The Evolution of the U.S. Internet Peering Ecosystem

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5 Yr Mission

W/Peering Coordinators

90% Externally Focused

Correct Lack of Operations Documentation on Peering Practices

Document Internet Operations Findings in Publicly Available White Papers...
1. Find Operations Area
2. Experts-White Paper v0.1
3. Community Walk Through
4. Revise White Paper
5. Present White Paper at conferences
6. Solicit comments over lunches and dinners
Public Network Operations Documents

Interconnection Strategies for ISPs
Internet Service Providers and Peering
A Business Case for Peering
The Art of Peering: The Peering Playbook
The Peering Simulation Game
Do ATM based Internet Exchanges Make Sense?
Evolution of the U.S. Peering Ecosystem
Asia Pacific Peering Guidebook

Email to wbn@equinix.com for any of these
The Evolution of the U.S. Peering Ecosystem

150 Peering Coordinators:

How has Peering changed since Telecom Crash?

Foreign Tier 1 ISP enters U.S. and expects peering with all the Tier 1 ISPs

--> explain / document motivations of NO

Explain Peering Motivations and Behavior, particularly across Internet Regions
The U.S. Peering Ecosystem

Internet Regions

Definition: Global Internet Peering Ecosystem consists of many Autonomous but interconnected Internet Regions (Countries)

Each Internet Region has roughly three classes of organism each with their own position, motivations → predict peering behavior:

1. Tier 1 ISPs
2. Tier 2 ISPs
3. Content Players

NOTE: RECLAIMING DEFINITIONS HERE
**Tier 1 ISP**

**Definition:** An ISP that has access to the entire Internet region routing table, solely through peering relationships.

**Peering Behavior**

**Motivation:** "We don’t need any more peering."

**Inclination:** Restrictive
**Tier 2 ISP Model**

**Definition:** All non-Tier 1 ISPs (must buy transit)

**Peering Behavior**

**Motivation:** Peer to reduce transit fees, performance

**Inclination:** Open $\rightarrow$ Selective

**Peering Links**

**Upstream Links**

**Transit (Downstream) Links**

**Sparse Peering**
**Content Provider**

*Def:* Provides content, does not peer, does not sell transit, mostly outbound traffic.

**Peering Behavior**

*Motivation:* Focus on end-user experience;

*Inclination:* No peering; generally few netstaff.
The Internet Peering Ecosystem

Pre-Crash: circa 2000

Pre-Crash: 1998
1998

Tier 1 ISP
Tier 2 ISP
Content

Tier 2 ISPs

Transit

Tier 1 ISPs

In-group Peering

Content

Tier 1 Full Mesh
Tier 2 Sparse Mesh
Transit $388/MBPS
Booming Economy
Peering Growth

And then, the crash
A fatal exception 0E has occurred at 0028:C001E36 in VXD UMM(01) + 00010E36. The current application will be terminated.

* Press any key to terminate the current application.
* Press CTRL+ALT+DEL again to restart your computer. You will lose any unsaved information in all applications.

Press any key to continue _
NO, NOT THAT TYPE OF CRASH...
THE TELECOM INDUSTRY CRASH

CRASH: ’99-’01

Internet Peering Ecosystem

Pre-Crash: circa 2000

Crash: ’99-’01
Five key events led to a drastic disruption in the U.S. Peering Ecosystem:

1) TIER 1 ISP BANKRUPTCIES
2) THE GROWTH OF THE USED EQUIPMENT MARKET
3) THE UPSTREAM PROVIDER FOR THE CABLE COMPANIES (@HOME) WENT BANKRUPT
4) PEER-TO-PEER FILE SHARING SYSTEMS (LIKE KAZAA) GROW IN POPULARITY, TRAFFIC GROWS EXPONENTIALLY BETWEEN ACCESS PROVIDERS (1.5MB MP3 $\rightarrow$ 700MB AVI FILES)
5) TRANSIT PRICES DROP, TRANSPORT PRICES DROP

Led to 3 major evolutions $\rightarrow$ A new Organism
**Peering Behavior**

**Motivation:** Peer to save money, improve performance

**Inclination:** Open-selective

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Cable Company

@HOME Handled Internet

30-60 Days Notice

→ Tier 1 Transit

40% Traffic Kazaa

3-5 Gbps of Transit

→ Up to 2Gbps of Peering Traffic!
<table>
<thead>
<tr>
<th>MSO</th>
<th>Country</th>
<th>YE02</th>
<th>Change in 02</th>
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<tbody>
<tr>
<td>Comcast</td>
<td>USA</td>
<td>3,620,300</td>
<td>1,199,100</td>
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<tr>
<td>Time Warner</td>
<td>USA</td>
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<td>1,027,000</td>
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<td>Charter</td>
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<td>1,180,000</td>
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<td>CableVision</td>
<td>USA</td>
<td>770,100</td>
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<tr>
<td>Shaw (Big Pipe)</td>
<td>Canada</td>
<td>750,000</td>
<td>?</td>
</tr>
<tr>
<td>Rogers</td>
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<td>650,000</td>
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<td>49,800</td>
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<td>Insight</td>
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<td>144,800</td>
<td>56,700</td>
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<td>Cable One</td>
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<td>45,200</td>
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<td><strong>Total</strong></td>
<td></td>
<td><strong>12,665,600</strong></td>
<td><strong>4,278,900</strong></td>
</tr>
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</table>
AOL is the 800 Pound Gorilla
Evolution #1
Cable Companies Peer

Significant Evolution…

1) **Volume of traffic is huge**
2) **Cable Cos Open Peering**
3) **“Kazaa Effect” amplifies peering benefits**
**Peering Behavior**

**Motivation:** Peer to save money, improve performance

**Inclination:** Open

**Transit (Upstream) Links**

**Large Scale Network Savvy Content Providers**

**Peering Links**

**2002 Tier 1 ISP Tier 2 ISP Content Cable Co. LSNSCP**

**Sparse (Regional) Peering**
Evolution #2
Large Scale Content Players Peer

Significant Evolution…

1) *Volume of traffic is huge*
2) *Content is open peering*
3) *Improves end-user experience*
4) *Leading players are paving the way*

…need to move out of bankrupt colo anyway…
1) Volume of traffic pulled away from T1s is huge
2) Reduces perceived need for T1s (for local delivery anyway)
3) T1s still needed for distance

→ Content Literally right on the Cable Company Network
Questions?