



# ATLAS

## Internet Observatory

### 2009 Annual Report

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# ATLAS Internet Observatory



*Graphic not an accurate representation of current ATLAS deployments*

- **Largest Internet monitoring infrastructure in the world**
- **Global deployment across 110+ ISPs / Content Providers**
  - Near real-time traffic and routing statistics (14 Tbps)
  - Leverages commercial security / traffic engineering infrastructure
  - Participation voluntary and all data sources are anonymous

# ATLAS Observatory Report

- **Few observations in report are completely unique / new**
  - Previous discussion on growth of video, flatter Internet, Google, etc.
  - By press, academic papers, analysts, and NANOG
  - But may be first to quantitatively measure these trends
- **First global traffic engineering study of Internet evolution**

- **Related work**

Bill Norton “Video Internet: The Next Wave of Massive Disruption to the US Peering Ecosystem”, Equinix White Paper 2008.

Akamai, “State of the Internet”. White Paper 2009.

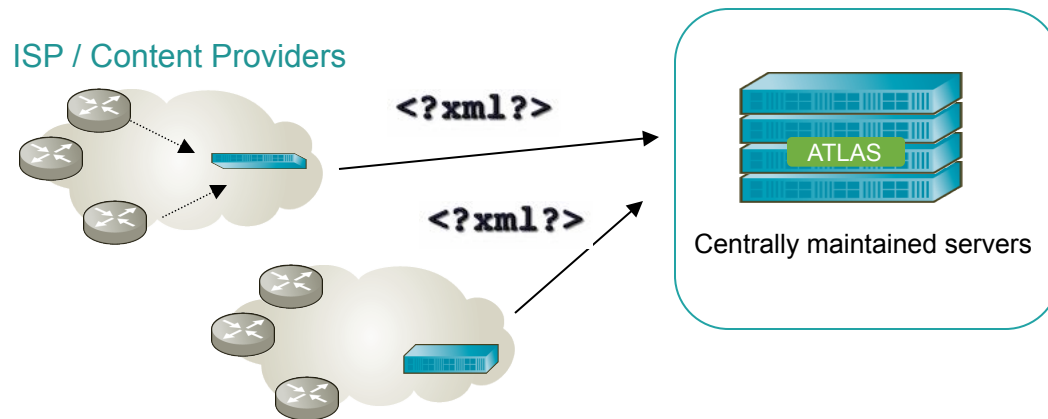
Andrew Odlyzko, “Minnesota Internet Traffic Studies (MINTS)”

Nate Anderson, “P2P traffic drops as streaming video grows in popularity”. Ars Technica, September, 2008.

P. Faratin and D. Clark and P. Gilmore and S. Bauer and A. Berger and W. Lehr, “Complexity of Internet interconnections: Technology, incentives and implications for policy”. The 35th Research Conference on Communication, Information and Internet Policy (TPRC), 2007.

# Methodology

# Observatory Data Details



- **Within a given ISP, commercial probe infrastructure**
  - Monitors NetFlow / Jflow / etc and routing across possible 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**

# What Observatory Measures

- **Relative inter-domain traffic between ISPs**
    - Based on a small sample of ASNs and weighted towards core
    - Roughly matches analyst ISP market data / distributions
    - Believe data representative of global inter-domain traffic
    - Focus on “market share” as opposed to absolute volumes
  
  - **Inter-domain traffic volume and ratios provide**
    - Important design / engineering metric
    - Negotiation / business strategy
- **Does NOT measure**
    - Number of web hits, tweets, transactions, customers, etc.
    - Internal / private customer traffic (e.g. VPNs, IPTV)
    - ISP success nor profitability

# Major Findings

## 1 Consolidation of Content Contributors

- Content migrated out of enterprise / edge to aggregators
- Consolidation of large Internet properties
- Now only 150 origin ASNs now contribute 50% of traffic

## 2 Consolidation of Applications

- Browser increasingly application front end (e.g., mail, video)
- Applications migrate to HTTP or Flash ports / protocols
- All other ports / app groups decline (except games and VPN)

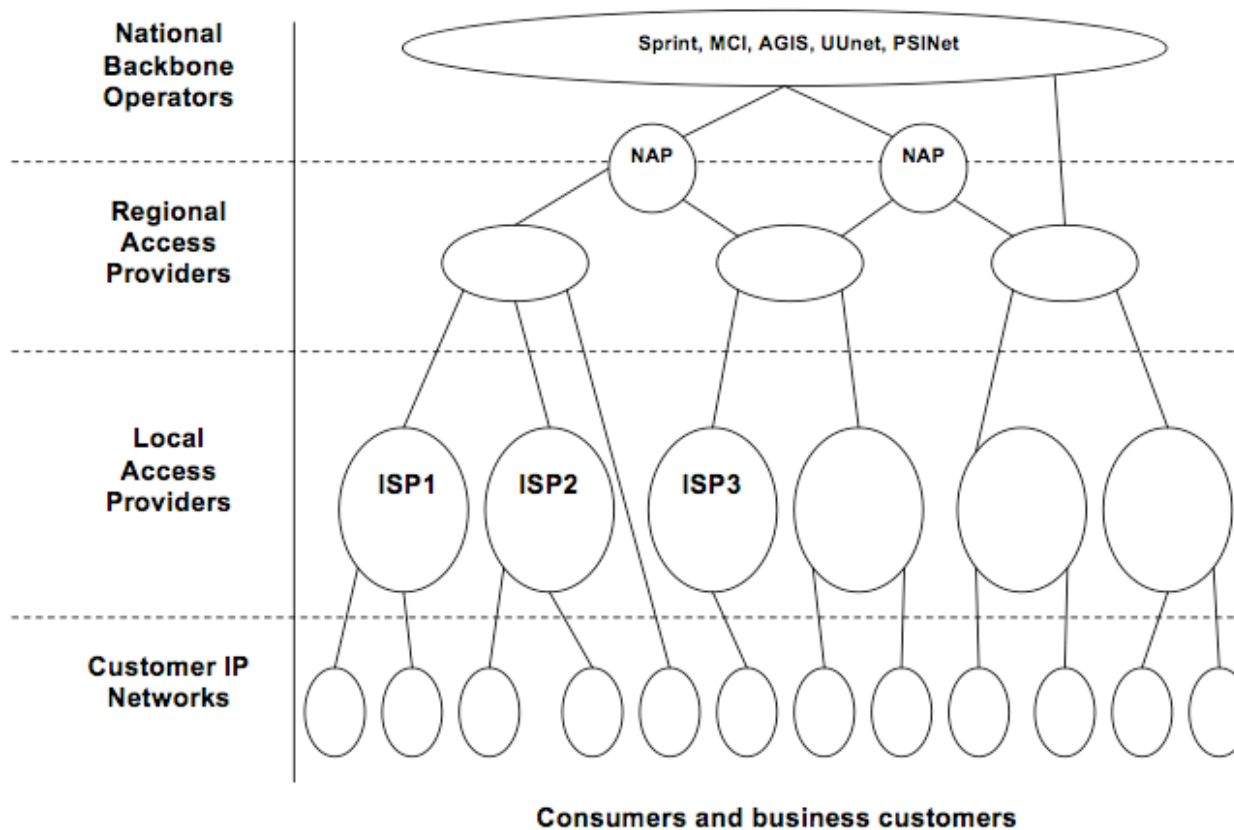
## 3 Evolution of Internet Core and Economic Innovation

- Majority of traffic direct between consumer and
- Market shifts focus to higher value services (MSSP, VPN, CDN, etc)
- Experimentation with paid transit
- Experimentation with paid content

# Evolution of Internet Core



# Textbook Internet (1995 – 2007)



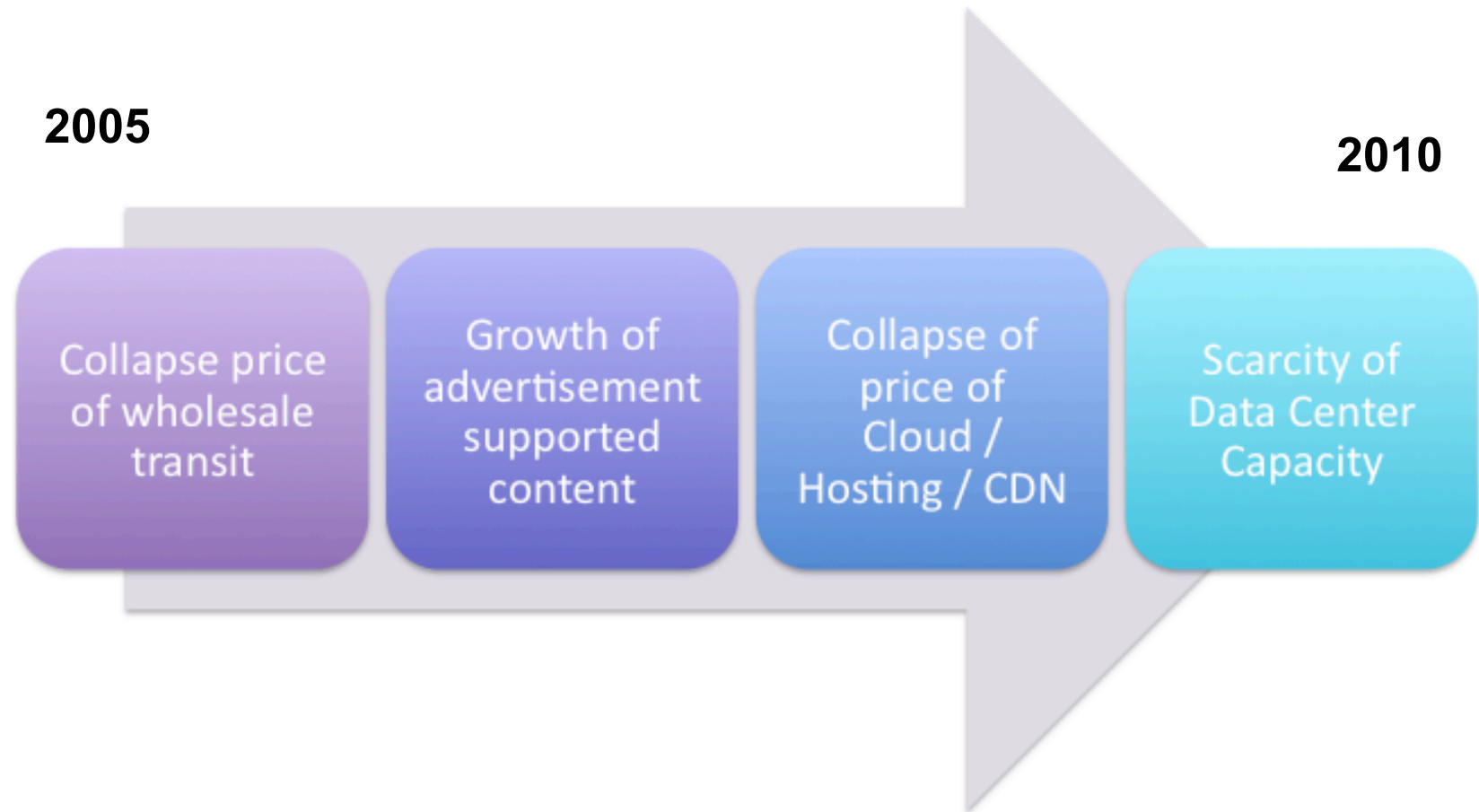
- Tier1 global core (modulo a few name changes over the years)
- Still taught today

# The “ATLAS 10” in 2007

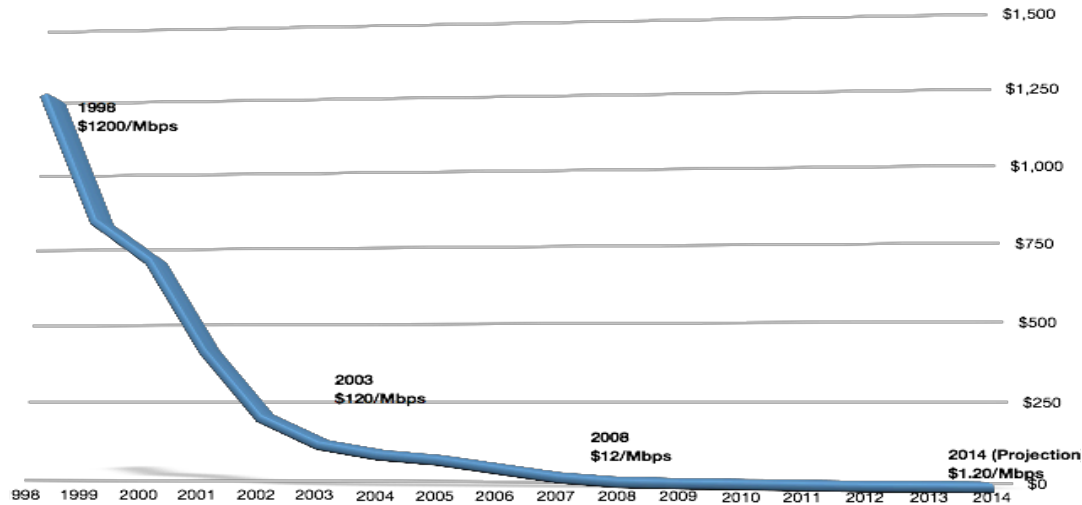
Rank	Provider	Percentage
1	Level(3)	5.77
2	Global Crossing	4.55
3	ATT	3.35
4	Sprint	3.2
5	NTT	2.6
6	Cogent	2.77
7	Verizon	2.24
8	TeliaSonera	1.82
9	Savvis	1.35
10	AboveNet	1.23

- Based on analysis of anonymous ASN (origin/transit) data
- Top ten has NO direct relationship to Observatory participation
- By weighted average percentage of all Internet traffic
- Corresponds with expected “tier-1” ISPs (e.g., Wikipedia)

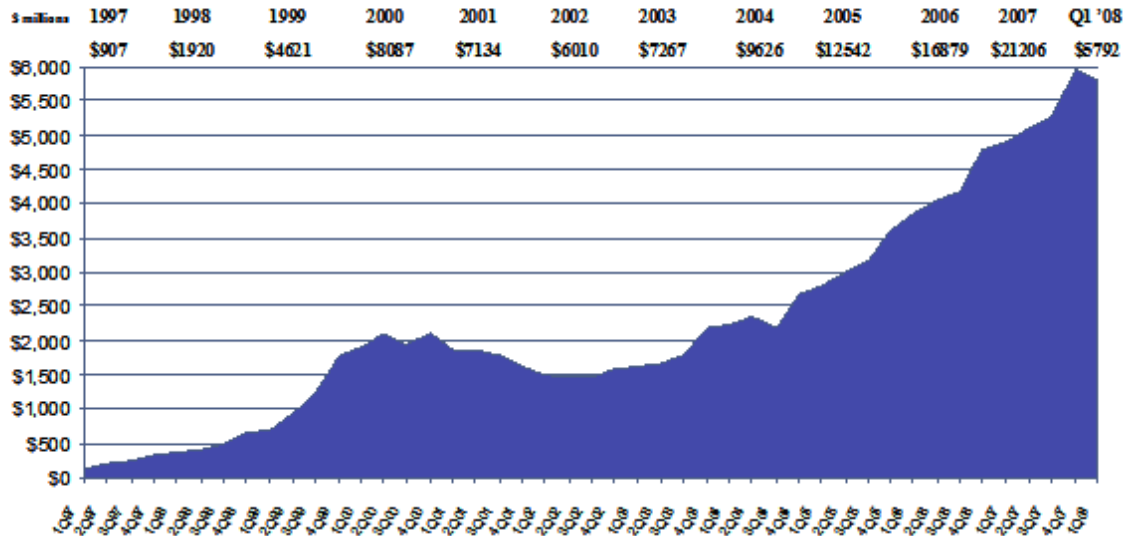
# And then the World Changed



# Market Forces in New Internet



Quarterly Internet Ad Revenues



# The “ATLAS 10” Today

Rank	Provider	Percentage
1	Level(3)	5.77
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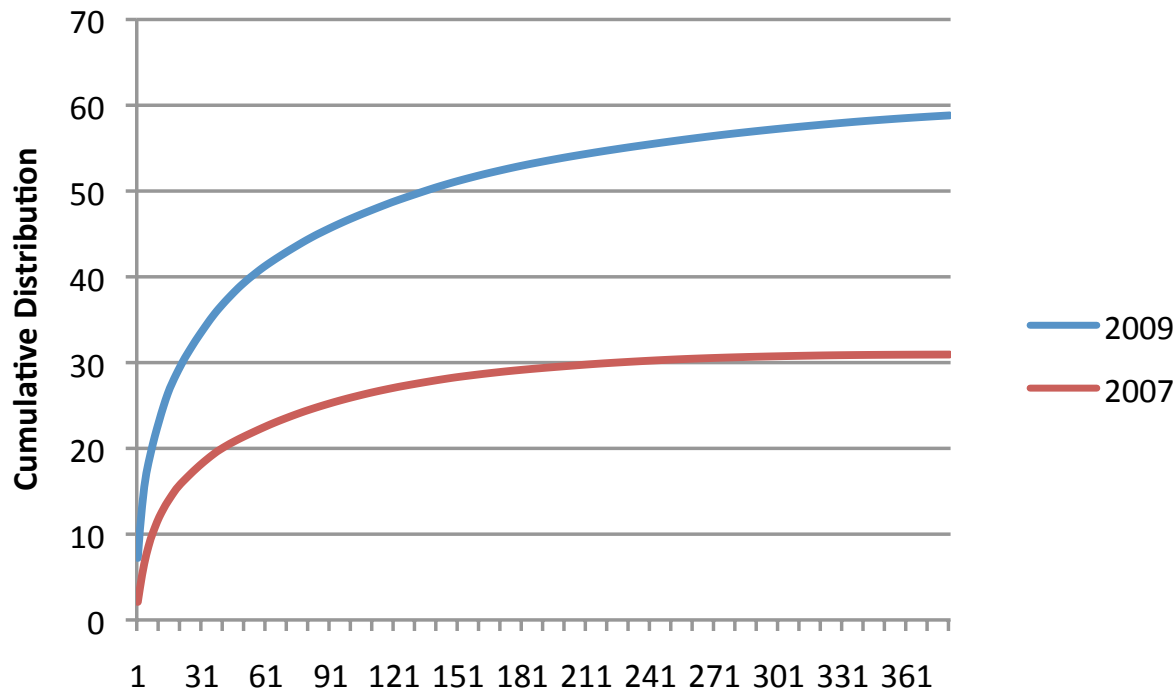
(a) Top Ten 2007

Rank	Provider	Percentage
1	Level(3)	9.41
2	Global Crossing	5.7
3	Google	5.2
4		
5		
6	Comcast	3.12
7		
8	<i>Intentionally omitted</i>	
9		
10		

(b) Top Ten 2009

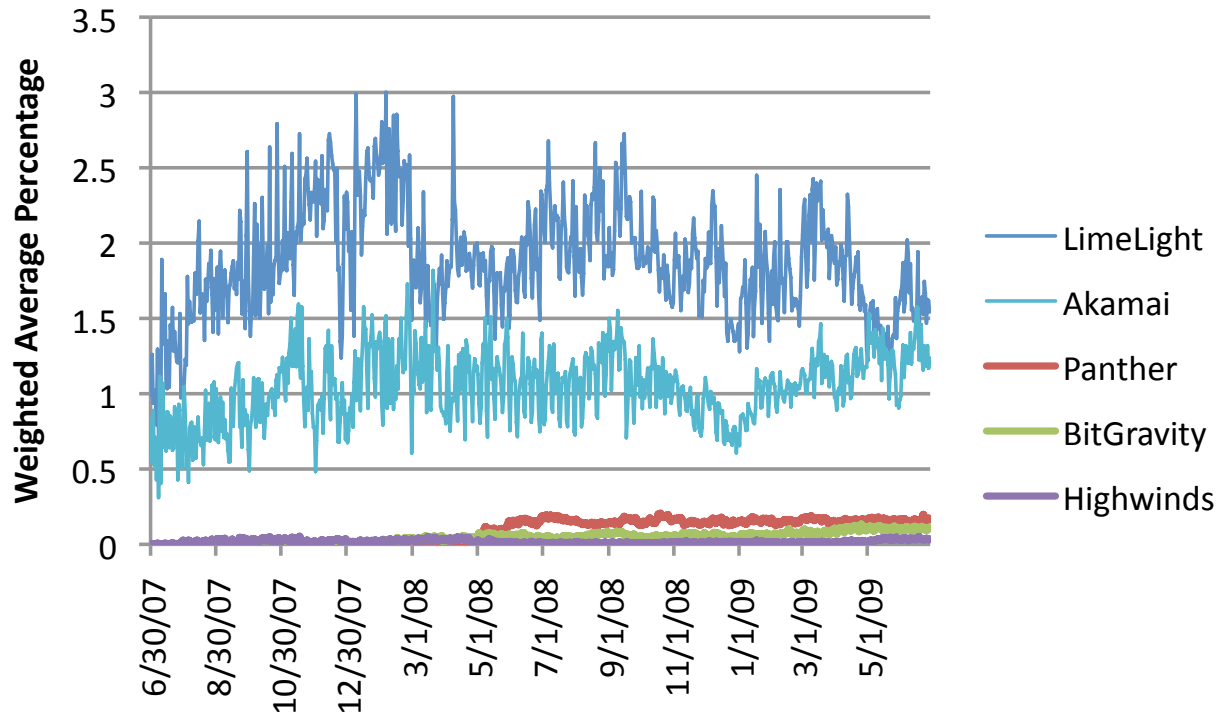
- Based on analysis of anonymous ASN (origin/transit) data
  - Weighted average percentage
- Top ten has NO direct relationship to Observatory participation
- Tier1s still carry significant traffic volumes (and profitable services)
- But Comcast and Google join the top ten

# Consolidation of Content *(Grouped Origin ASN)*



- In 2007, thousands of ASNs contributed 50% of content
- In 2009, 150 ASNs contribute 50% of all Internet traffic
- Approximates a power law distribution

# Growth of CDNs *(and consolidation of content)*



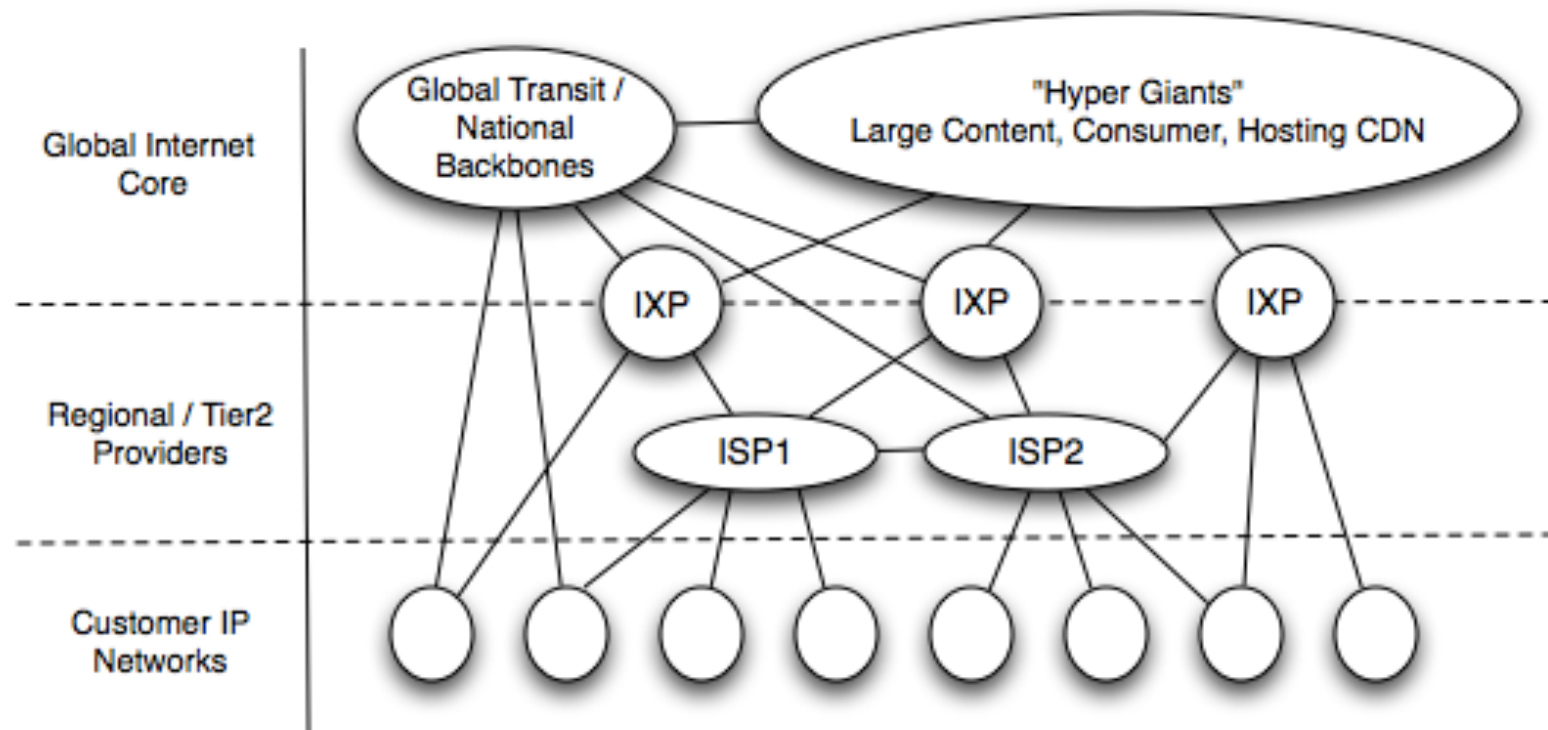
- **Graph shows top 5 ‘pure-play’ CDN origin ASN groups**
  - Increasingly blurred lines between ISP and CDN, etc.
  - Significant competition and new entrants
- **Only includes Akamai inter-domain (likely 1/4 or less of Akamai)**
- **As category, CDNs represent close to 10% of Internet traffic**

# What's Happening?

- **Commoditization of IP and Hosting / CDN**
  - Drop price of wholesale transit
  - Drop price of video / CDN
  - Economics and scale drive enterprise to “cloud”
- **Consolidation**
  - Bigger get bigger (economies of scale)
  - e.g., Google, Yahoo, MSFT acquisitions
- **Success of bundling / Higher Value Services**
  - Triple and quad play, etc.
- **New economic models**
  - Paid content (ESPN 360), paid peering, etc.
  - Difficult to quantify due to NDA / commercial privacy
- **Disintermediation**
  - Direct interconnection of content and consumer
  - Driven by both cost and increasingly performance

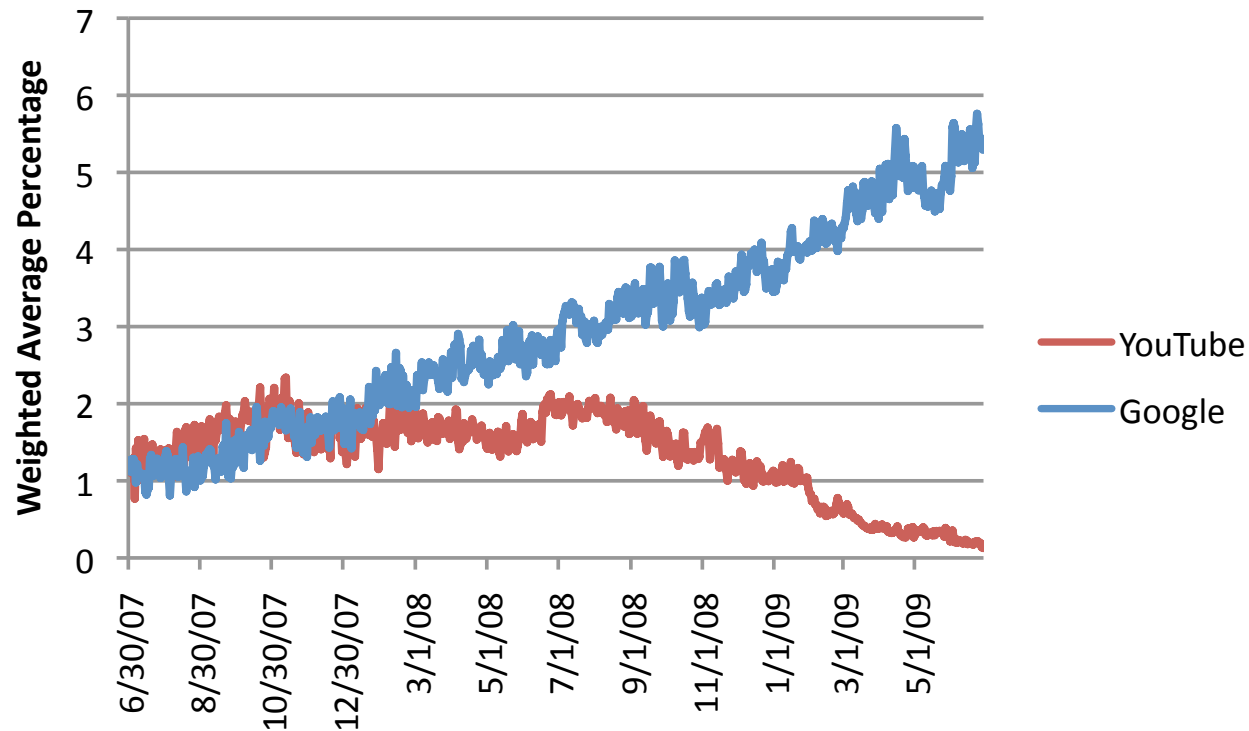


# The New Internet



- **New core of interconnected content and consumer networks**
- **New commercial models between content, consumer and transit**
- **Dramatic improvements in capacity and performance**

# Case Study: Google

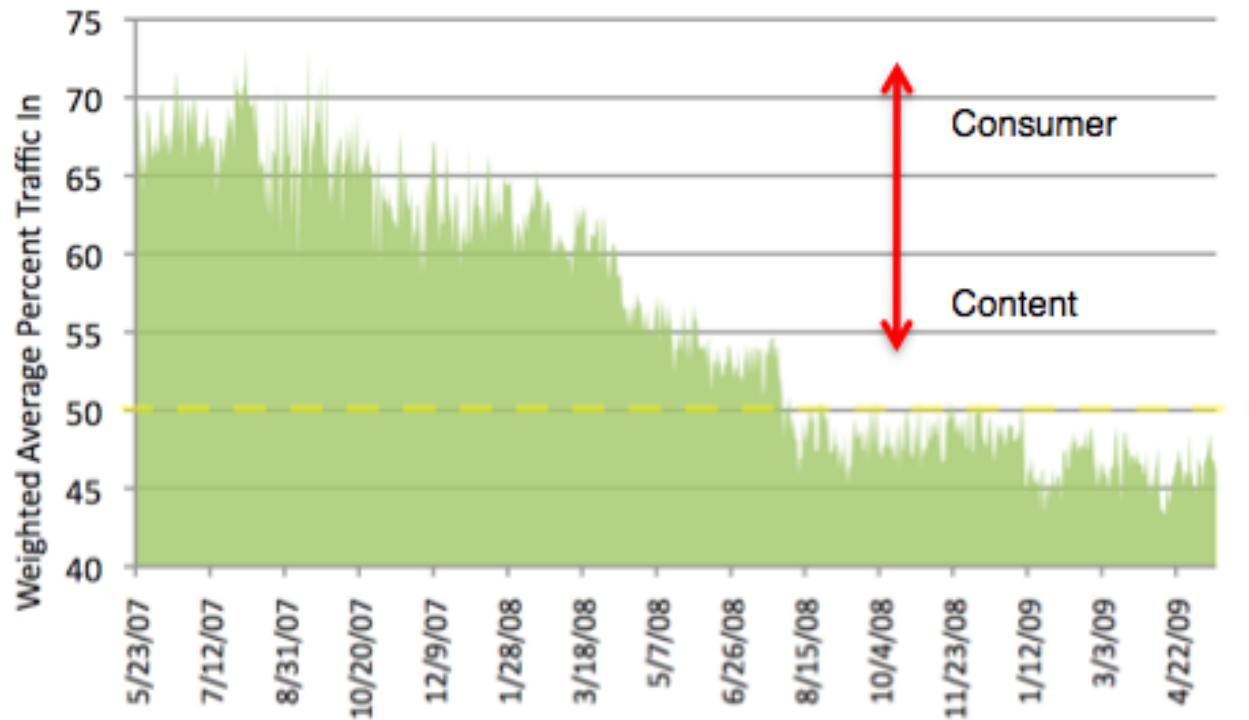


- **Graph of weighted averaged grouped ASNs**
  - Over time Google absorbs YouTube traffic
- **Google now accounts for 6% of all Internet traffic globally**
- **Google one of the fastest growing origin ASN groups**

# Case Study: Comcast

- **In 2007, Comcast looked like a traditional MSO**
  - Lacked a nationwide network backbone
  - Focused on residential Internet Services
  - Highly dependent upon upstream transit supplier
- **In 2009, Comcast is significantly different**
  - Net contributor of Internet traffic
  - 6<sup>th</sup> largest origin / transit group ASN by volume
- **Evidence of new Comcast business models**
  - Execution of triple play
  - Cell backhaul
  - Wholesale voice and IP transit
  - Video for other cable operators
  - Metro Ethernet

# Case Study: Comcast



- Graph of weighted average In/Out ratio with Comcast grouped ASN
- Comcast most significant ratio shift (20%) of any AS in top 100
- Increasingly blurred lines between content, consumer ISP, transit, CDN, etc.

# Application Consolidation

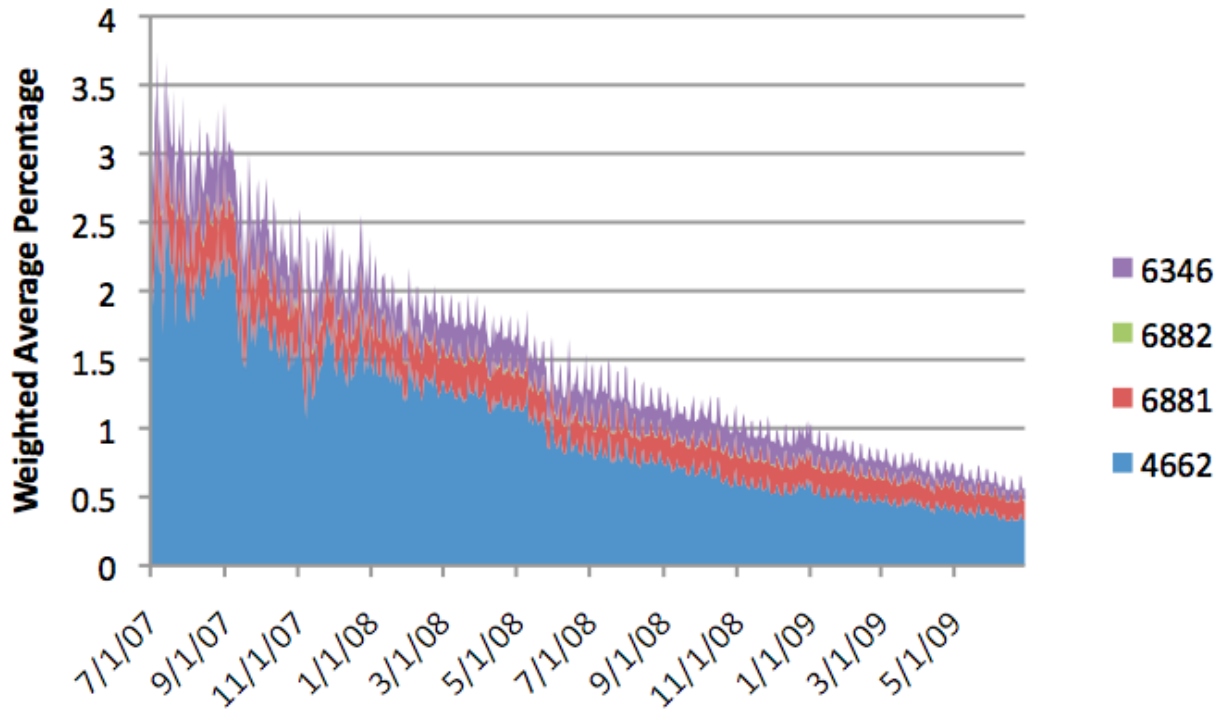
# Top ATLAS Global Applications

Rank	Application	2007	2009	Change
1	Web	41.68	52.00	+10.31
2	Video	1.58	2.64	+1.05
3	VPN	1.04	1.41	+0.38
4	Email	1.41	1.38	-0.03
5	News	1.75	0.97	-0.78
6	P2P	2.96	0.85*	-2.11
7	Games	0.38	0.49	+0.12
8	SSH	0.19	0.28	-0.08
9	DNS	0.20	0.17	-0.04
10	FTP	0.21	0.14	-0.07
	Other	2.56	2.67	+0.11
	Unclassified	46.03	37.00	-9.03

\* 18% via payload inspection

- **Weighted average percentage Internet traffic**
  - Change is in terms of percentage of all Internet traffic
- **Limited payload based application classification dataset**
  - P2P likely closer to 18%, and video significantly larger
- **Web (and video over HTTP) largest and faster growing**
- **Followed by P2P (which is also fastest shrinking)**

# Global P2P Trends



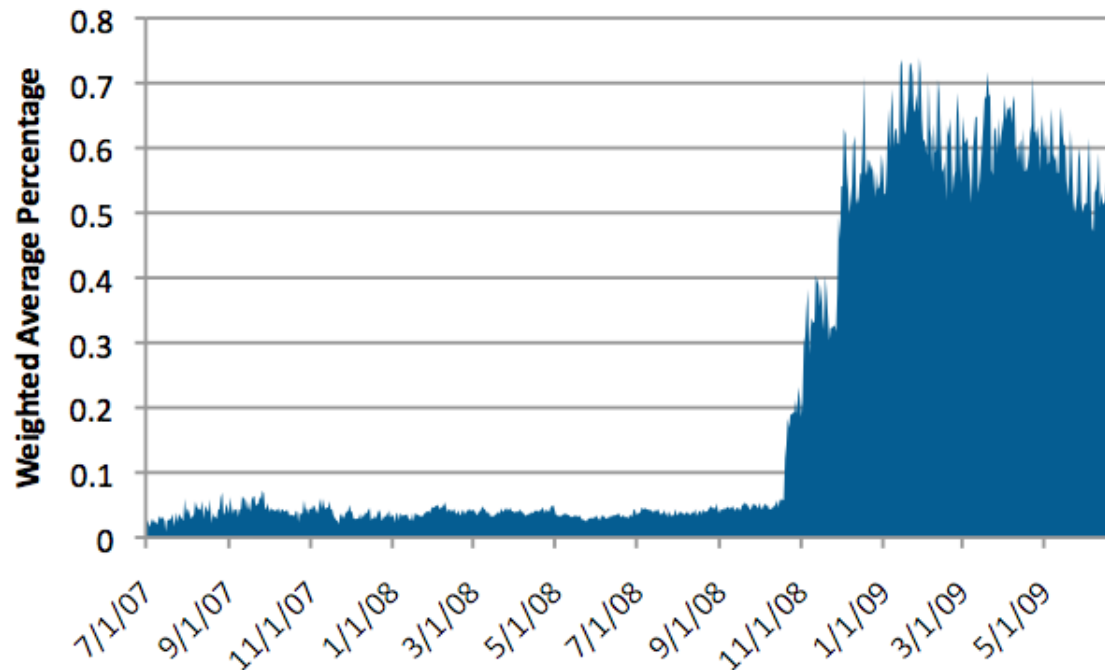
- **Graph of weighted average traffic using well-known P2P ports**
- **Trend in both well-known ports and payload based analysis**
  - Not enough data to graph payload based data decline
  - Most P2P uses random ports and 40% or more encrypted
- **Slight differences in rate of decline by region (i.e. Asia is slower)**

# P2P Decline

- Still significant volumes of P2P
- But slower growth and some absolute decline
  - Provider traffic management
  - Improved P2P clients / algorithms
  - Migration to other content sources
- Mainly P2P increasingly eclipsed by streaming, CDN, and direct download



# P2P Replaced by Direct Download



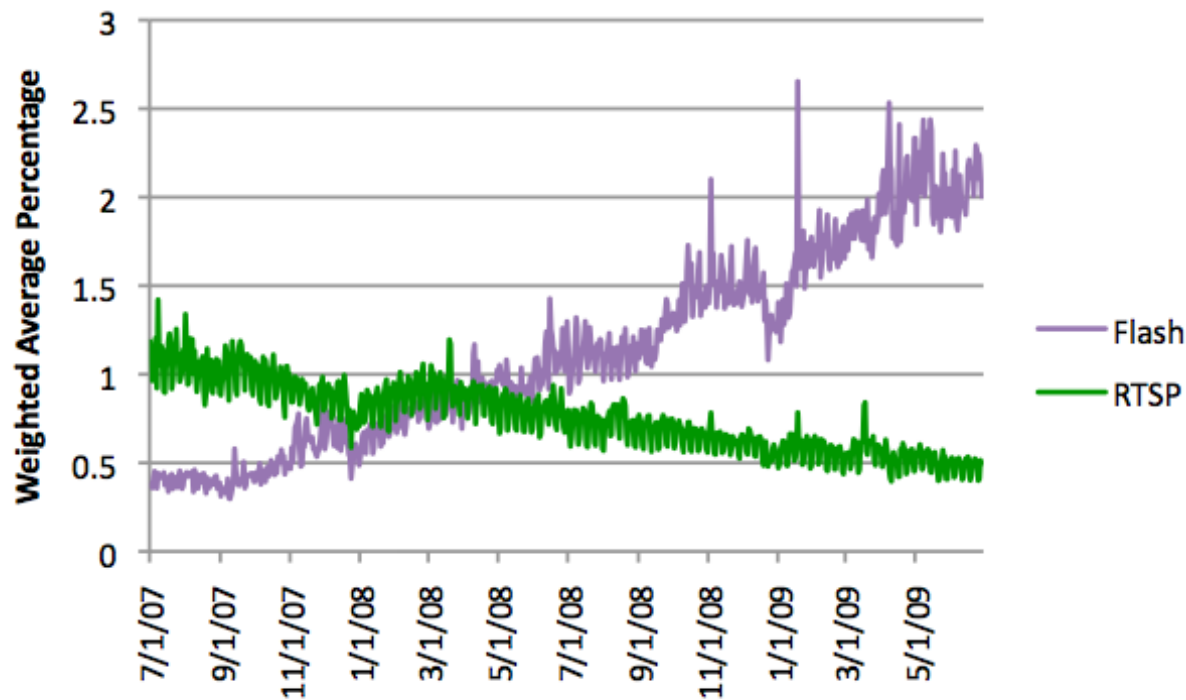
- Graph shows weighted average percentage Carpathia traffic
- Carpathia Hosting represents more than 0.5% of all traffic
  - Provider to MegaUpload, MegaErotic, etc.
  - Mega became Carpathia customer November 2008

# Conclusion

- **Internet is at an inflection point**
- **Transition from focus on connectivity to content**
  - Old global Internet economic models are evolving
  - New entrants are reshaping definition / value of connectivity
- **New technologies are reshaping definition of network**
  - “Web” / Desktop Applications, Cloud computing, CDN
- **Changes mean significant new commercial, security and engineering challenges**
- **This is just the beginning...**

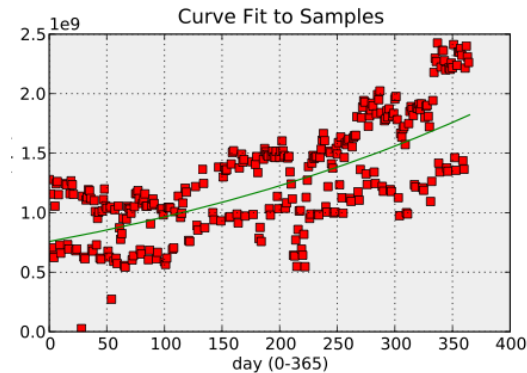
# Backup Slides

# Video

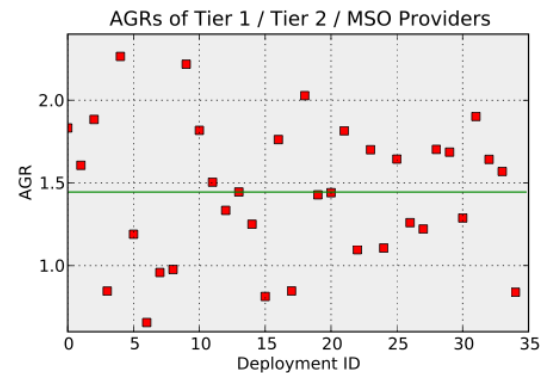


- Estimate 25%+ of all traffic (including 10% of HTTP)
- Video migrating to HTTP and flash
- Video fastest growing Internet application class

# Internet Size / Growth



(a) Example AGR Calculation

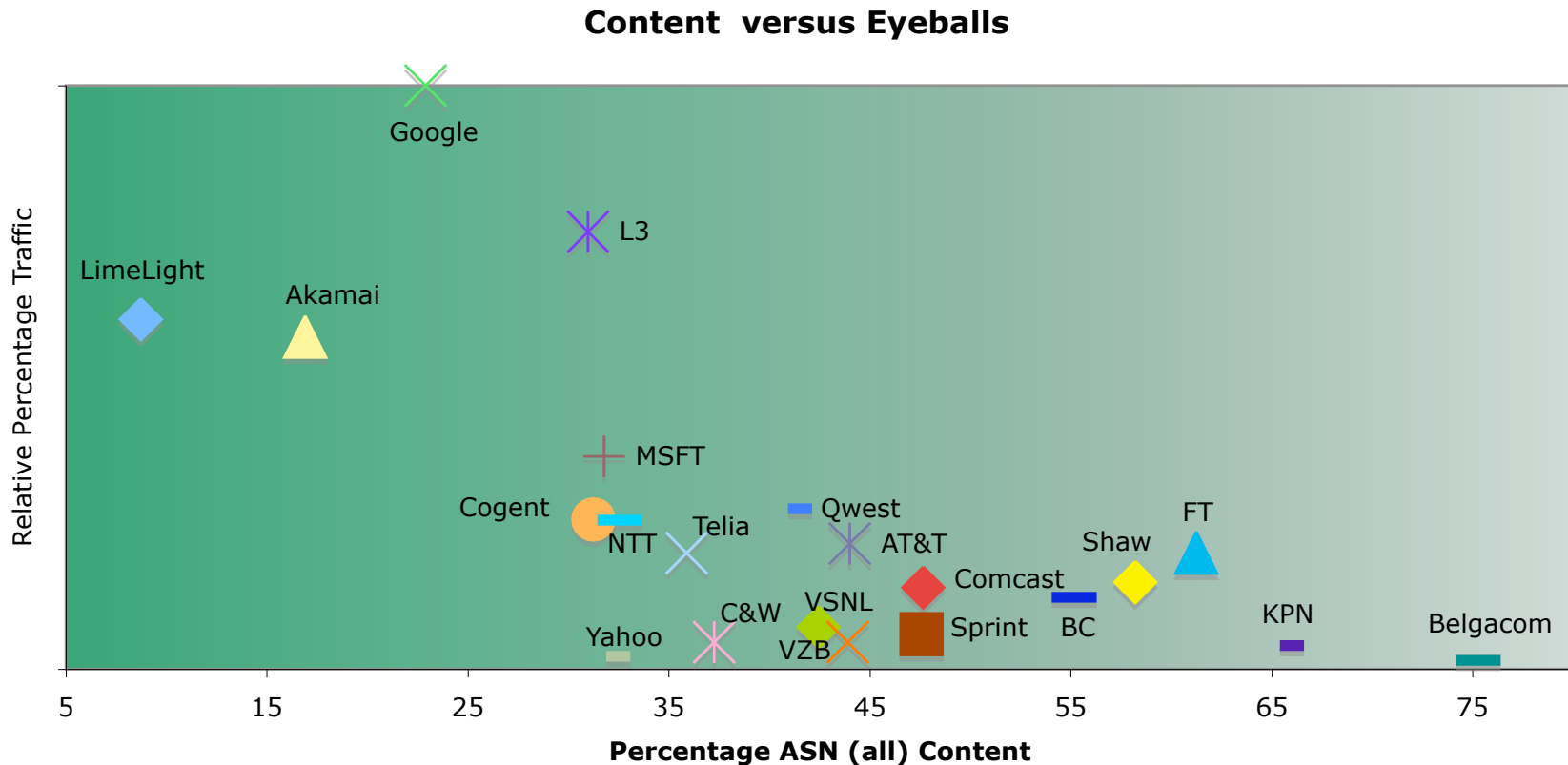


(b) Per-deployment AGRs

Estimate	Observatory	ISP Survey	Cisco	MINTS
Traffic Volume Per Month	9 exabytes	N/A	9 exabytes	5-8 exabytes
Traffic Annual Growth Rate	44.5%	35-45%	50%	50-60%

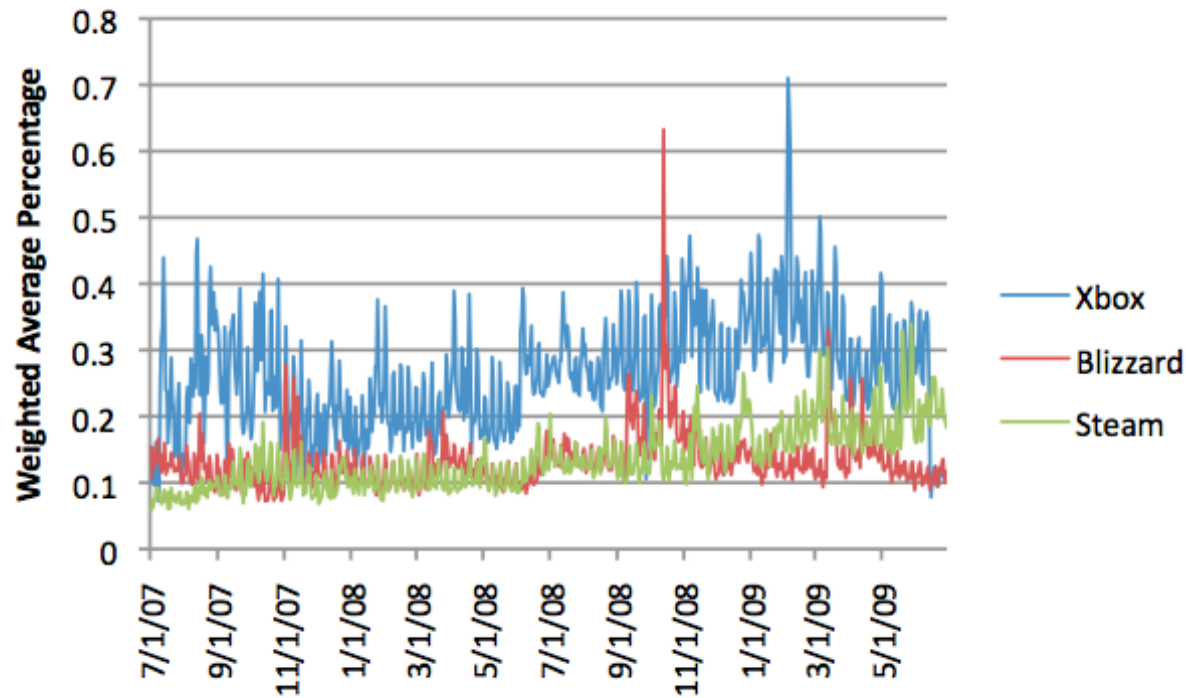
- **Followed MINTS methodology for AGR**
  - Used 10 known ISP totals (MRTG / Flow based) to extrapolate Internet total
- **Similar findings to MINTS and Cisco**
  - Significant growth, but no “Exaflood”

# Map of Evolving Internet



- **Graph of relative size and peering ratios of group ASNs**
  - Vertical axis not to scale
- **As you go left and towards top, large “Hyper Giants”**
- **Transit providers with 50% ratios in middle**
- **Heavy tailed smaller ASNs / consumer networks to the right**

# Games



- **WoW spikes mates Lich King on November 13, 2008**
- **Microsoft live moved to port 80 only on June 26, 3009**

# 2009 ATLAS Observatory Statistics

Data Overview	
Number of Deployments	110
Number of Routers	2,949
Number of Interfaces	441,528
Peak Traffic Rate	14 Tbps
Total Observed Traffic	264 Exabytes

- All data from anonymous statistics
- No direct relationship between any companies discussed in this report and Observatory participants