ATLAS Internet Observatory

- 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

Graphic not an accurate representation of current ATLAS deployments
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
  Andrew Odlyzko, “Minnesota Internet Traffic Studies (MINTS)”
  Nate Anderson, “P2P traffic drops as streaming video grows in popularity”. Ars Technica, September, 2008.
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

- Tier1 global core (modulo a few name changes over the years)
- Still taught today
The “ATLAS 10” in 2007

<table>
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<tr>
<th>Rank</th>
<th>Provider</th>
<th>Percentage</th>
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</table>

- 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

2005

Collapse price of wholesale transit

Growth of advertisement supported content

Collapse of price of Cloud / Hosting / CDN

2010

Scarcity of Data Center Capacity
Market Forces in New Internet

Revenue from Internet Transit
Source: Dr. Peering, Bill Norton

Revenue from Internet Advertisement
Source: Interactive Advertising Bureau
### The “ATLAS 10” Today

#### 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

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</table>

(a) Top Ten 2007  
(b) Top Ten 2009

*Intentionally omitted*
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
  - 6th 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

<table>
<thead>
<tr>
<th>Rank</th>
<th>Application</th>
<th>2007</th>
<th>2009</th>
<th>Change</th>
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<td>3</td>
<td>VPN</td>
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<td>1.41</td>
<td>+0.38</td>
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<td>Email</td>
<td>1.41</td>
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<td>5</td>
<td>News</td>
<td>1.75</td>
<td>0.97</td>
<td>-0.78</td>
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<td>6</td>
<td>P2P</td>
<td>2.96</td>
<td>0.85*</td>
<td>-2.11</td>
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<tr>
<td>7</td>
<td>Games</td>
<td>0.38</td>
<td>0.49</td>
<td>+0.12</td>
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<td>SSH</td>
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</table>

- **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)**

* 18% via payload inspection
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

- 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, 2009
2009 ATLAS Observatory Statistics

Data Overview

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Number of Deployments</td>
<td>110</td>
</tr>
<tr>
<td>Number of Routers</td>
<td>2,949</td>
</tr>
<tr>
<td>Number of Interfaces</td>
<td>441,528</td>
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<tr>
<td>Peak Traffic Rate</td>
<td>14 Tbps</td>
</tr>
<tr>
<td>Total Observed Traffic</td>
<td>264 Exabytes</td>
</tr>
</tbody>
</table>

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