Internet Traffic Evolution 2007 - 2011

Craig Labovitz

April 6, 2011

Talk Outline

- **Four-year ongoing inter-domain traffic study**
- **Review of 2010 results** ***(NANOG / IETF / SIGCOMM)***
  - Methodology
- **Changing carrier / interconnect economics**
- **New 2011 Observations**
  - Transit / peering trends
  - Application / service trends
  - Security / Middle East
- **Ongoing research**
  - We could use your help

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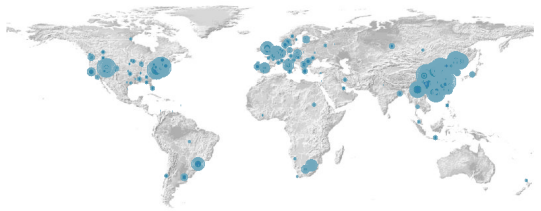
All data / results are preliminary!

This is a snapshot of ongoing analysis. Data has not been verified.
We're working on an academic paper for later this year.

About

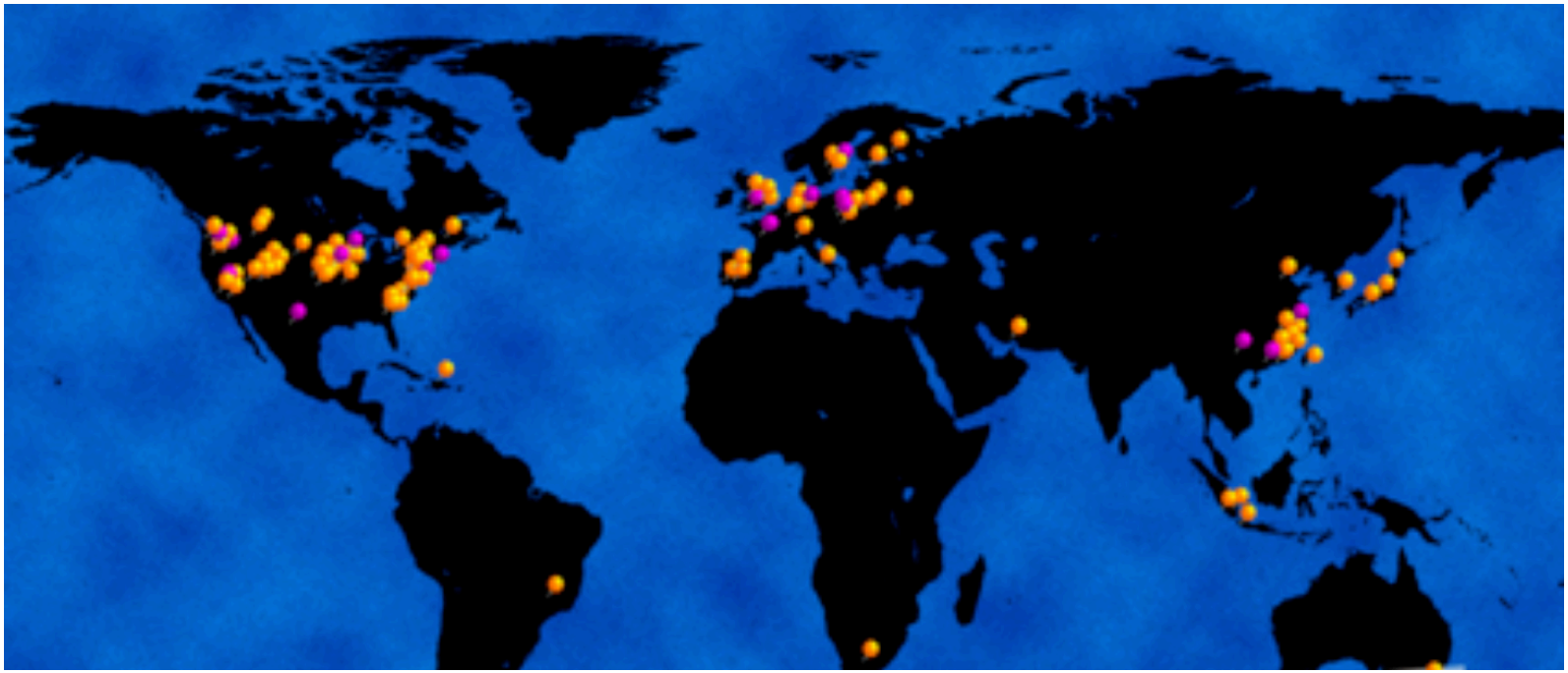


- **Arbor**
  - Leading vendor of carrier / IDC infrastructure security
  - Including DDoS defense, visibility, traffic engineering and more
  - Established company (founded 2000, acquired Tektronix 2010)
  - 400+ customers (90% tier1, 60% tier2)

- **Me**
  - Chief Scientist at Arbor Networks
  - Responsible technical direction, architecture, algorithms, code
  - Occasionally still do research (this talk)

Pointer to papers: http://www.monkey.org/~labovit/

Four Year Ongoing Research Study



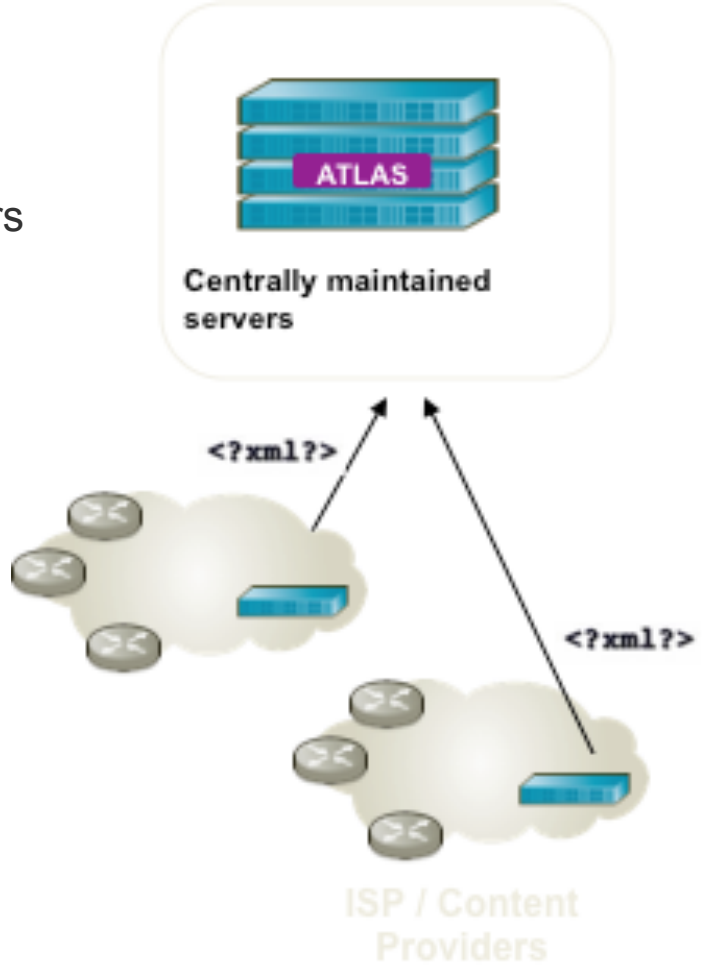
Graphic not an accurate representation of current ATLAS deployments

- **Leverage large, widely deployed commercial Internet monitoring infrastructure**
- **Global deployment across 110+ ISPs / Content Providers**
  - Coarse-grain real-time traffic engineering data
  - 4,000 backbone routers and 600,000 interfaces
  - Direct visibility into 25% of all Internet traffic

Study Details

- **Within a given ISP, commercial probe infrastructure**
  - Monitors Flow and routing across hundreds of routers
  - Probes topology aware of ISP, backbone and customer boundaries
  - Routers typically include most of peering / transit edge
  - Some deployments include portspan / inline appliances

- **Deployments send anonymous XML file to central servers**
  - Includes self-categorization of primary geographic region and type
  - Data includes coarse grain anonymized traffic engineering statistics

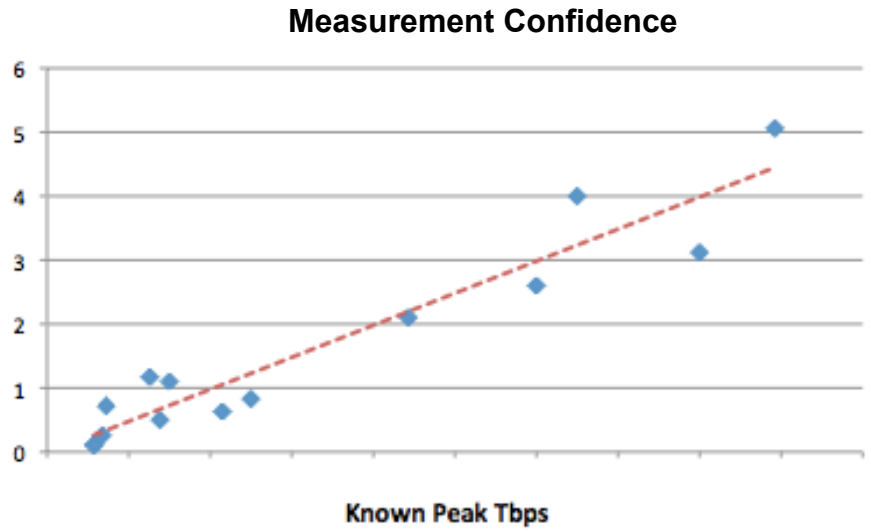


- **See research paper for more information**

C. Labovitz et al., “Internet Inter-Domain Traffic”, SIGCOMM 2010

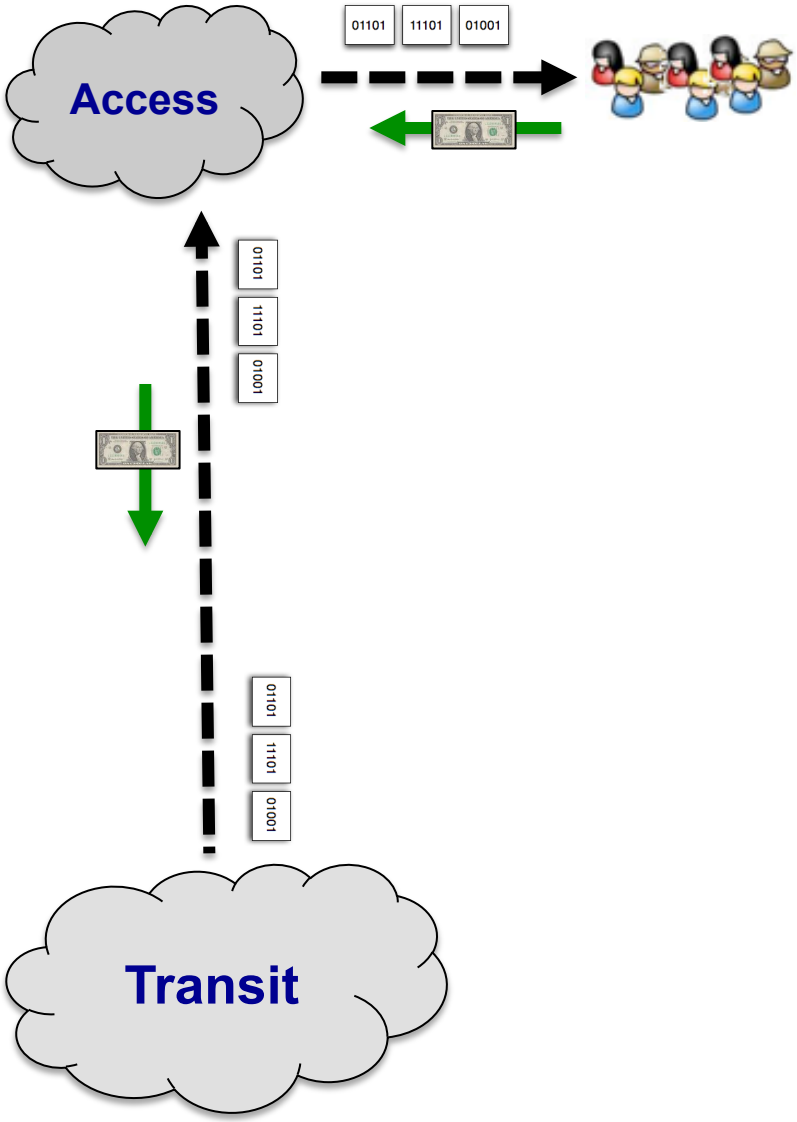
Validation

- **Inter-domain traffic volumes**
  - Estimate directly monitoring 25% all inter-domain traffic
  - Believe data representative of global inter-domain traffic
  - Validate 2007-2009 predictions based on data (using 12 known ISP traffic demands)
  - Key challenge is observer bias
  - 2009-2011 data is preliminary!



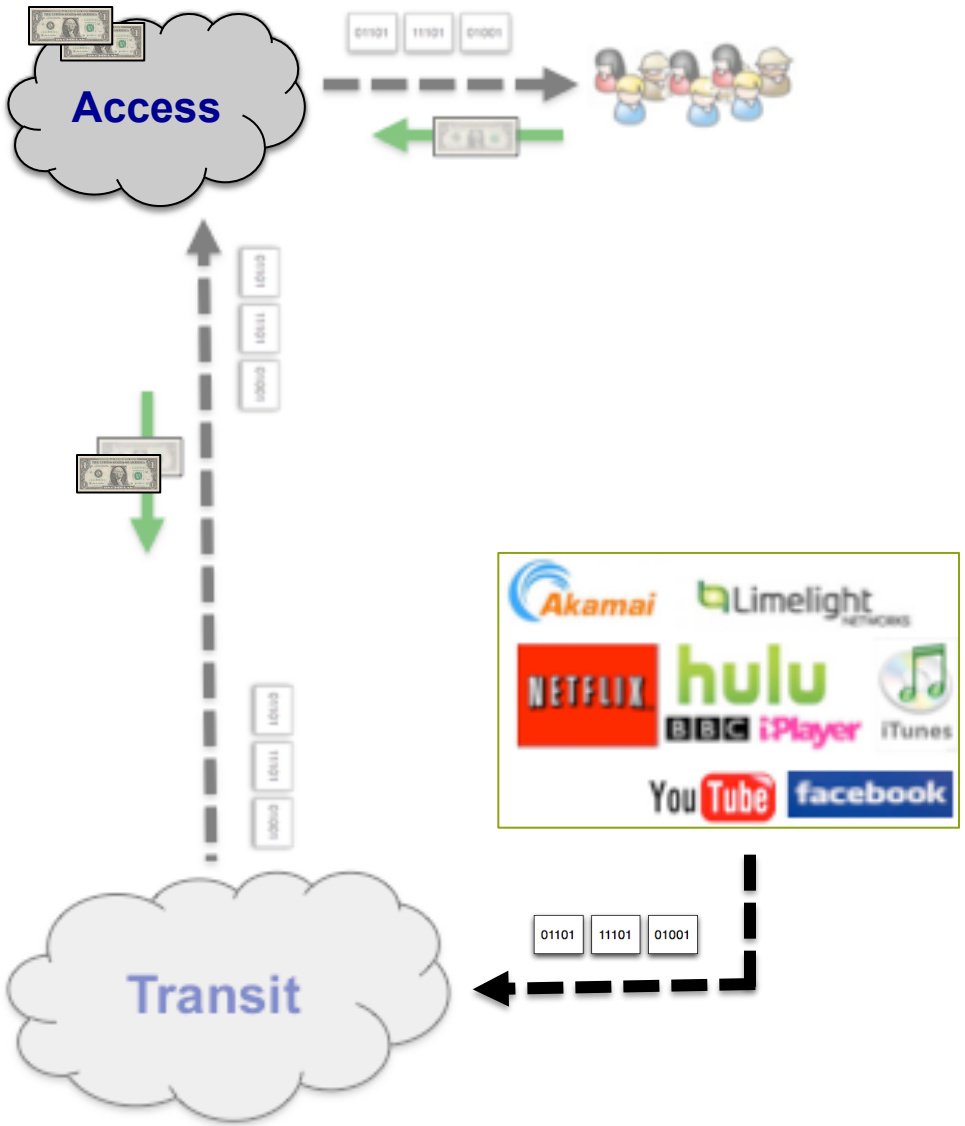
- **Does <u>NOT</u> measure**
  - Number of web hits, tweets, transactions, customers, etc.
  - Internal / private customer traffic (e.g. VPNs, IPTV)
  - ISP success nor profitability

Changing Economics



- **Access prices remain constant**
- **Bandwidth commoditized**
  - Maybe not last mile
  - Definitely not mobile

Changing Economics



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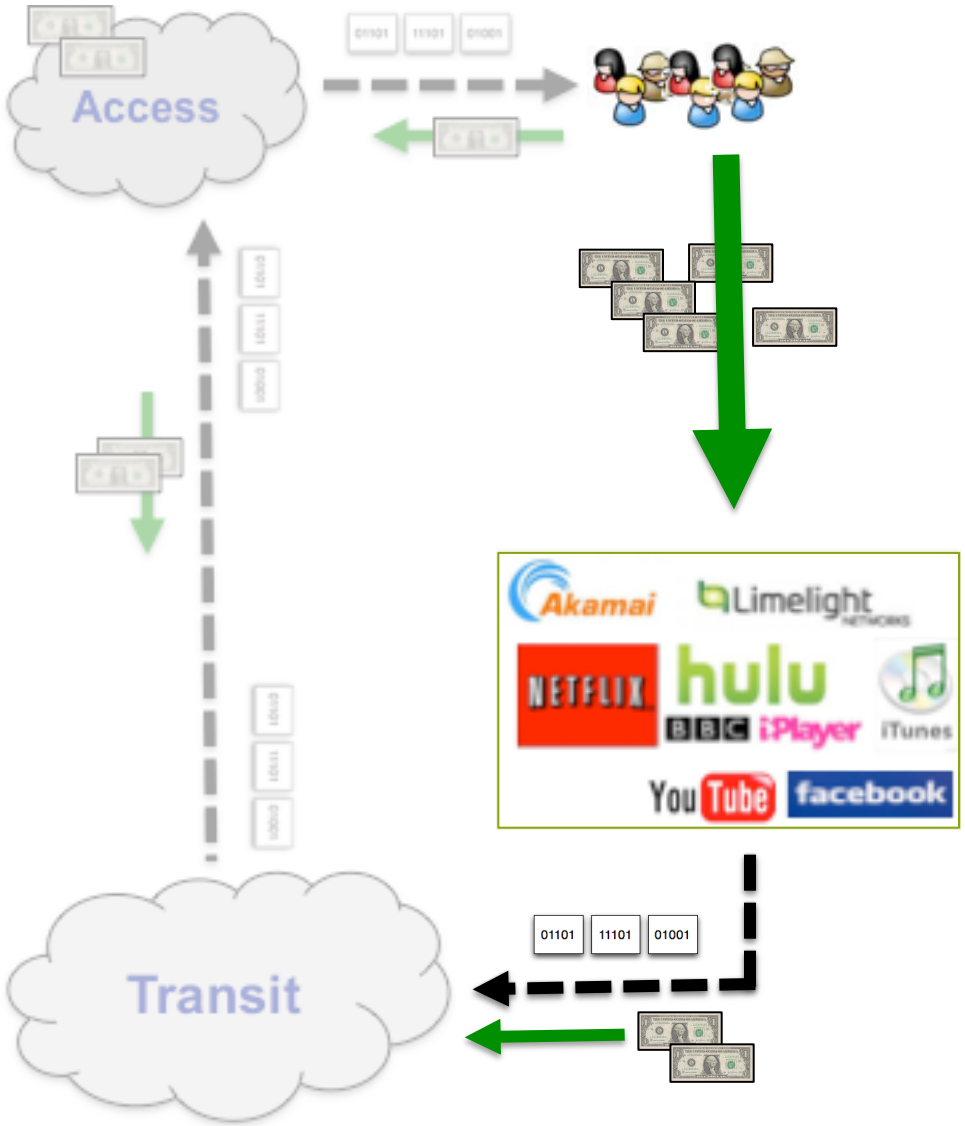

- **Access prices remain constant**
- **Bandwidth commoditized**
  - Maybe not last mile
  - Definitely not mobile
- **Increased infrastructure cost**
  - Including transit / ports
- **Billions in "cloud" revenue**
  - But not always for carriers
  - Pie remains same size
  - Or significant new consumer / advertisement spend
- **Carrier Competition**
  - Compete on price
  - Preserve subscribers / ARPU
  - Find new revenue

Market

- Commoditization / Consolidation
- Disintermediation
- Cloud / Service Components
- HD Video

Market -> Infrastructure Changes

- Commoditization / Consolidation
- Disintermediation
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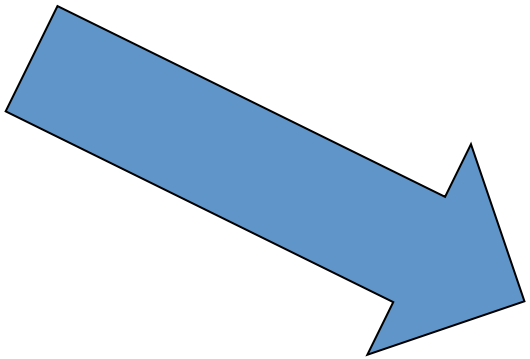
- HD Video



Exchange point selection
Changes in network design
New Commercial strategies
Changes in Peering / Transit
New Internet topology

Top Ten Providers 2007 - 2010

2007

Rank	Name	%
1	ISP A	5.77
2	ISP B	4.55
3	ISP C	3.35
4	ISP D	3.20
5	ISP E	2.60
6	ISP F	2.77
7	ISP G	2.24
8	ISP H	1.82
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Top ten grouped ASN as a weighted average percentage of all Internet traffic. Based on daily In and Out average inter-domain traffic to each ASN group from each of the 110 providers participating in study.

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Matches Wikipedia 'Tier1'

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5	ISP H	3.22
6	Comcast	3.12
7	ISP D	3.08
8	ISP E	2.32
9	ISP C	2.05
10	ISP G	1.89

Content and consumer provider join ranks of largest transit providers.

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Top ten account contribution grows from 30-40%

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Google alone gains two percentage points between 2009 and 2010
CDN growth continues

Traffic Volumes

- **Aggregate estimated inter-domain Internet**

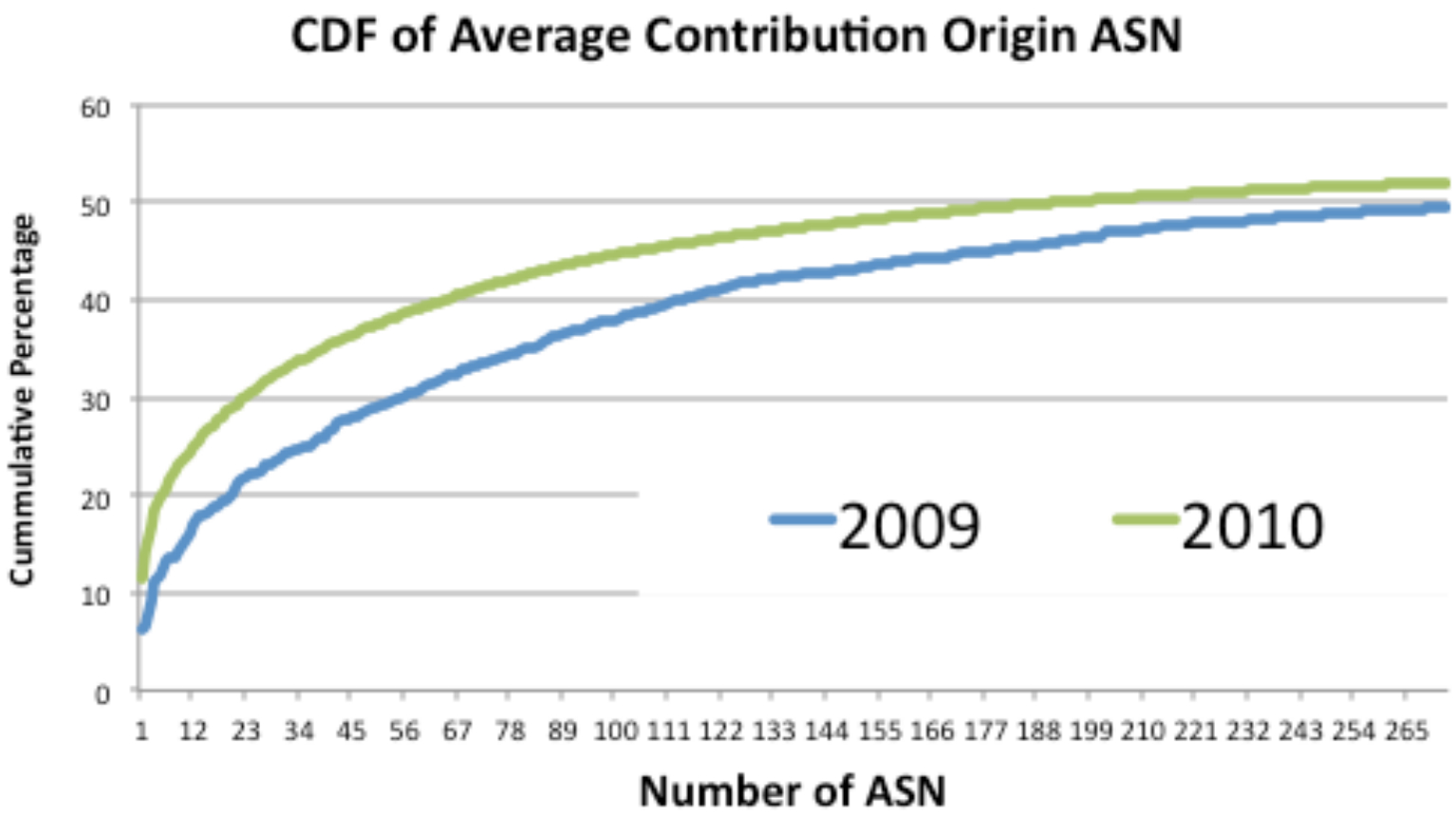
90-110 Tbps

(as of February 2011)

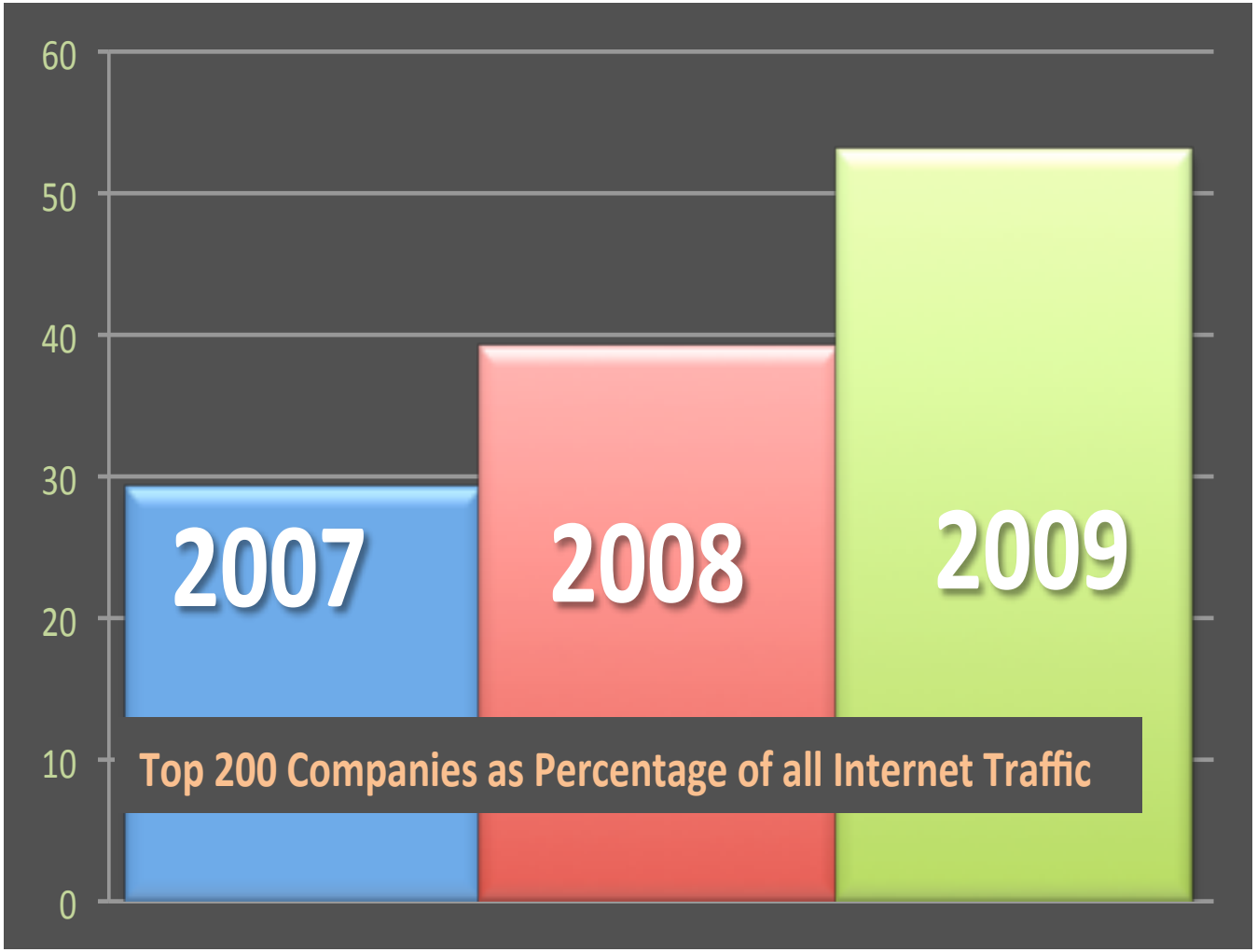
- **Representative traffic volumes**
  - Global transit 5 -15 Tbps
  - Large cable 2 - 5 Tbps
  - PTT 0.5 - 3 Tbps
  - Large CDN 0.5 - 3 Tbps
  - Regional / Tier2 0 - 0.5 Tbps

- **Growing 40-45% per year**

ASN Consolidation



ASN Traffic Consolidation



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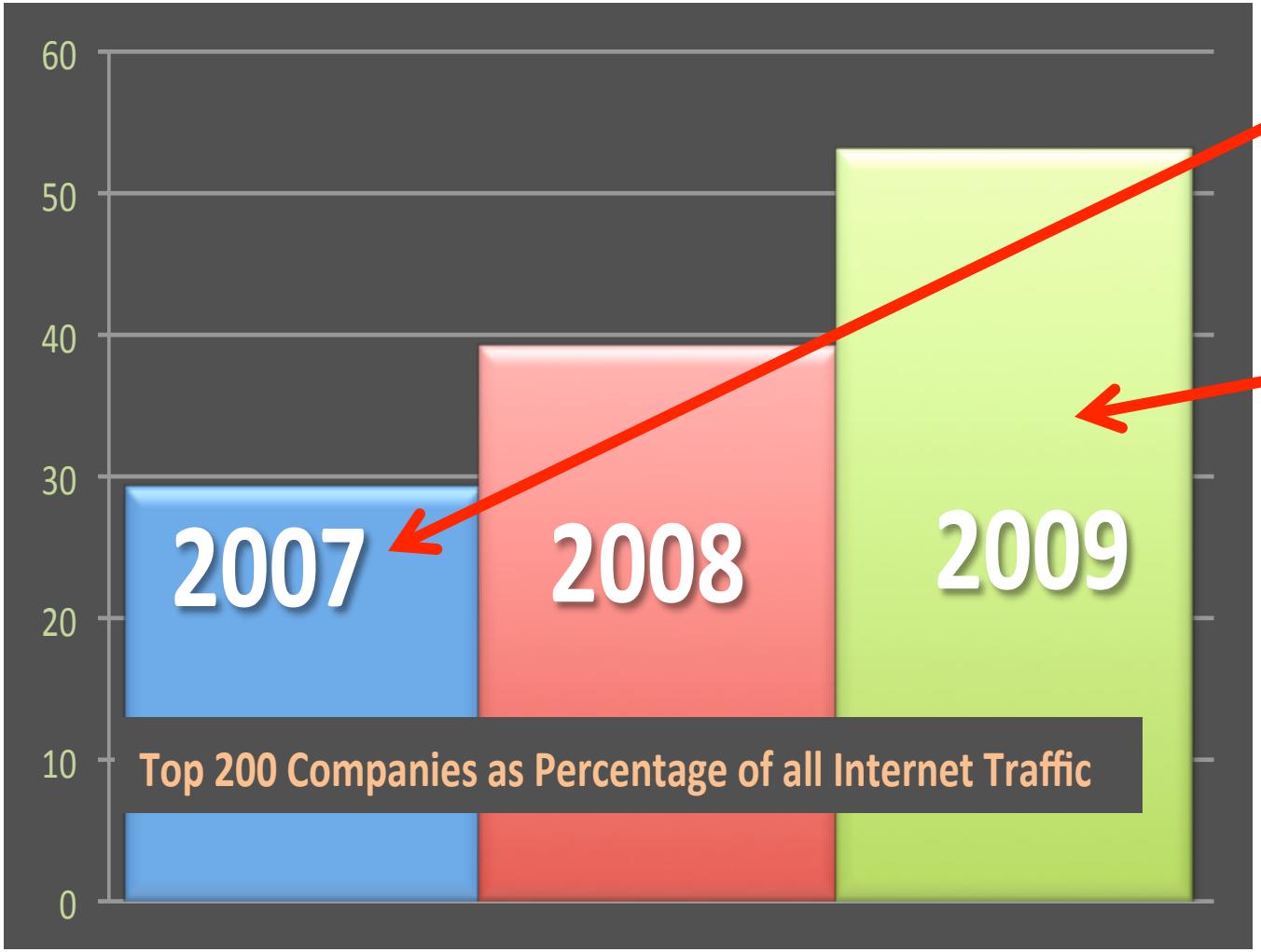
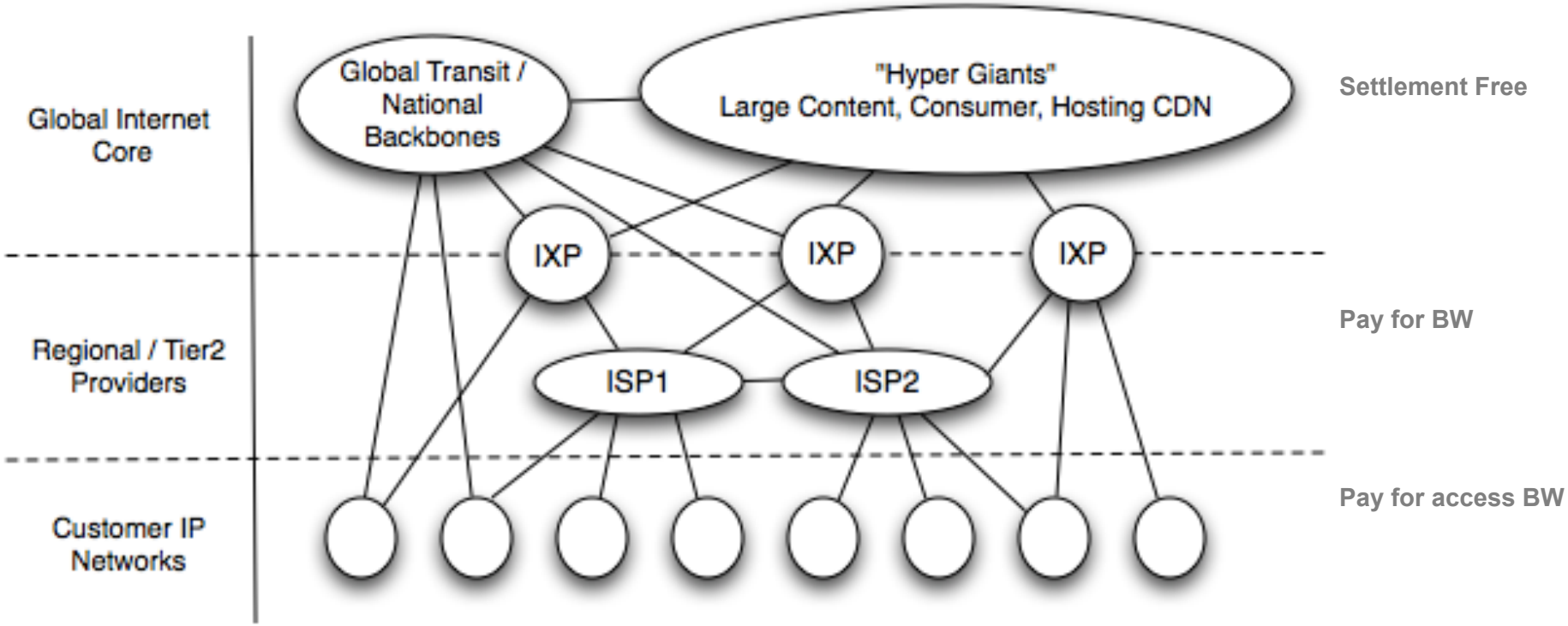


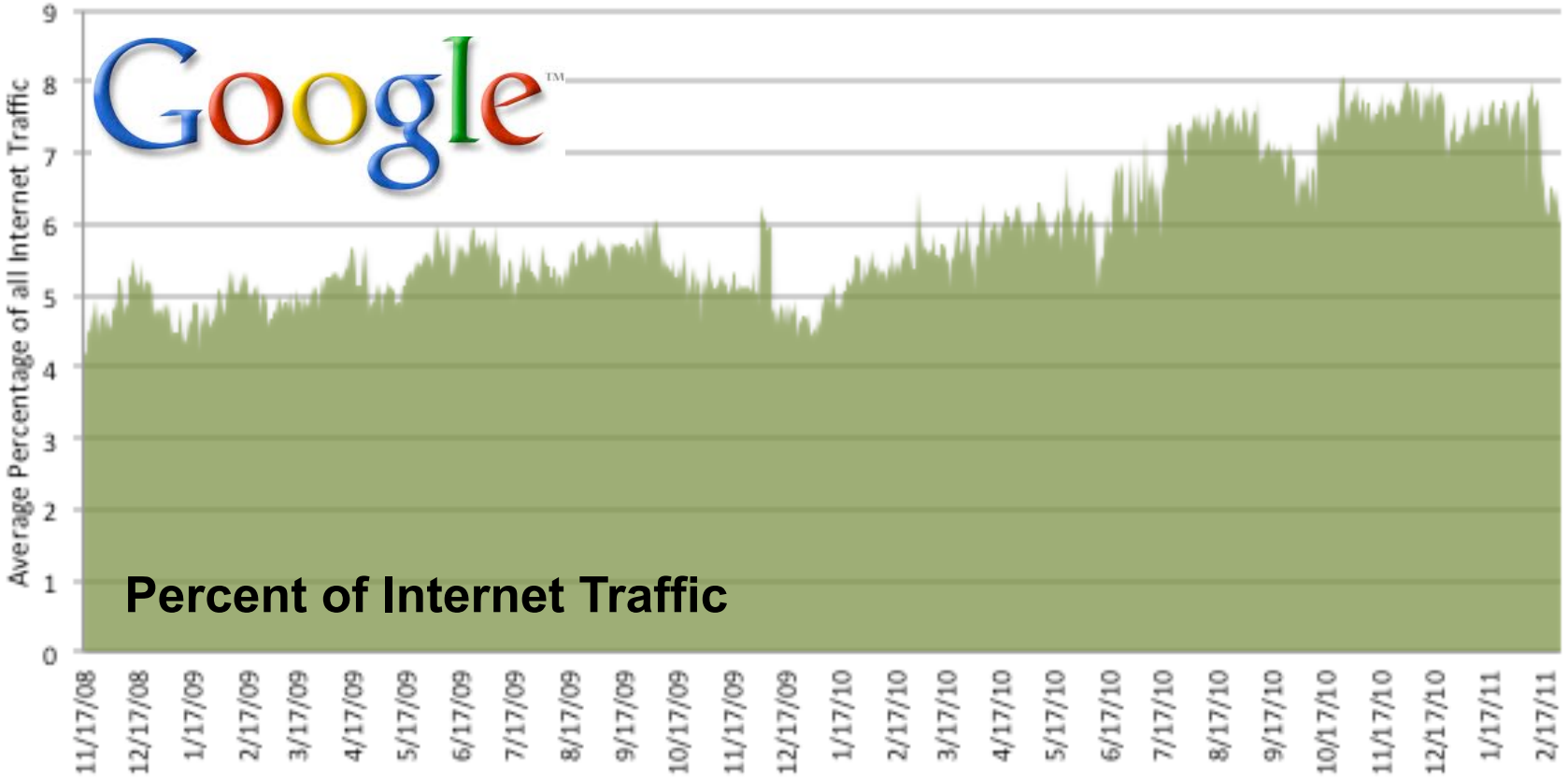
- In 2007, top 200 grouped ASN generate **30%** of all Internet traffic
- In 2009, top 200 grouped ASN generate **53%**

The New Internet



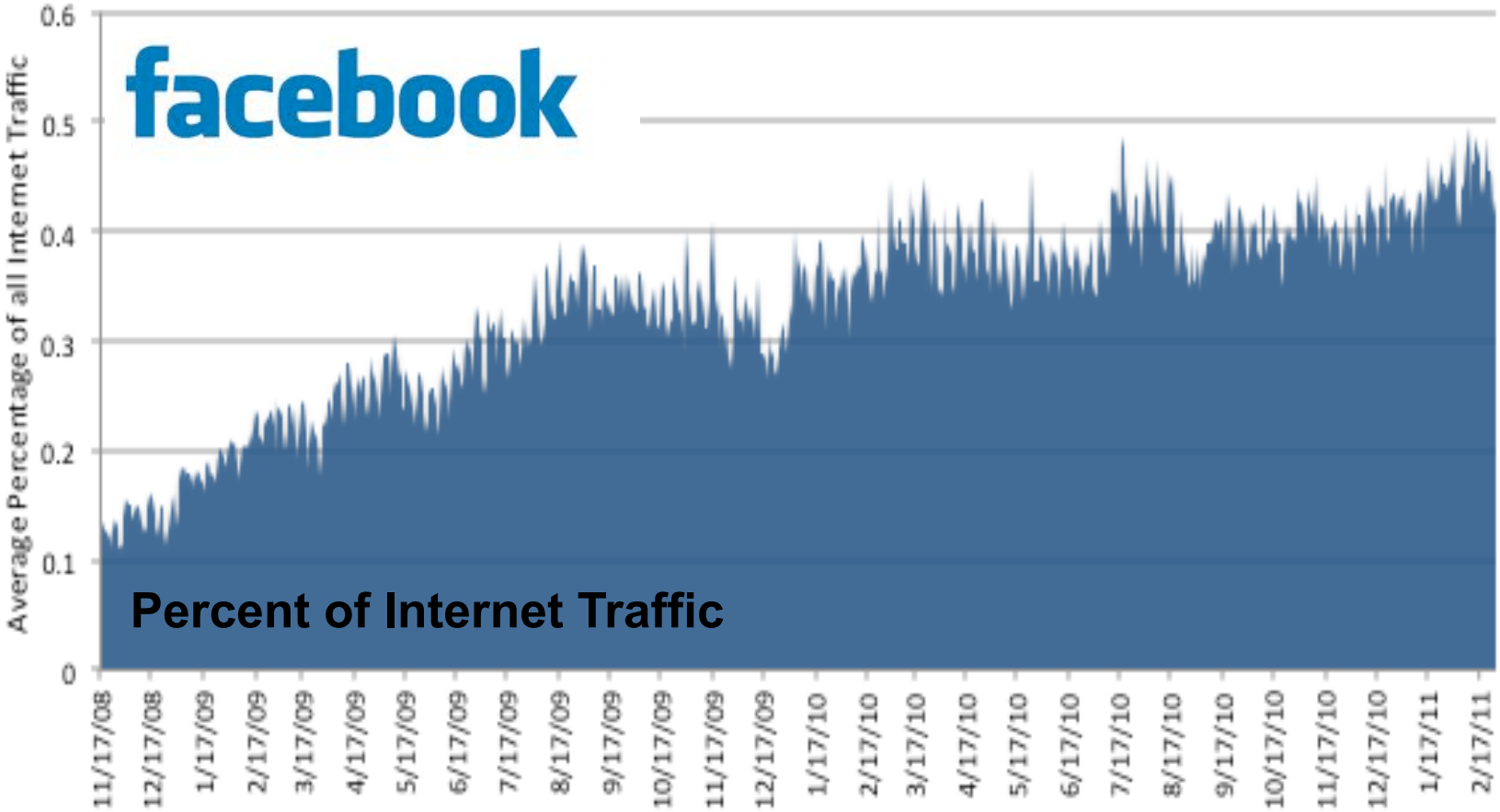
- Flatter and much more densely interconnected Internet
- Disintermediation between content and eyeball networks
- Complex commercial models between content, consumer and transit

“Hyper Giants”



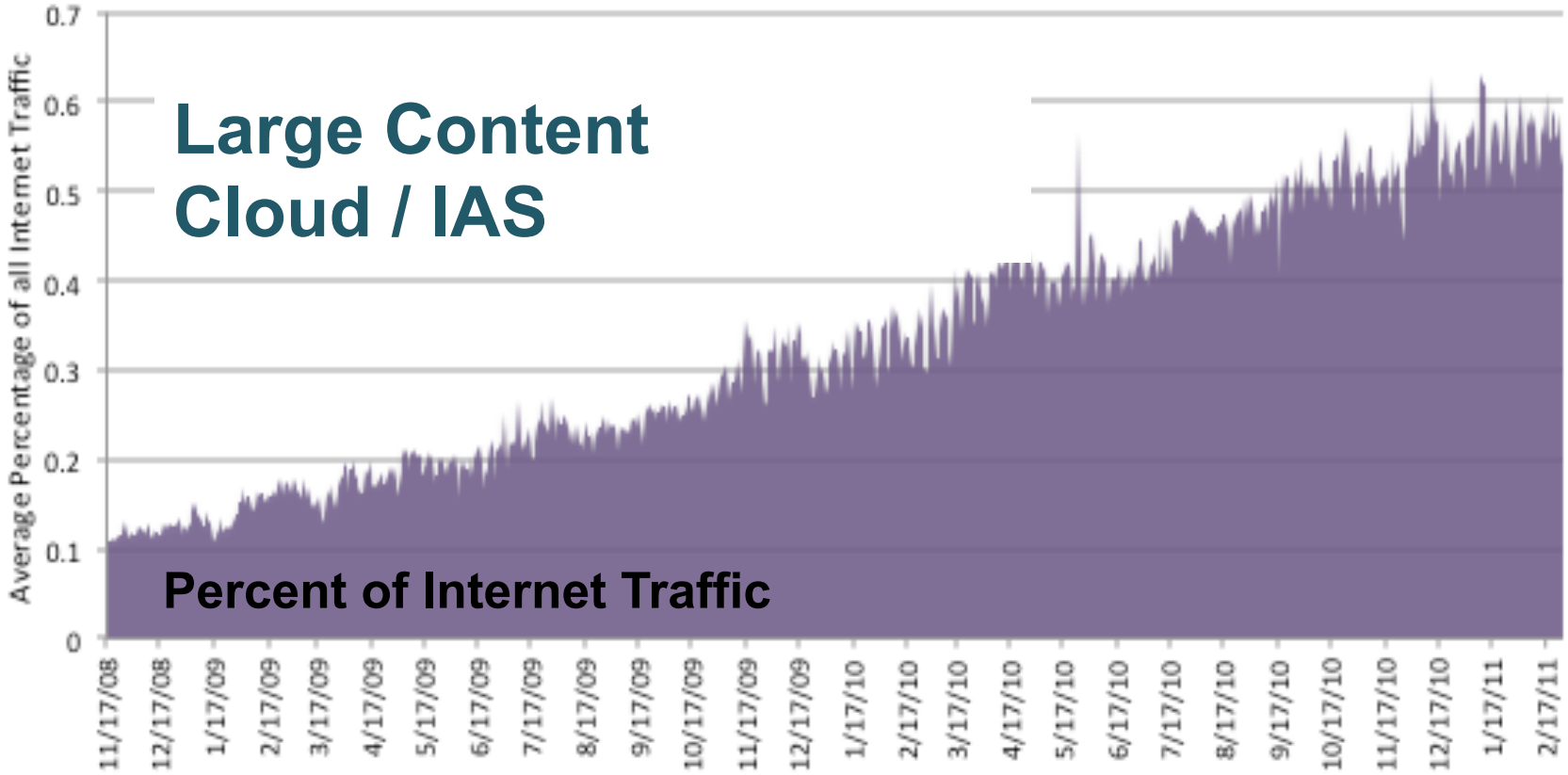
Since 2007, YouTube / Google has grown to more than a weighted average 7%percent of all Internet traffic (not including GCC)

“Hyper Giants”



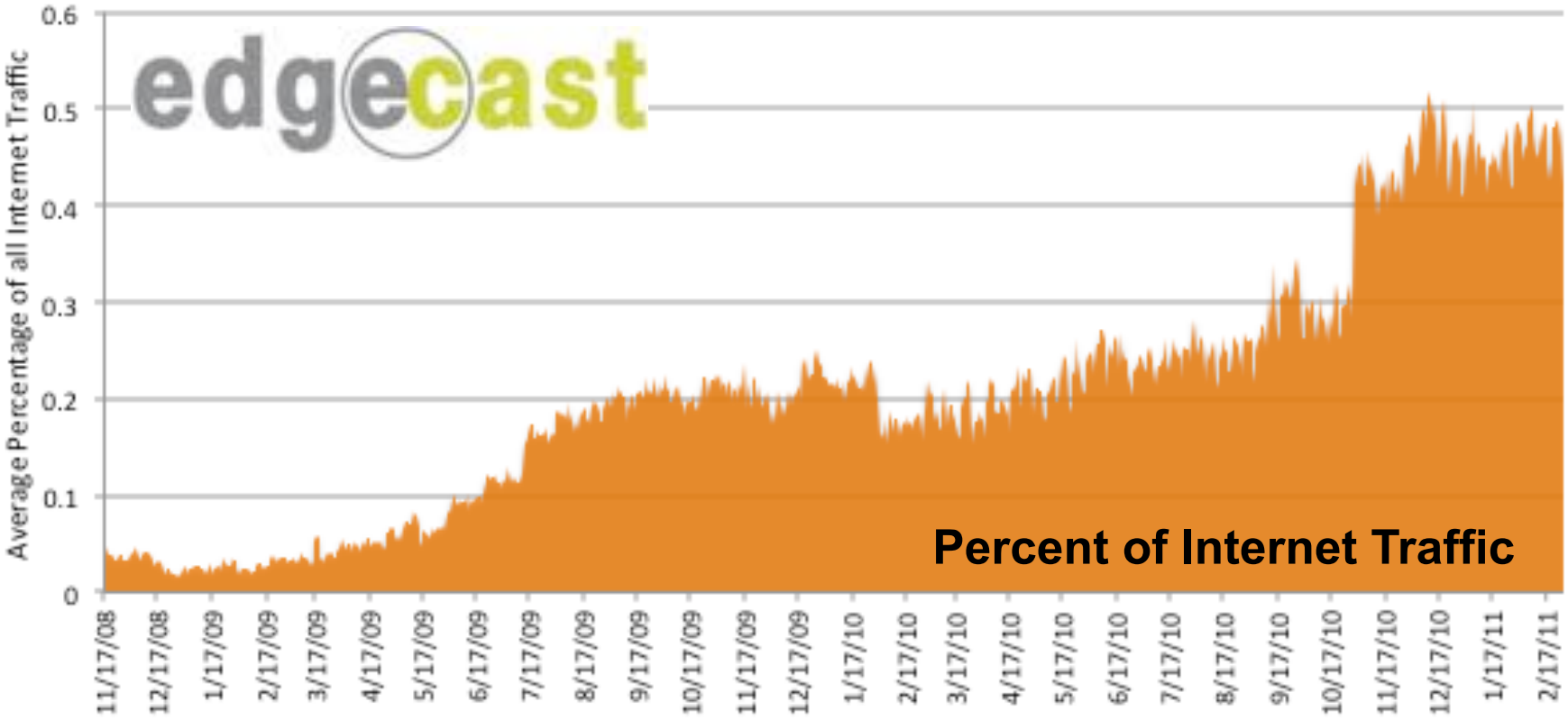
Facebook rapidly approach half percent of all Internet traffic.
Will likely grow as FB incorporates additional video content.

“Hyper Giants”



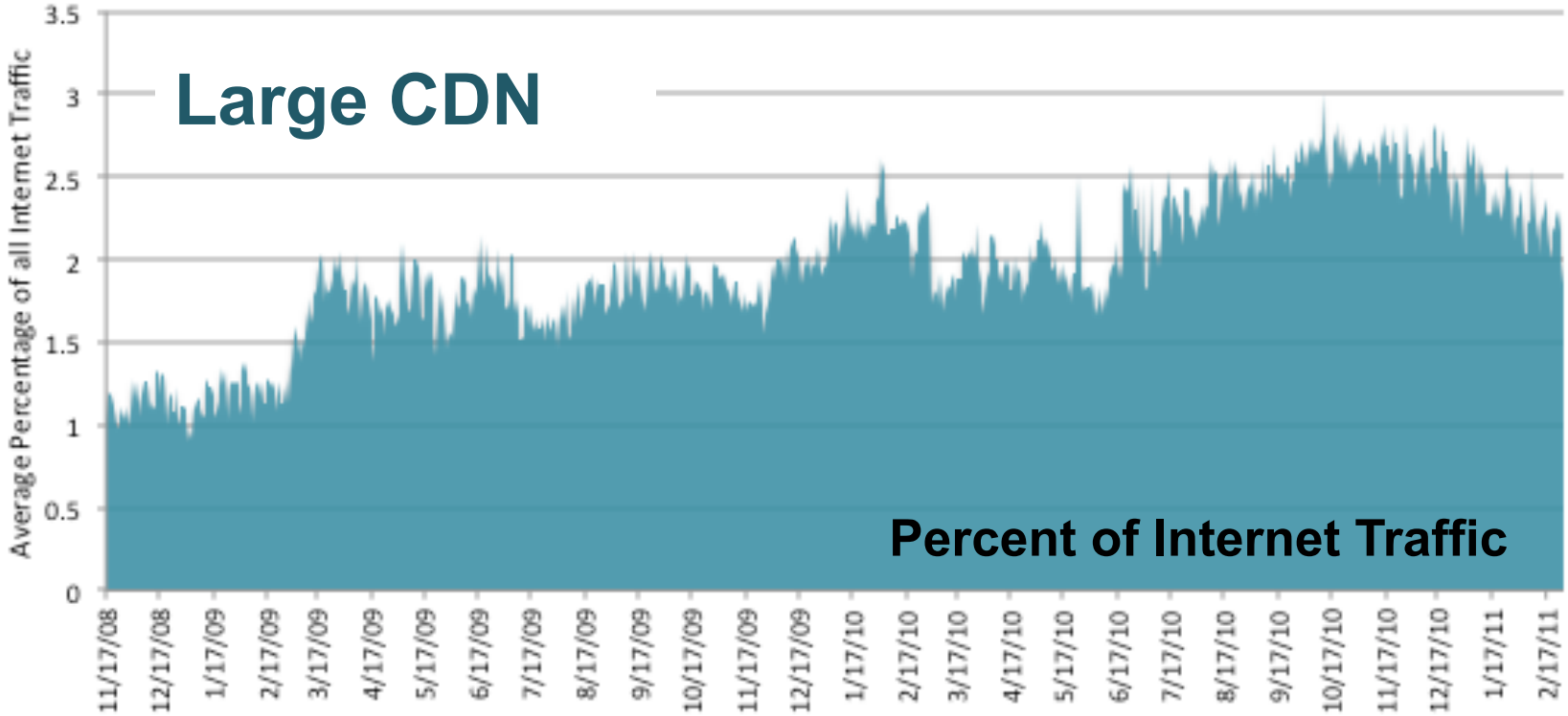
Amazon grew from 0.1 to 0.6% of all Internet traffic between November 2008 and March 2011. Does not include Amazon use of CDN.

“Hyper Giants”



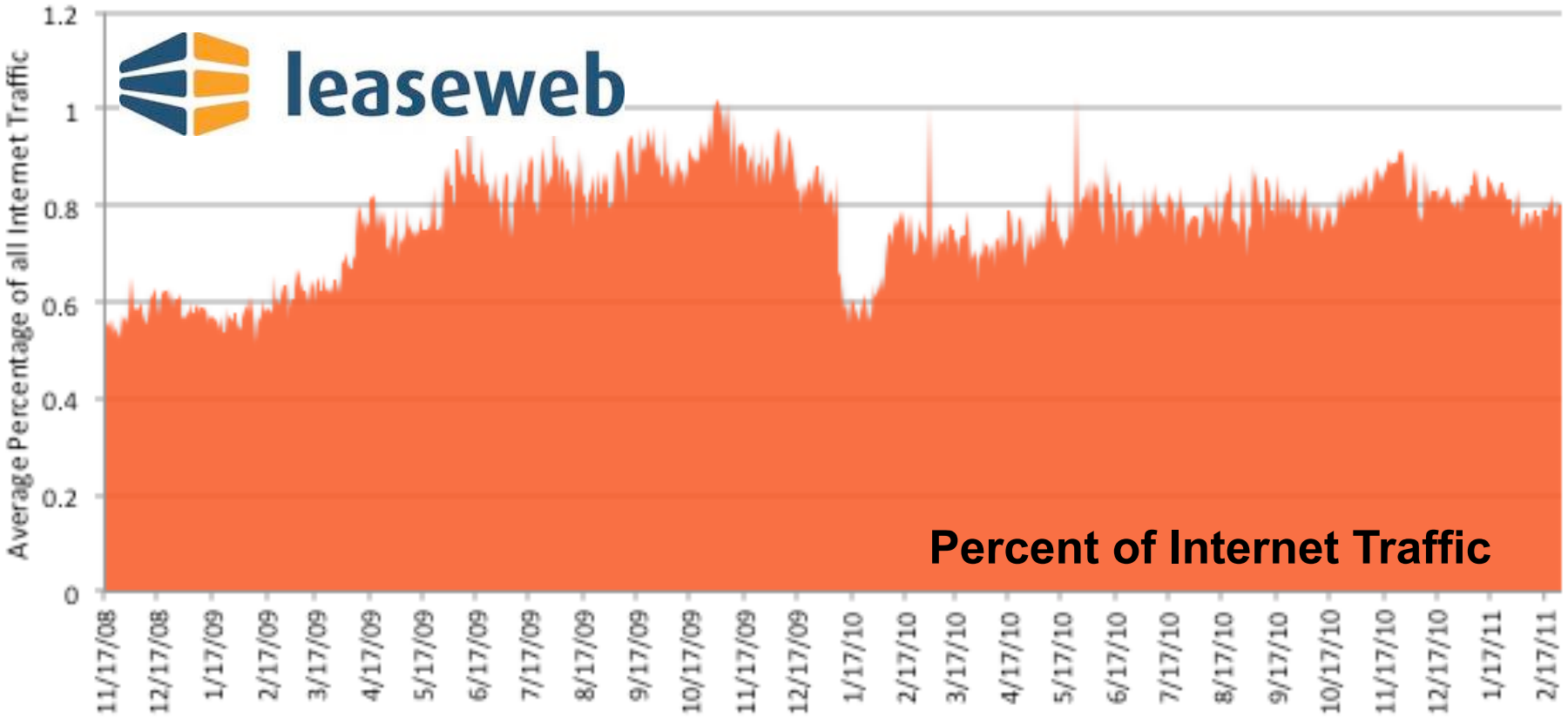
Edgecast grew from 0.02 to 0.5% of all Internet traffic between November 2008 and March 2011.

“Hyper Giants”



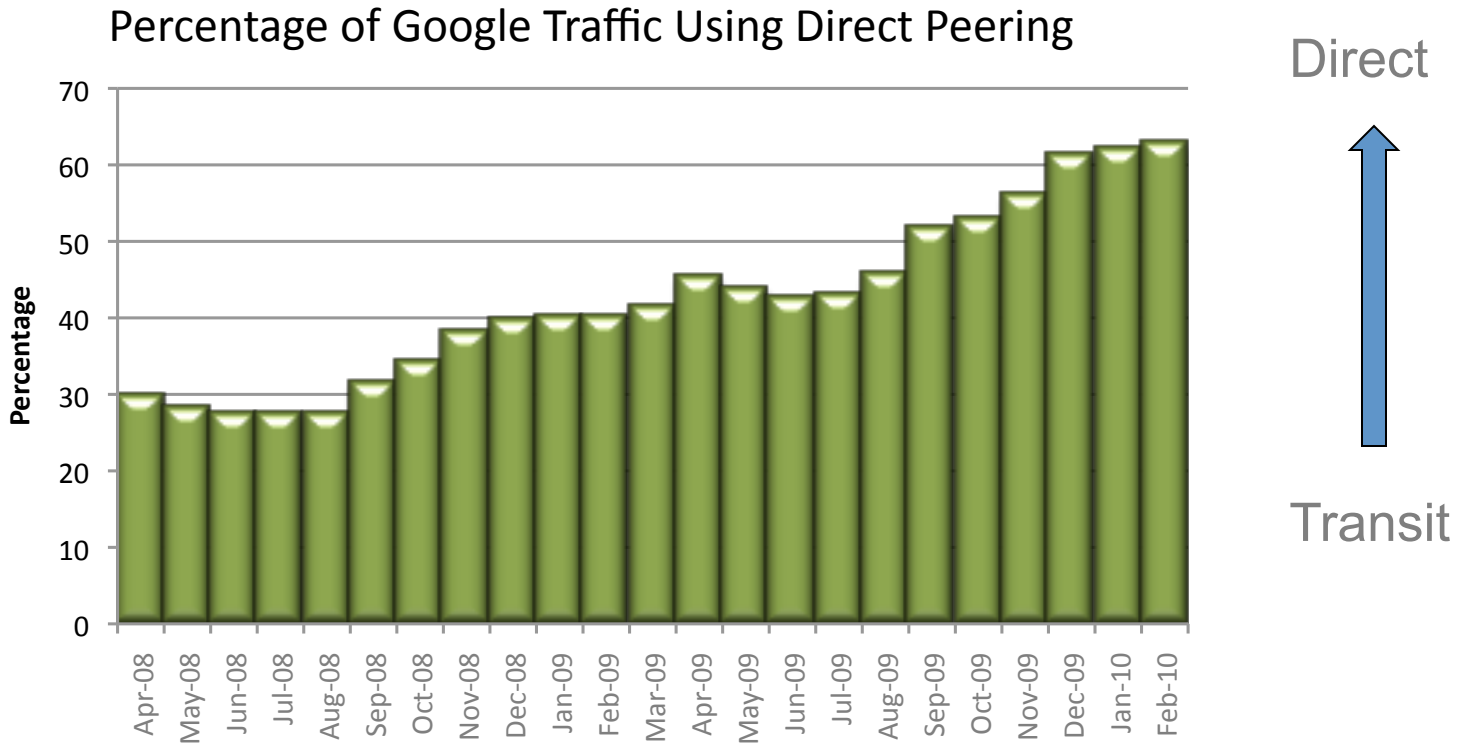
- Average 2.25% of inter-domain traffic in March 2011
- Edge caches average 15-25% of access ISP subscriber traffic
- Or an average of ¼ ratio inter-domain to edge cache

“Hyper Giants”



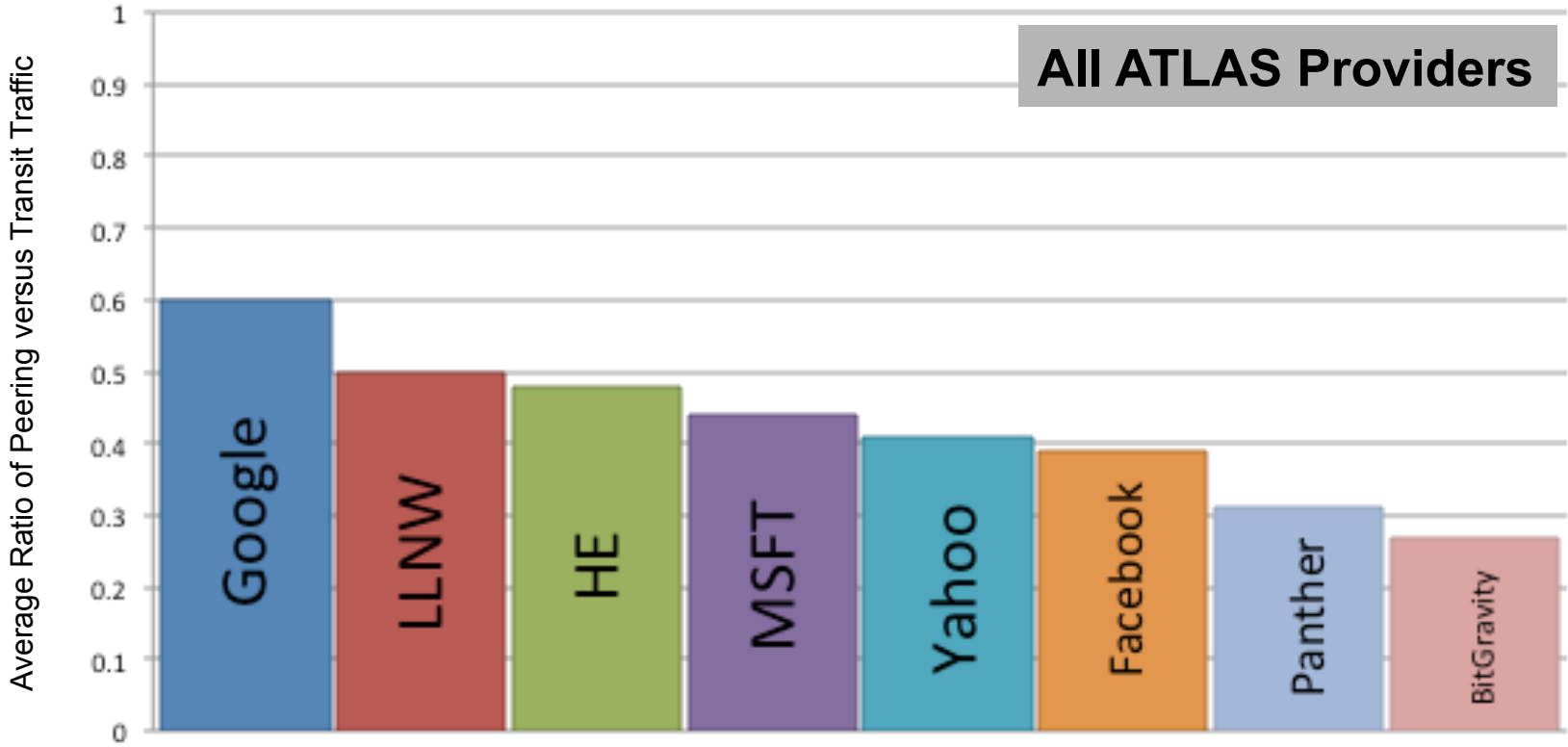
Leaseweb represents 0.8% of all Internet traffic in March of 2011

Peering Traffic Density



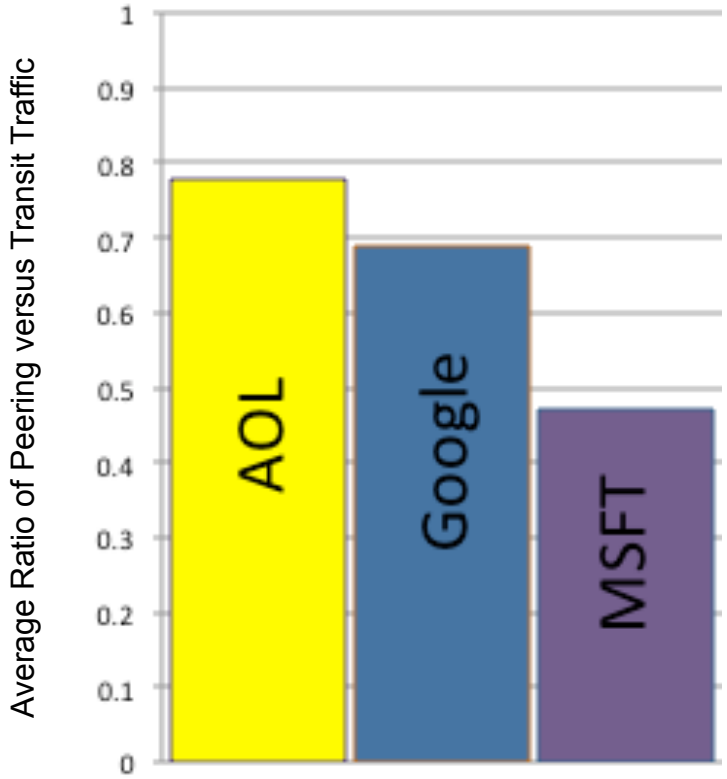
- Over time, Google increasingly using direct peering with tier2/3 and consumer networks
- As of February 2010, more than 60% of Google traffic does not use transit

Peering Traffic Density (March 2011)



Average percent traffic for each grouped ASN using direct peering versus transit across 110 ATLAS providers in March 2011. Over time, increasing volumes of traffic use direct adjacencies.

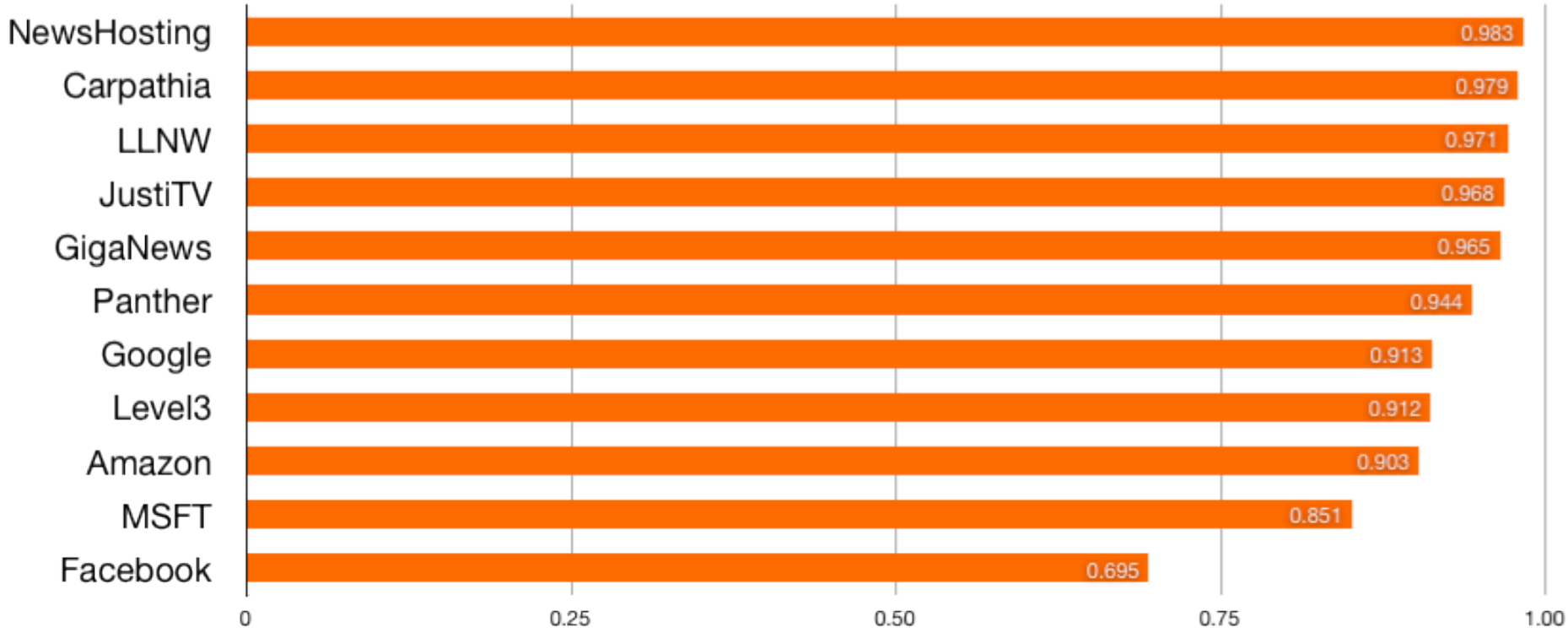
Peering Traffic Density (March 2011)



Tier1

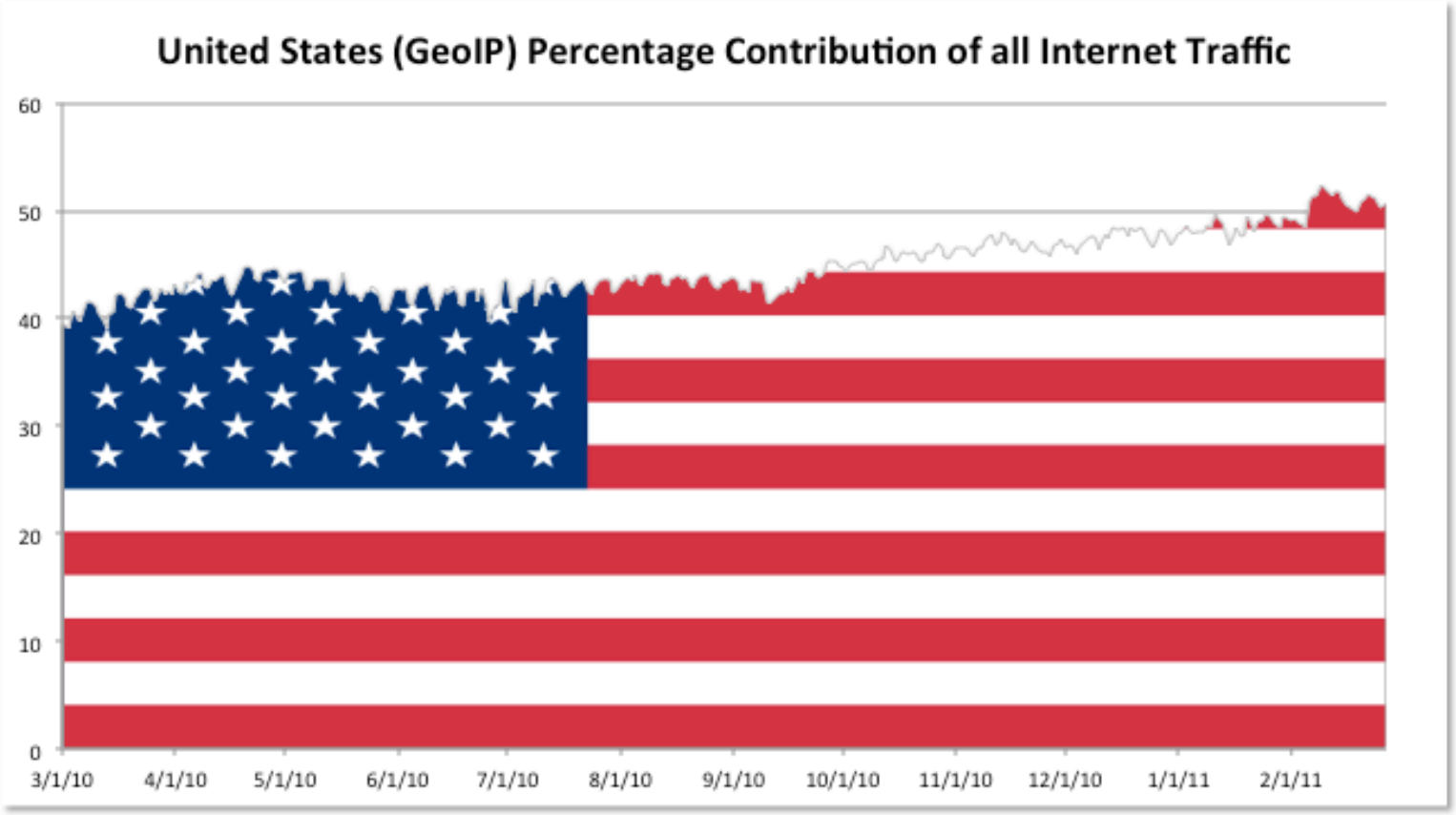
ATDN disproportionate high peering density with tier1. Large CDN / content slightly higher percentage. All others smaller percentage.

Peering Ratios (grouped origin ASN)



Representative select of group ASN peering ratios from the perspective of 110 ATLAS providers.

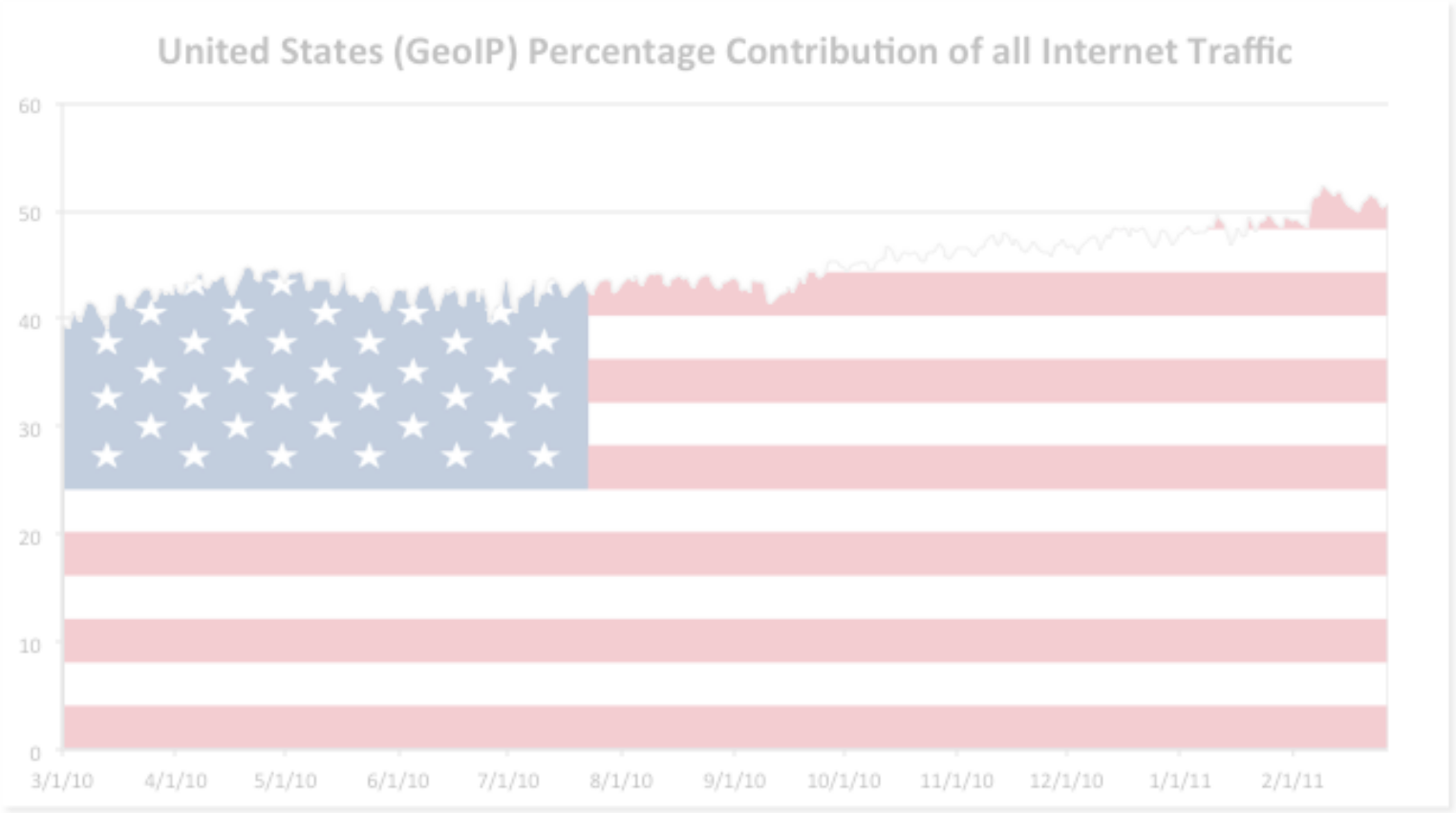
Changing Geography of Internet Traffic



United States is growing in both absolute traffic volume and as a weighted average percentage of Internet traffic

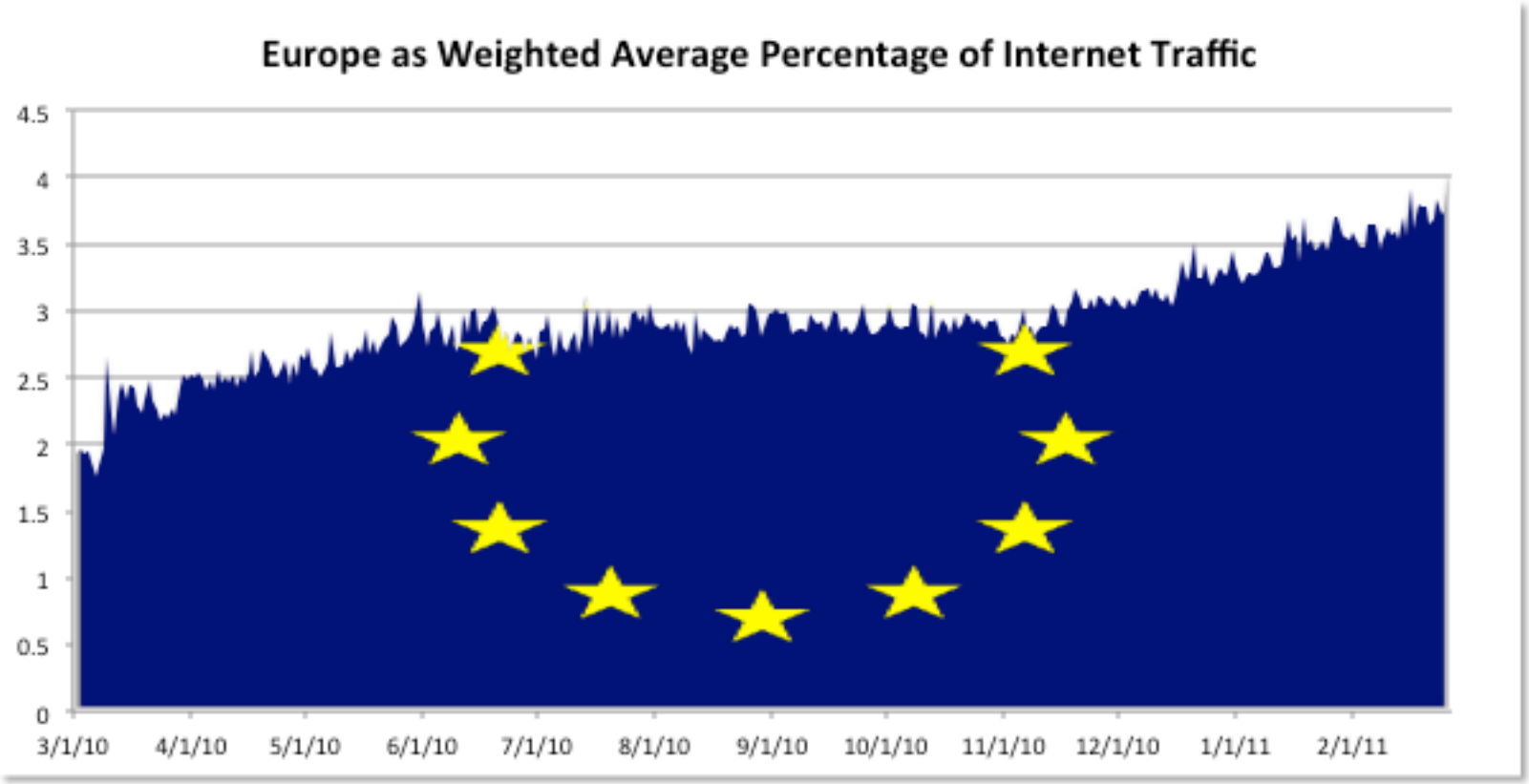
(Grew from 40% to 50% by average aggregate traffic volume in 2011)

Changing Geography of Internet Traffic



Which is not what I would have expected…

Changing Geography of Internet Traffic



Europe also growing as weighted average contributor of Internet traffic

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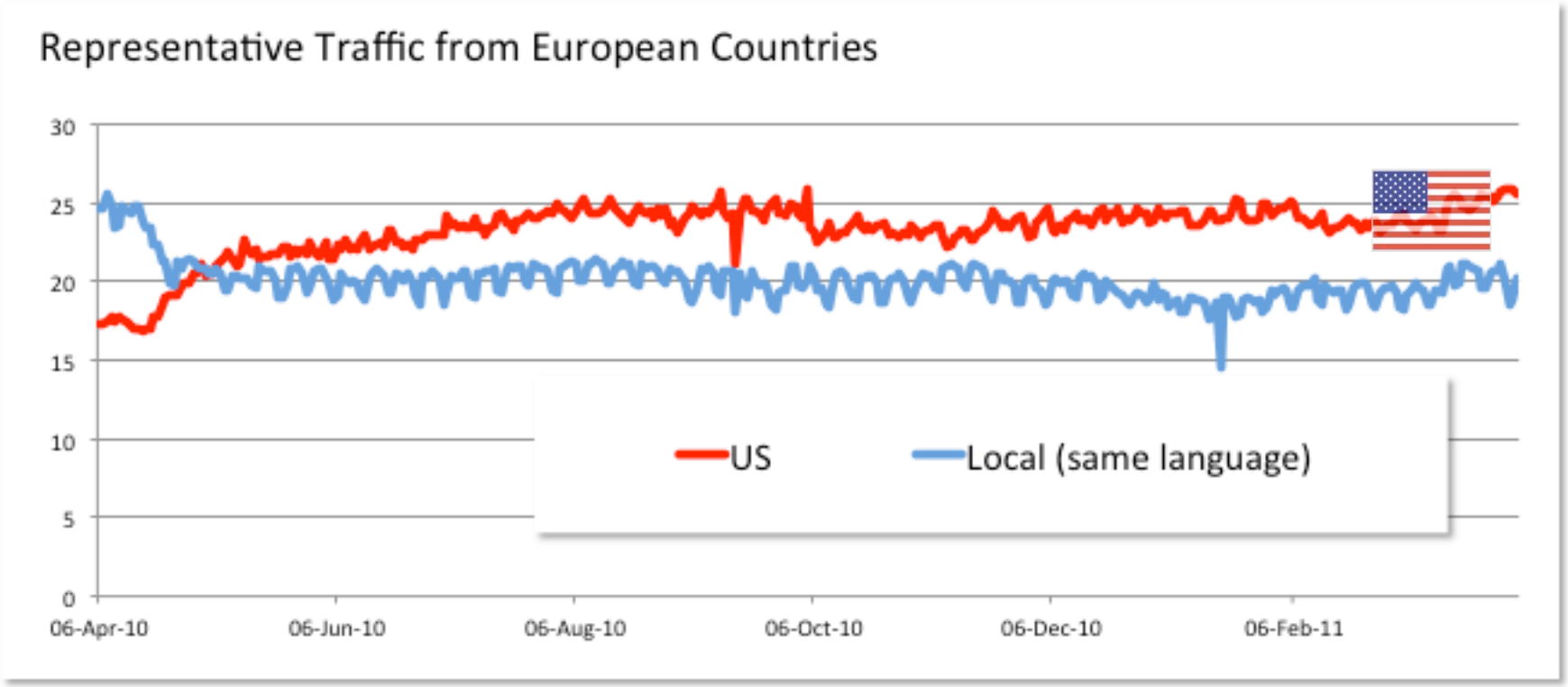

Within a given European country:
25% US, 20% local, 25% Europe

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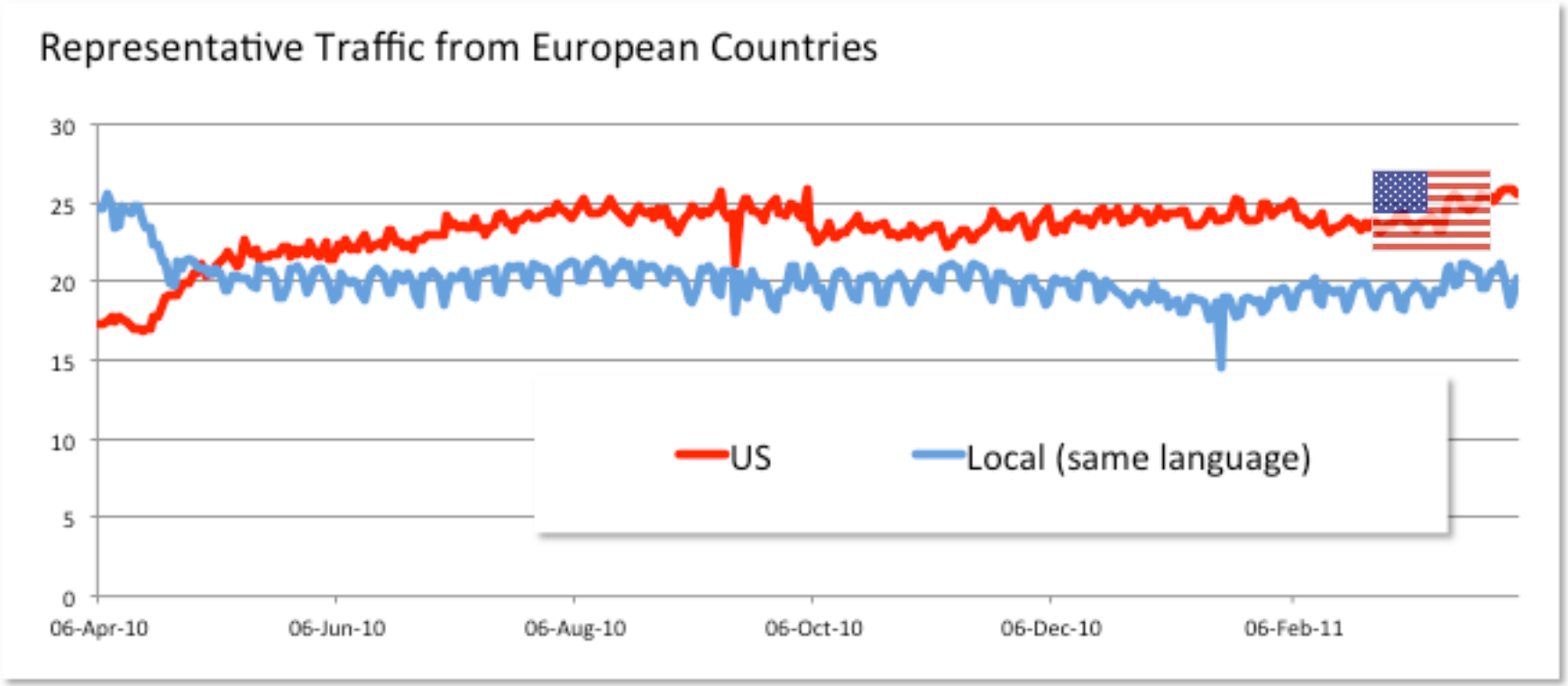

Within a given European country:

25% US, 20% local, 25% Europe

And local decreasing… (also not what I would expect)

End of the Internet

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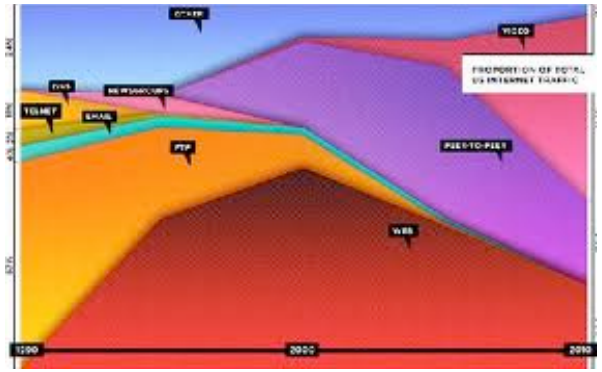


- **Wired says**
  - The web replaced by “curated” applications (iPhone Apps)
  - Rich population of web sites replaced by a few large content providers
  - Web traffic subsumed by video
- **Or basically what we said**
  - http://www.wired.com/epicenter/2009/10
- **But all of this misses the point**

The End of the Internet

- **Or really, the End of "End to End"**
- **Meaning**
  - Telephony had simple handsets
  - But incredible complexity in network (Gn, Gi, Gp)
  - and lots of network stuff manipulating traffic
  - Little innovation

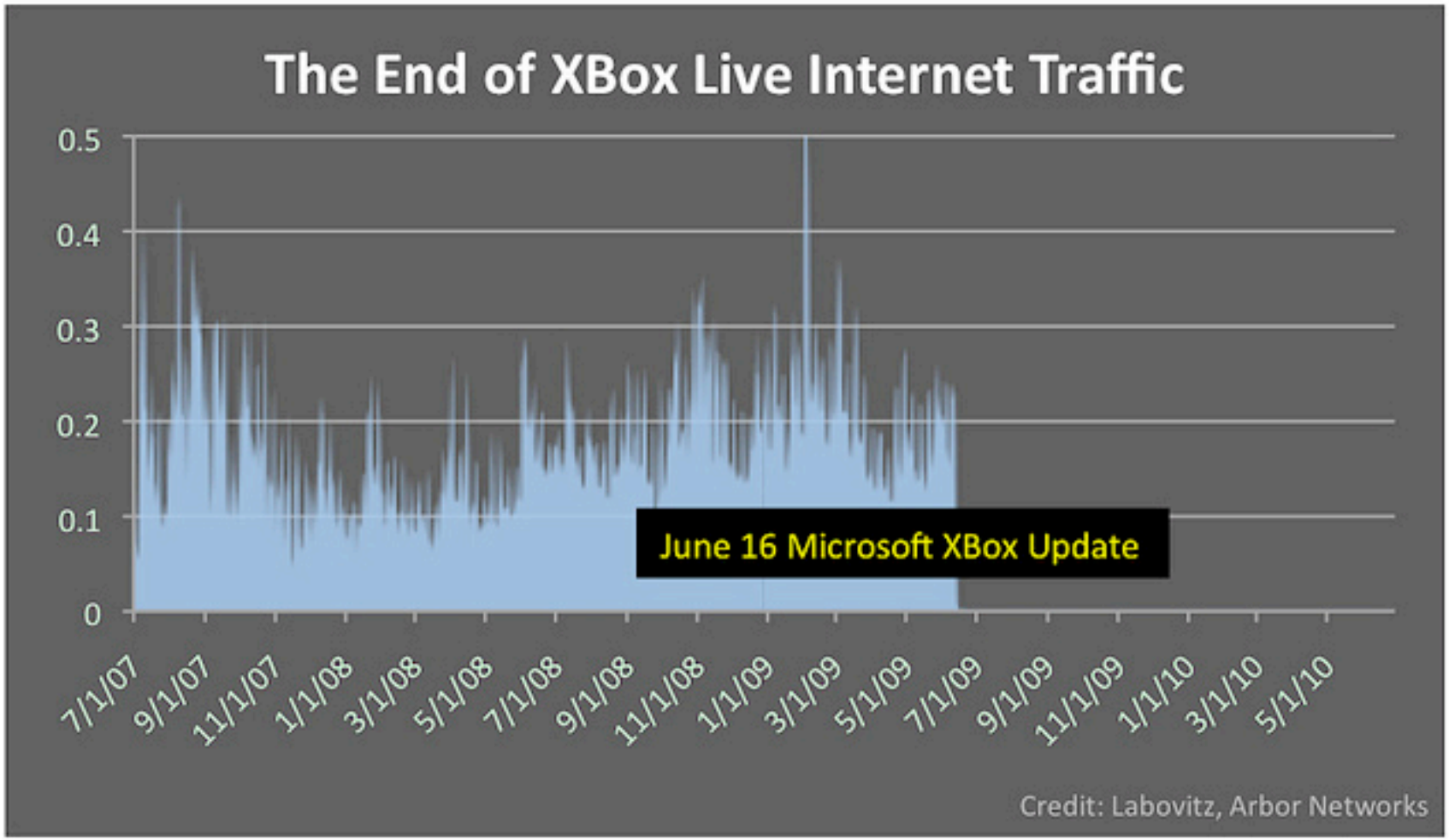
  - Internet had complex end-systems (computers)
  - with simple network -- only job to forward traffic
  - Everything IP
  - Lots of innovation!

- **But success got in the way…**

The End of End-to-End

- **Ubiquitous deployment of**
  - Security (firewall, IPS, IDS, etc)
  - Address translations (NAT / PAT, 6to4)
  - Policy (traffic shaping, policing)
  - Aging web clients
- **Broke end-to-end**
- **So industry developed work-arounds**
  - Like STUN and UPnP
- **But If you have millions of users, just need a small percentage to have problems**
- **Before you decide like Microsoft…**

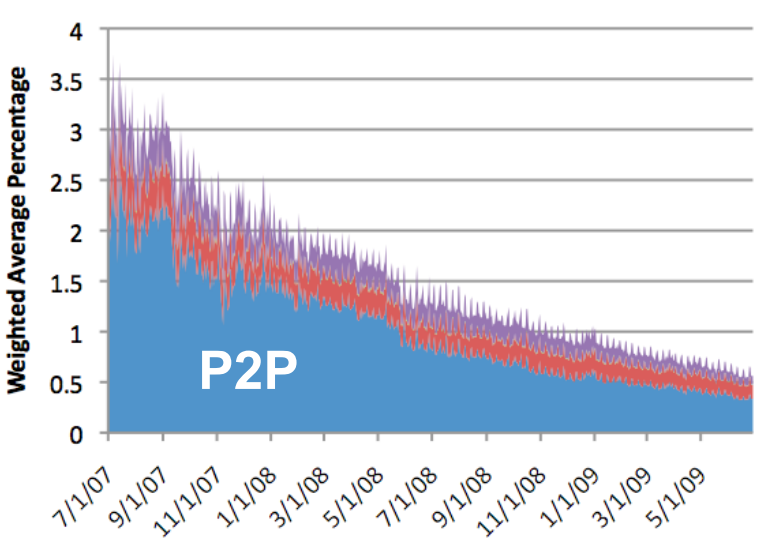
The End of XBox

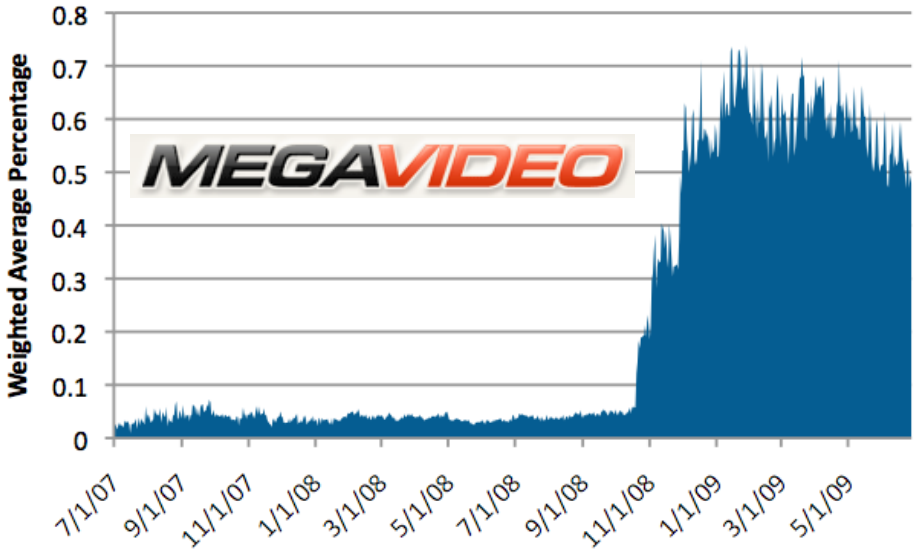


The Rise and Fall (and rise?) of P2P

- **In 2007, P2P threatened the Internet**
  - Almost 30-40% of Internet traffic,
  - ISPs were out of capacity
- **Only weeks left in regions like trans-Pacific**

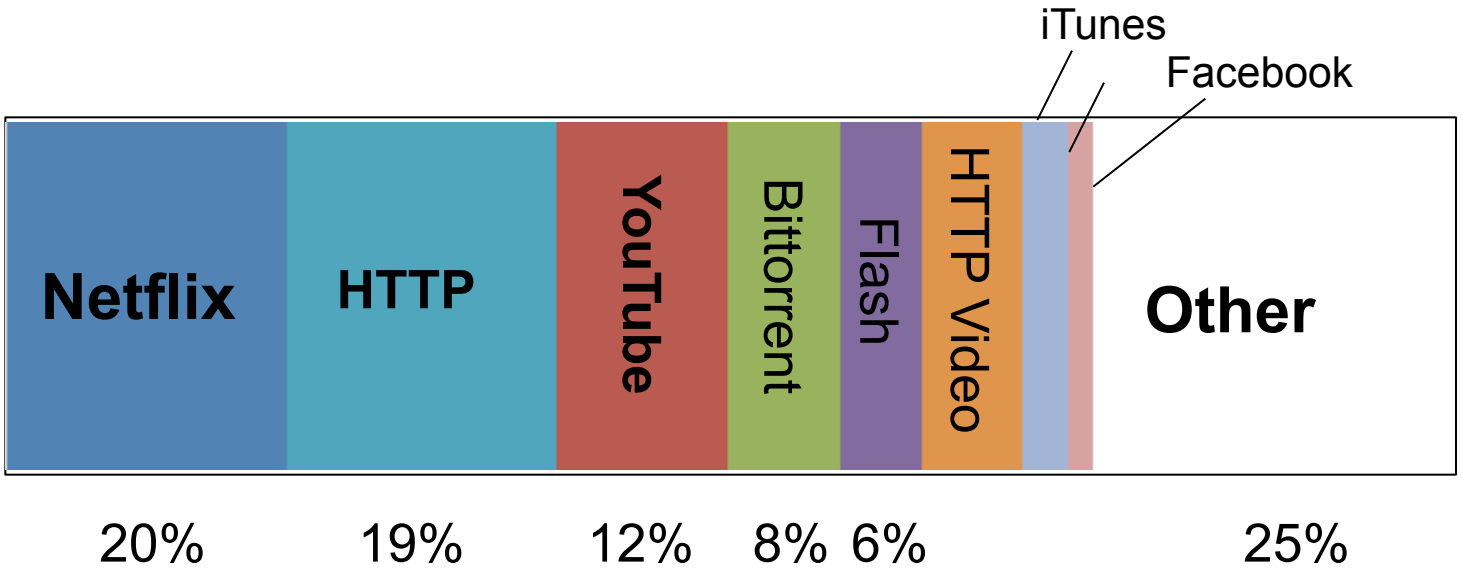
The Rise and Fall (and rise?) of P2P





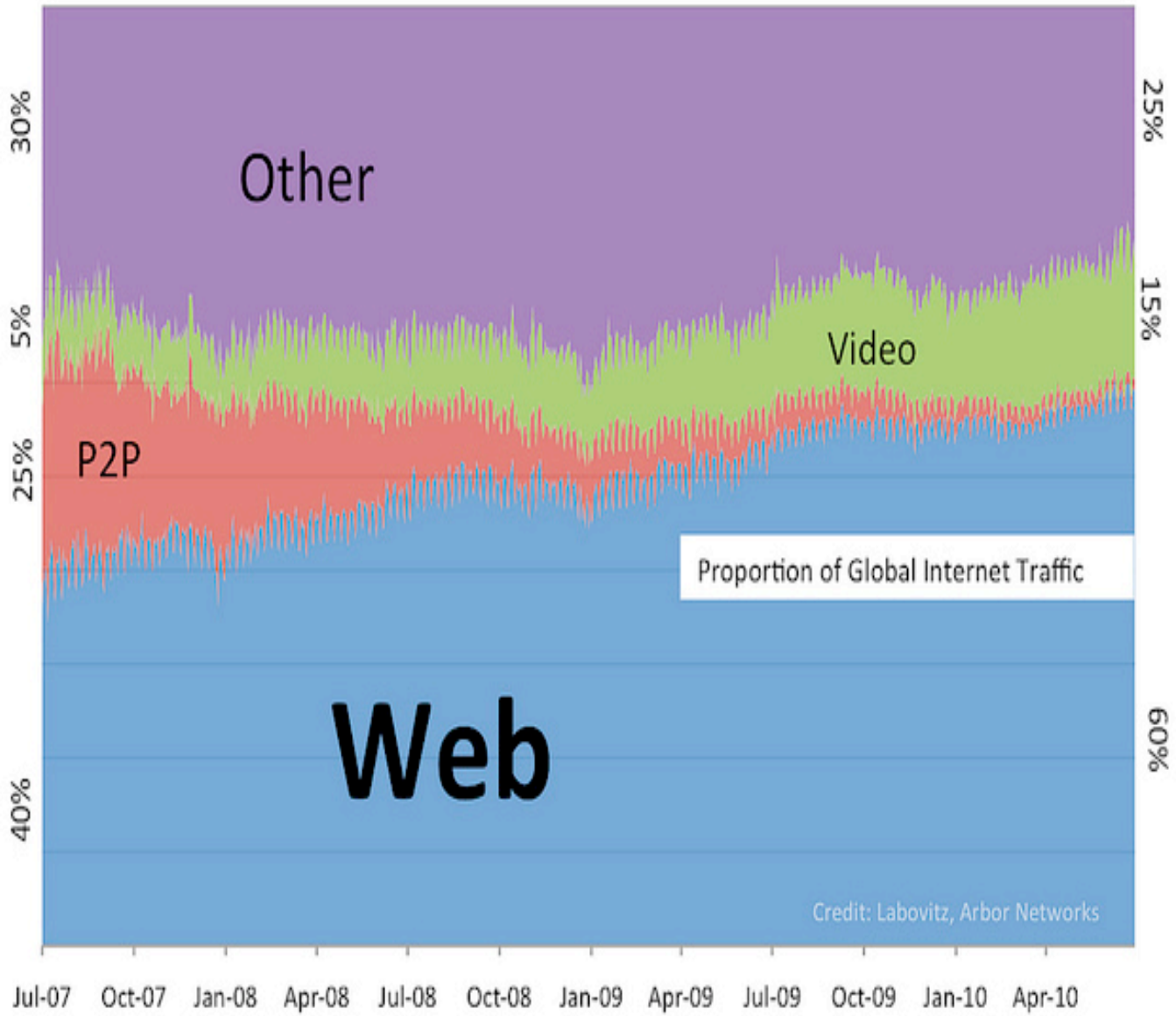
- **P2P stopped growing 2007-2010**
- **Replace by direct download over web (e.g. MegaVideo)**
  - Carpathia small hosting company by traffic volume in Fall 2008
  - Mega becomes Carpathia customer in November 2008
  - Carpathia Hosting grows overnight to more than 0.5% of all traffic
- **Evidence P2P again growing within access networks**
  - Commercial adoption
  - Regulatory
  - Blu-Ray

NA Residential Applications (Payload Inspection)



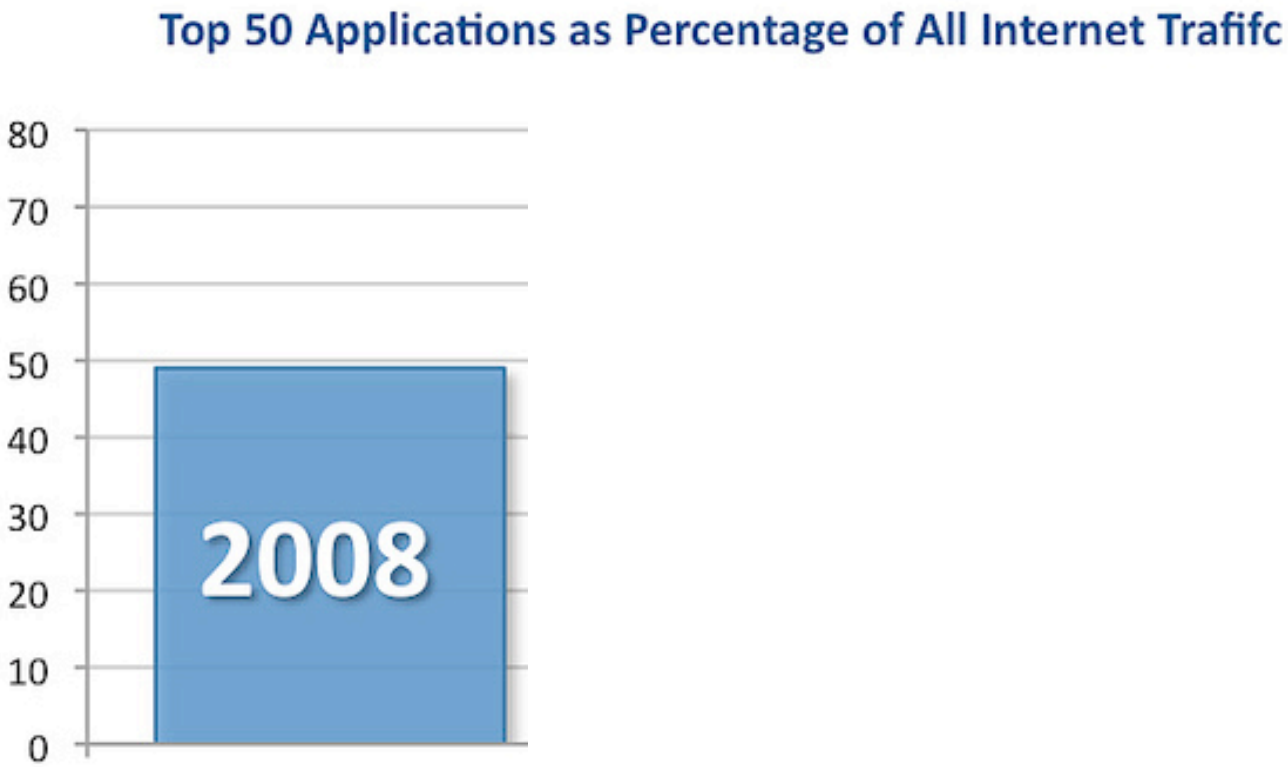
Average payload based classification of small sample (< 5) of North American residential networks over a week in March 2011.

Global Protocol Trends (protocol / port)



- Web becomes main transport for video and everything else
- Thousands small web sites subsumed by large content providers

Everything But HTTP is Declining



- In 2008 many different Internet applications / protocols

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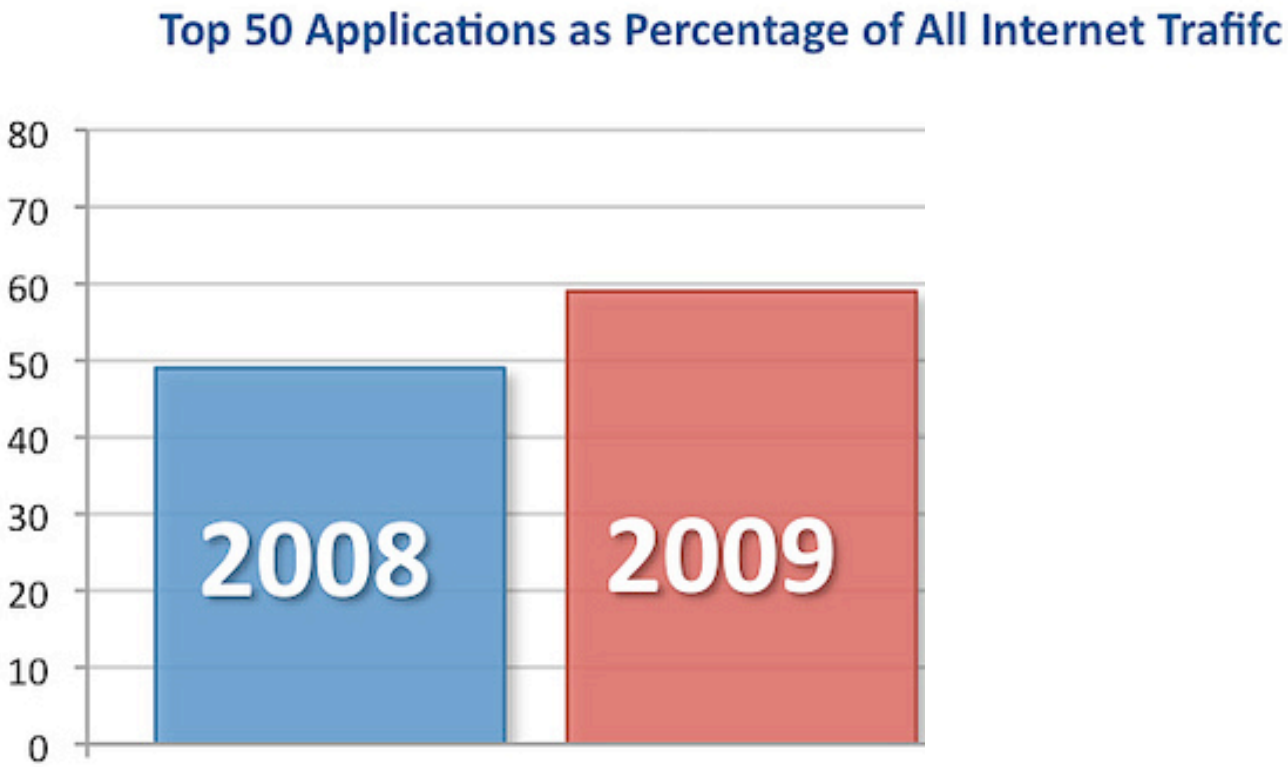

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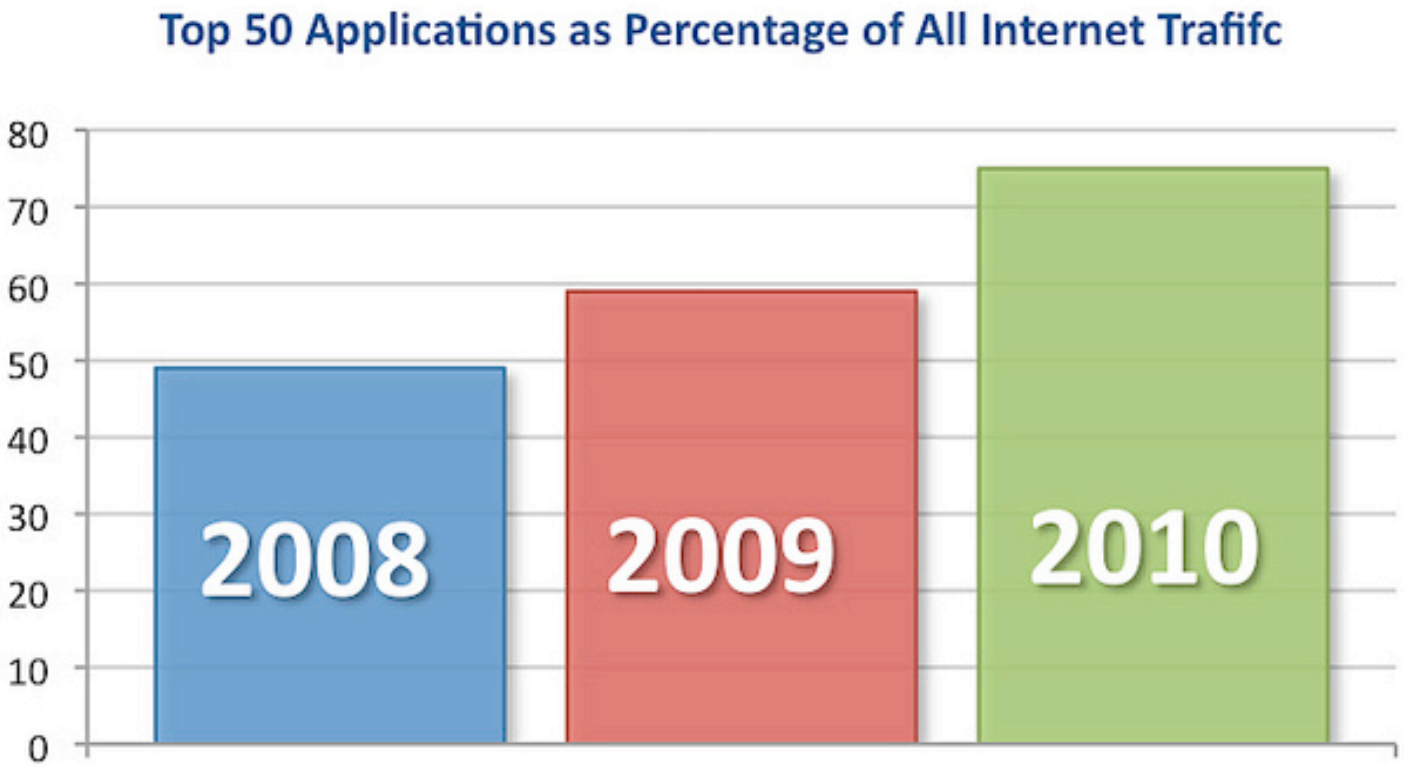
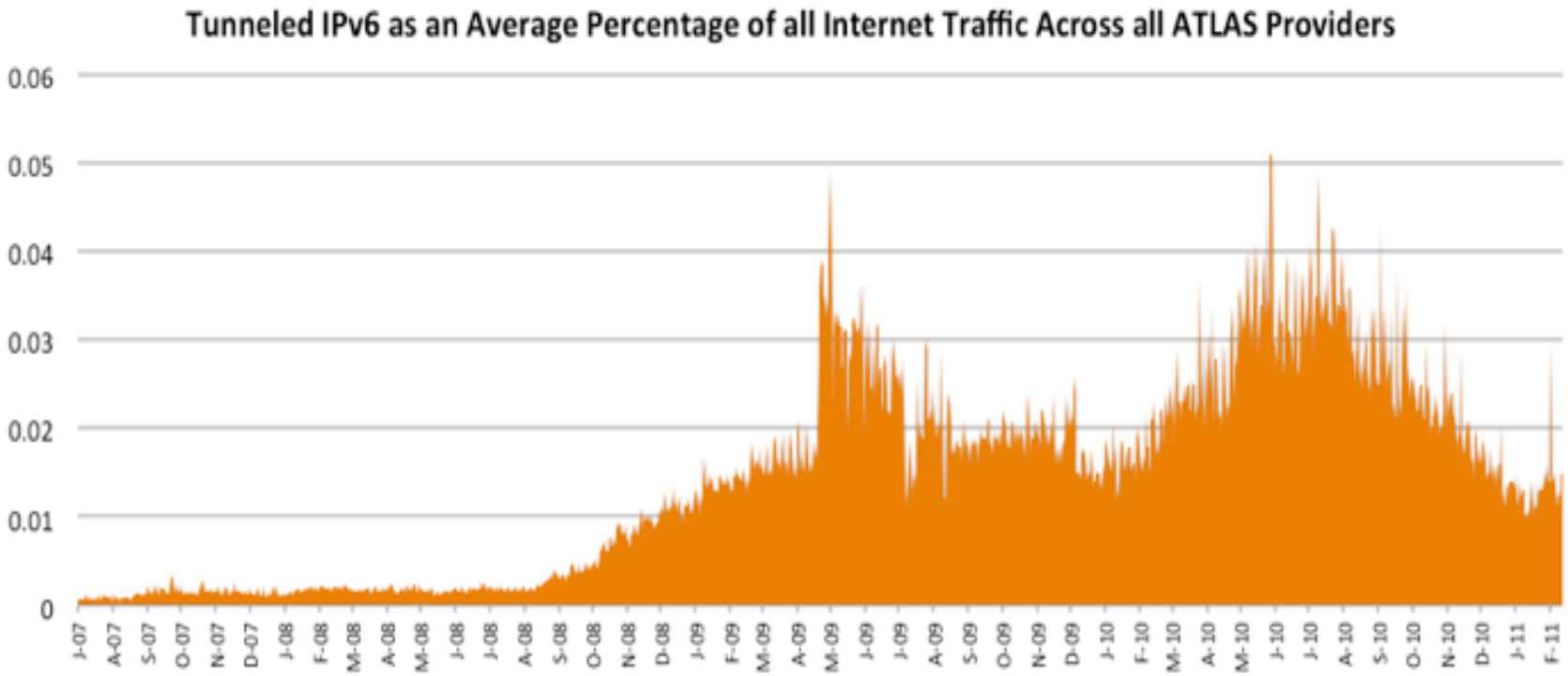


- In 2008 many different Internet applications / protocols
- By 2010, majority of Internet traffic comes from 50 apps
- And most of this is the Web

IPv6 Tunneled Traffic



- Tunneled IPv6 miniscule percentage of Internet traffic (.04 %)
- Tunneled decreasing (why?)

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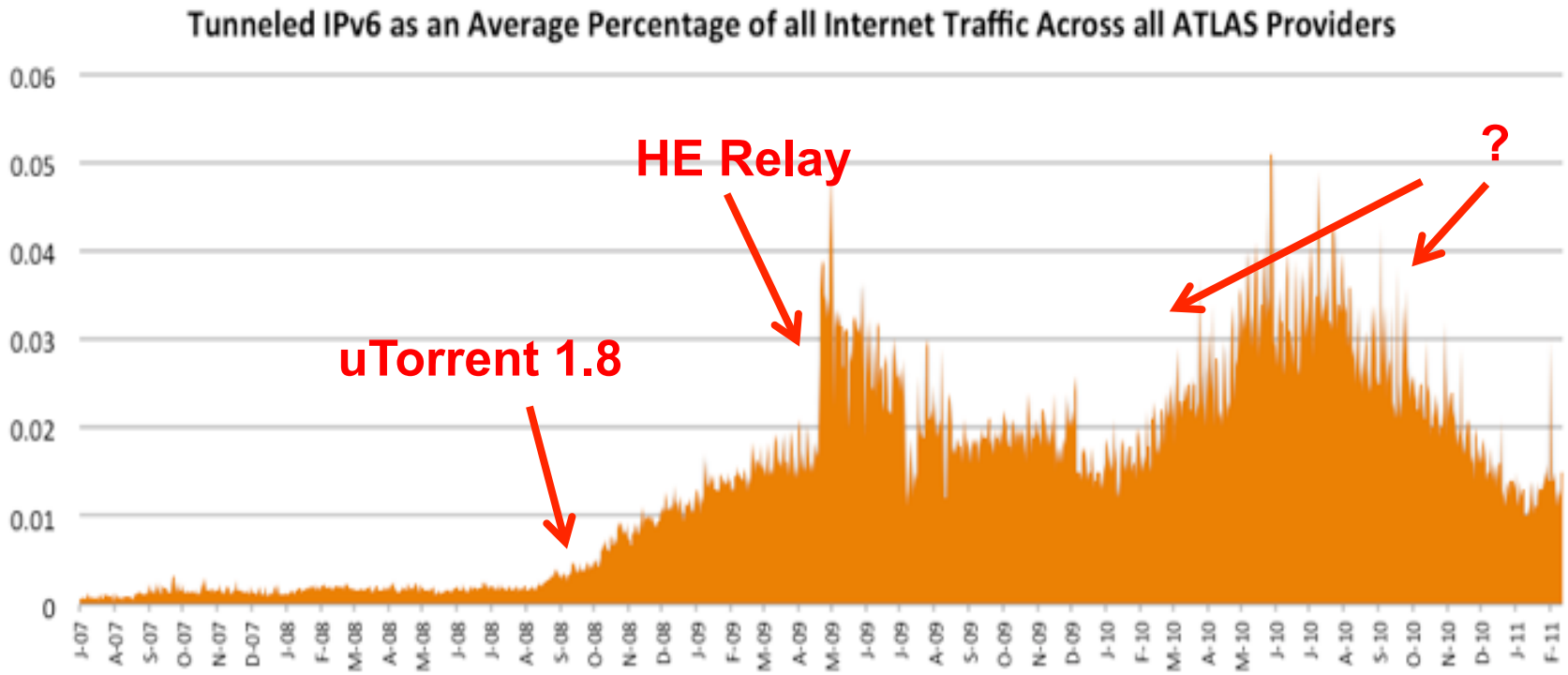

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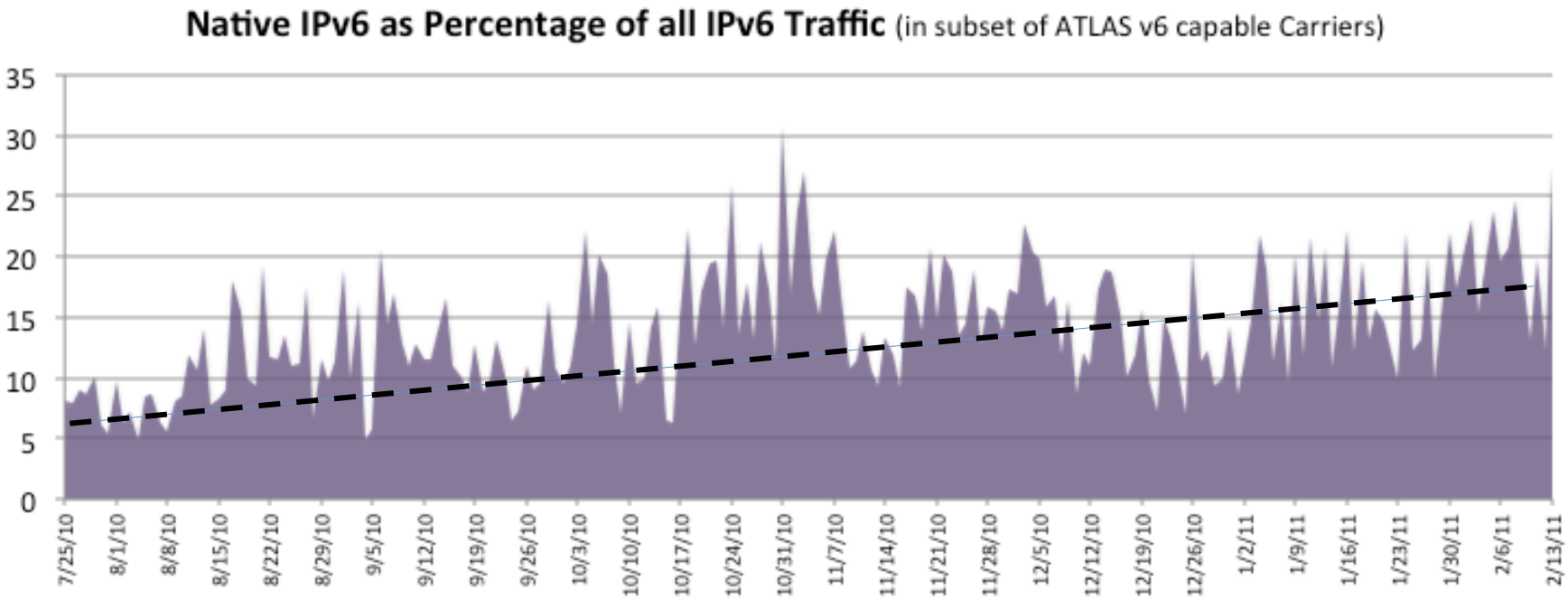
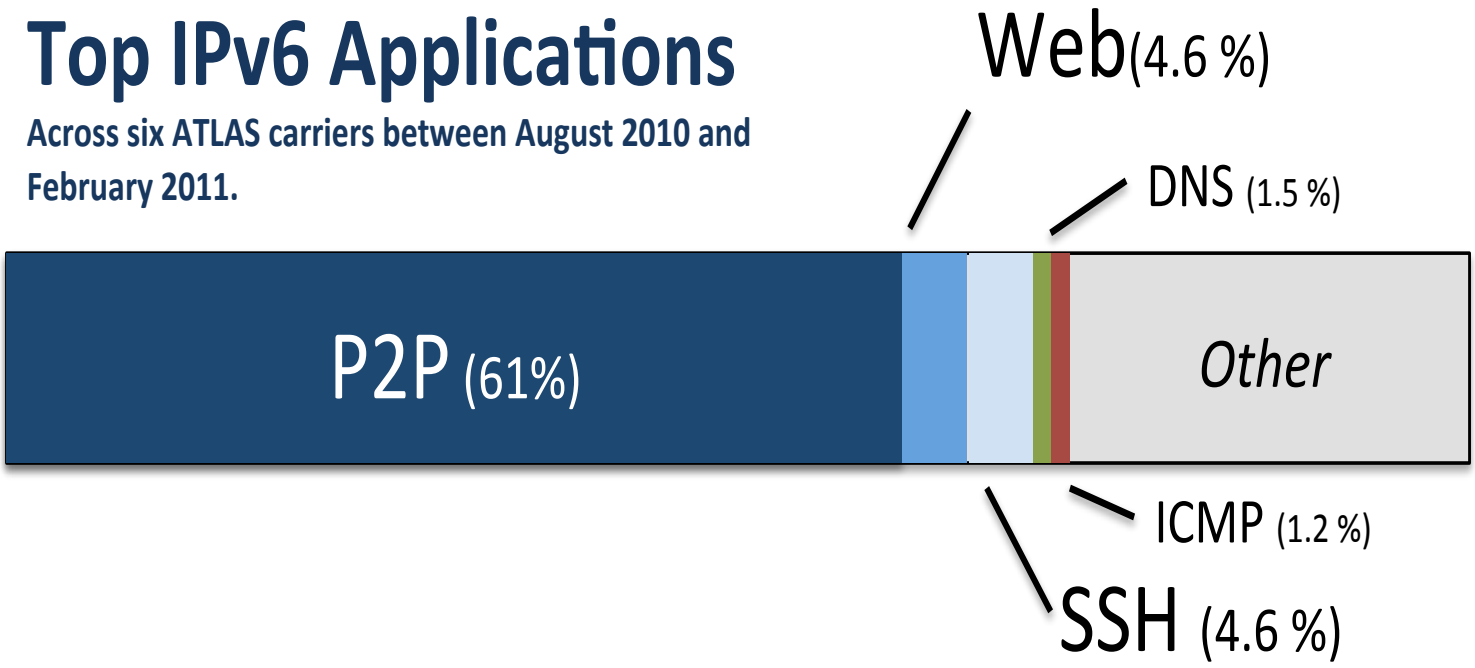
Native IPv6



Native IPv6 traffic as a percentage of all IPv6 traffic (i.e. including tunneled) in six ATLAS carriers with v6 and majority IPFIX capable routers

- **Native IPv6 has grown to 25% of all v6 in carriers with IPv6**
- **All of these carriers still have hundreds of thousand of managed tunnels**

Native IPv6 Applications



- Small volumes of v6 traffic mostly uTorrent
- Some networks mostly v6 ICMP
- More than a million managed tunnels (all with almost no traffic)

What all of this Means

- **New Internet Economics**
  - Fundamental shift from connectivity to content
  - New emphasis on latency / loss (and SLAs)
  - New business models
- **HTTP is the new IP**
  - Glacial innovation at network / IP layer (e.g. IPv6)
  - Cloud is the new network?
- **Challenges**
  - Threat regulatory action
  - Security (port based firewalls)
  - Lack of tools / data (especially mobile)
  - Monoculture / innovation

Collaboration

- **You can help**
- **Participate in survey**
  - Conducting interviews changing strategies / economics
  - Online survey (soon)
- **Additional data**
  - Network telemetry (sampled flow)
  - Particularly World v6 Day statistics

To collaborate, email labovit@umich.edu