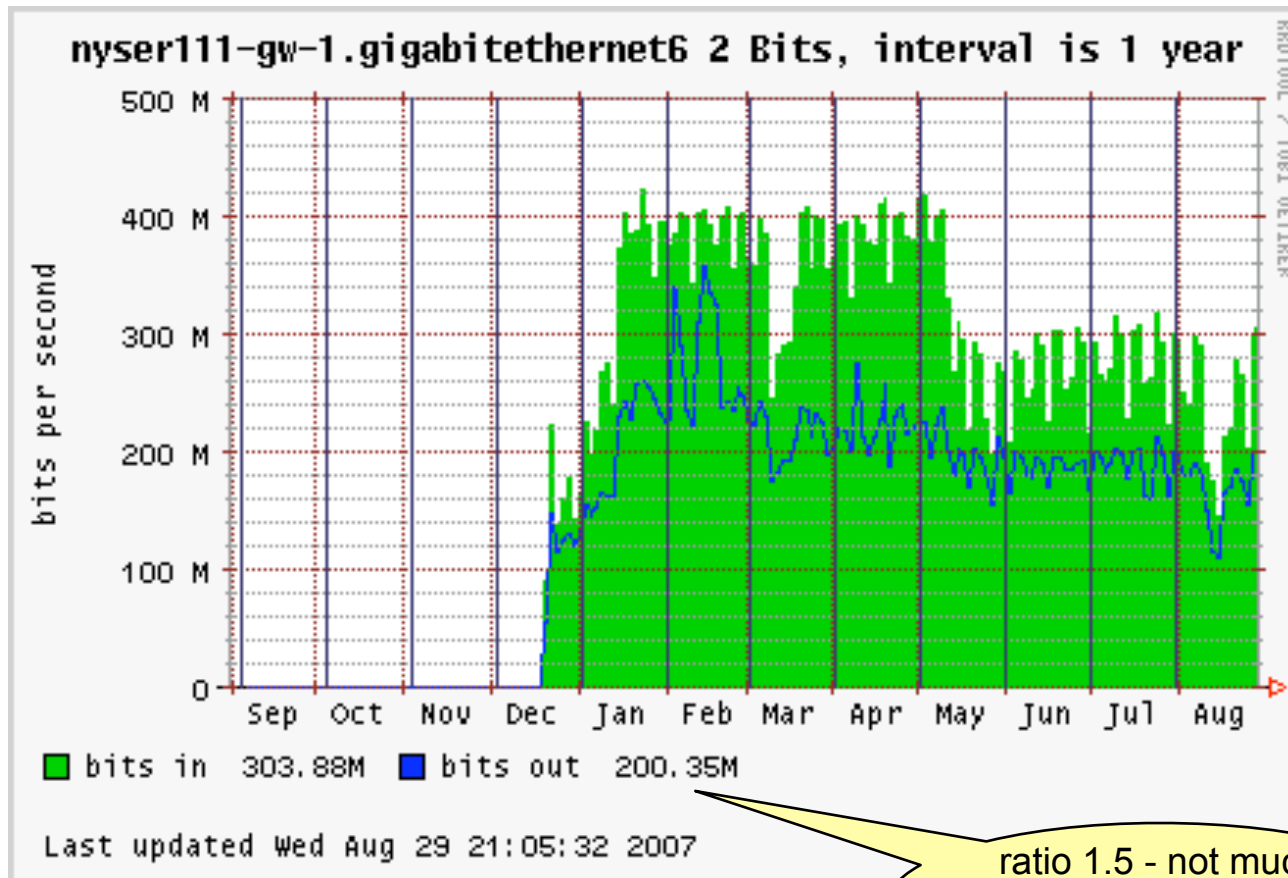
short clips < 10'
(long tail)

feature-length

- avoid Netflix queue
- avoid stocking 20,000 DVDs

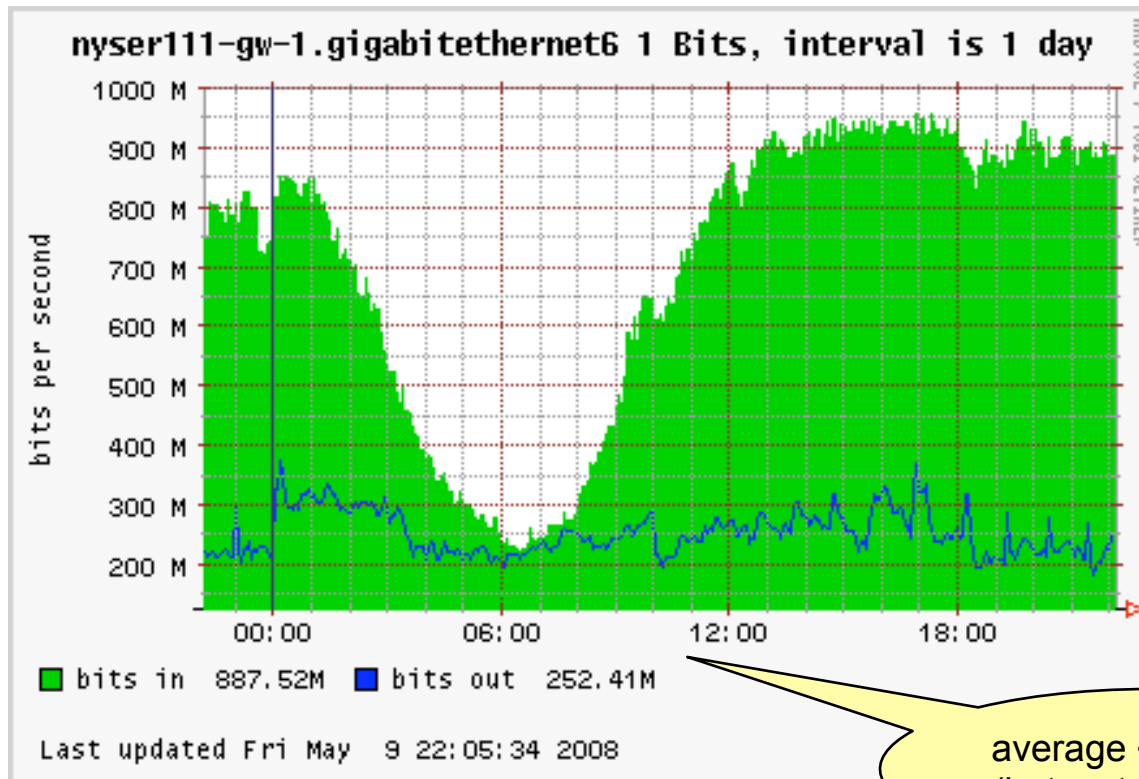
- Example: Superbad grossed \$33M during August 17 weekend (in US)
- = roughly 3M viewers
- = roughly 1% of US population
- \Rightarrow if VoD, each neighborhood has likely one copy
- 2 problems:
 - get initial copy to neighborhood
 - multicast, OTA
 - distribute in neighborhood
- only viable for top 1000 content
- need data on popularity distribution

Example: Columbia University



Diurnal variation

- Use off-hours to download content?



average ~ 0.8 peak
(but: saturated link)

Mechanisms

- Goals and requirements
 - application neutral: not just for BitTorrent or VoD
 - no lawyers
 - no saints \Rightarrow assume economically-rational actors
- Mechanisms
 - network proximity
 - real-time cost and charging information
 - common DiffServ code points
 - Scavenger service

Network topology discovery

- Incentive:
 - lower cost (later)
 - better performance - throughput and delay (e.g., VoIP relay node)
- Indications
 - AS number, ...
 - symmetric vs. asymmetric bandwidth
 - symmetric: local cache
 - asymmetric: cache in ISP network
 - see p4pnet.org
- Mechanisms
 - separate protocol (e.g., web service)
 - STUN
 - DHCP (requires NAT upgrade)

- Similar problems
 - discover network topology information server
 - STUN server
 - HELD server
 - LoST server
 - SIP local network configuration
- All likely provided by ISP
- Develop common set of discovery mechanisms
 - DHCP
 - DNS (SRV, NAPTR, ...)
 - anycast
 - ...

Scavenger service

- Explored by Internet2 QoS working group
- Less-than-best effort
 - lower scheduling priority than regular BE traffic
- Avoids self-interference
- Requires no admission control
- Improve RT service performance, but does not address wide-area cost issue
- Requires well-known (or discoverable) DS code point

Indication of charging

- If volume-based, need application-visible charging indication
 - “current cost of 1 GB to 128.59.16.1 is \$0.15”
 - “predicted cost in 3 hours is \$0.05”
 - “you have 47.5 GB of free local traffic left”
 - “you are currently in penalty box”
- May differ upstream vs. downstream
- Applications can then prefer local content
- or defer to later
 - “Do you want to watch the movie now (\$4) or wait until 10 pm (\$2.52)?”

DiffServ & Bandwidth charging

- Only two options:
 - limit supply of (high-priority) bandwidth (“1000 minutes of VoIP/month”) OR
 - charge for bandwidth
- Probably need to differentiate “local” and “long-distance” traffic
 - see “free local calls”
- Charging exposes user to risk
 - mis-behaving application or malware
 - need SE-Linux-like capability limitation
 - DoS attacks
 - need permission-based sending

Conclusion

- Simple network mechanisms needed
 - allow applications “to do the right thing”
 - prevent self-interference
 - work for both symmetric and asymmetric networks
 - incentive: better performance or lower cost
- Local network retrieval only works for short-tail content
 - what is the fraction of bandwidth for top-1000 content?