Start assuming no knowledge of Internet Interconnection

1. Internet Transit
2. Internet Peering
3. The Business Case for Peering
4. The ISP Peering Playbook (selections)
5. The IX Playbook (if there is time, how IX builds critical mass)
6. The Peering Simulation Game

Finish with an understanding of how the core of the Internet is interconnected
Internet Transit – Interconnection at the edge

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APRICOT 2012 Peering Forum
Jan 28, 2012
New Delhi, India

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Overview of this section

- Start assuming no knowledge
  - I know… many of you are very knowledgeable in this stuff
  - See how I explain things
  - These build effectively

- Introduce the Global Internet Peering Ecosystem

- In this context, metered Internet transit service

- Measurement and pricing models

- The Internet Transit Playbook
The Internet

- Network of Networks
- Organic from ARPANET, NSFNET
- Commercialization 1994
  - Planned economy
- Corporate interests 1997 onward
  - Limited information sharing
- Evolution: “Global Internet Peering Ecosystem”
The Global Internet Peering Ecosystem

- **Definition:** The Global Internet Peering Ecosystem models the internal structure of the Internet as a set of Internet Regions (typically bound by country borders), each with its own Internet Peering Ecosystem.
Definition: An Internet Region is a portion of the Internet, usually defined by geographical boundaries (country or continent borders), in which an Internet Peering ecosystem is contained.
The Global Internet Peering Ecosystem

**Definition**: The **Internet Peering Ecosystem** is a community of network service providers that interconnect their networks in various business relationships within an Internet Region.
Internet Transit

- **Definition:** Internet Transit is the business relationship whereby an entity provides (usually sells) access to the Internet.

  "Internet ➔ this way"

- **Definition:** An Internet Service Providers (ISP), also called a “Transit Provider”, is an entity that sells access to the Internet.
Internet Transit Service

- Announce Reachability
- Metered Service
- Simple
- “Internet → This Way”
- Equivalent Notations

(5-minute samples for 1 month. 95th percentile measure)
* transit fee = monthly bill)
Internet Transit Pricing Model

- Typically metered
- $/Mbps
- Volume measured at 95th percentile

**Definition:** The 95th Percentile Measurement Method (also called 95/5) uses a single measurement (the 95th percentile 5 minute sample for the month) to determine the transit service volume for monthly transit fee calculation.

Let’s walk through the 95th percentile measure
Question: at 95th I send 500Mbps and receive 800Mbps. My transit is priced at $10/Mbps. What is my monthly Internet transit bill?

a) $5,000
b) $8,000
c) $13,000
d) None of the above
Origin of the 95th Percentile

- Charged based on pipe capacity
- T1 Internet Service pricey
- Paid as if you filled it up 24/7
- Peak usage – bursty penalties
- 95th allows for 5% bursts
- Market adopted it
Transit Pricing with Commits

- Volume discounts
- Contracts with terms and duration

<table>
<thead>
<tr>
<th>Commit</th>
<th>Unit Price</th>
<th>MinSpend</th>
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<tbody>
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<td>10 Mbps</td>
<td>$12/ Mbps</td>
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</tr>
<tr>
<td>100 Mbps</td>
<td>$5/ Mbps</td>
<td>$500/month</td>
</tr>
<tr>
<td>1 Gbps</td>
<td>$3.50/ Mbps</td>
<td>$3,500/month</td>
</tr>
<tr>
<td>10 Gbps</td>
<td>$1.20/ Mbps</td>
<td>$12,000/month</td>
</tr>
<tr>
<td>100 Gbps</td>
<td>$0.70/ Mbps</td>
<td>$70,000/month</td>
</tr>
</tbody>
</table>

\[
\text{monthlyBill} = \max(T_v \times P_c, C \times P_c)
\]

where

\[T_v = \text{transitVolume}_\text{in}_\text{Mbps}\]

\[C = \text{commitLevel}_\text{in}_\text{Mbps}\]

\[P_c = \text{unit Price}_\text{at}_\text{commitLevel}_\text{in}_\text{$/per}_\text{Mbps}\]
Internet Price Declines (U.S.)

- “Can’t go lower”
- “No one is making $" 
- Pricing Varies Widely
- Trend unmistakable

<table>
<thead>
<tr>
<th>Year</th>
<th>Price</th>
<th>% Decline</th>
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</thead>
<tbody>
<tr>
<td>2012</td>
<td>$2.34</td>
<td>28%</td>
</tr>
<tr>
<td>2013</td>
<td>$1.57</td>
<td>33%</td>
</tr>
<tr>
<td>2014</td>
<td>$0.94</td>
<td>40%</td>
</tr>
<tr>
<td>2015</td>
<td>$0.63</td>
<td>33%</td>
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</tbody>
</table>
Internet Transit Growth

- Massive growth in Video
- Price Decline at 30%
- Volume grows at 60%
Implementation of Internet Transit

Architecture evaluates technology and designs a solution. Product Mgmt and capacity planning involved.

Engineering takes over implementation and early ops.

Operations phases transition.

Feedback throughout.

Always a new wave.
Observations: Internet Transit

- Simple Service
- Metered Service
- Transit Commits and Discounts
- Contract Terms
- Is a Commodity
- Customer-Supplier Relationship
- May have SLAs (joke)
Problem Sets

1. I am purchasing Internet Transit from ISP A for $5 per Mbps with no commits. At the end of the month I send 500 Mbps and receive 800 Mbps at the 95th percentile. What is my monthly bill?

A) $5/month  B) $2500/month  C) $4000/month  d) $6500/month

2. I am purchasing Internet Transit from ISP B for $5 per Mbps but I am considering buying their 1G commit transit product at a price of $3/Mbps. I still expect to send 500 Mbps and receive 800 Mbps at the 95th percentile. Should I commit to 1G?
Internet Peering – Peering at the Core of the Internet

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Overview of this section

- introduce Internet Peering
- 3 key ways *Internet Peering* is different from *Internet Transit*
- top five motivations ISPs gave for peering
- the Internet Peering Process
Introduction to Internet Peering

- Why bother with Peering?
- Transit is cheap ($1-$3/Mbps)
- Transit is getting cheaper
- “Does Peering make sense anymore?”
Does Peering Make sense anymore?

- #1 Question in ISP Peering Coordinator Community

- EVERY......YEAR

- Price drops 30%, volume increases 60%

- Transit Bill rising
**Internet Peering**

- **Definition:** Internet Peering is the business relationship whereby two companies reciprocally provide access to each others’ customers.
Internet Peering

**3 Key Points**

1. Peering is not a transitive relationship
2. Peering is not a perfect substitute
3. Peering is typically settlement free
Equivalent Notation

Text form: ApeerB
Create network diagrams

Notation shorthand to simply describe business relationships
Top 5 motivations for peering
Motivations to Peer

1. Lower Transit Costs
   (#1 from Tier 2 ISP motivation)

2. Improve end user experience
   (#1 from Content companies)

3. Better control over routing-strategic
   (#1 from Yahoo!, NetFlix 2008)

4. Usage based billing – make more money by peering
   (#1 from AboveNet)

5. Sell more underlying transport capacity
   (#1 from Telecom Italia)
The 3 Phases of the Internet Peering Process
Phase 1 – Identification of Target Peers

- NetFlow
- others
Cautionary Note

Top Internet Transit Traffic Destinations

- Top 20-40% will be restrictive peers

% of Internet Transit Traffic

Restrictive Peers

Selective and Open Peers

Target ISPs
Phase 2 – Initial Contact & Qualification

- Peering Steering Committee
- Finding the right person is a challenge (See The Peering Playbook)
- Here are the top 10 ways seasoned peering people use to establish contact
Top 10 ways seasoned Peering Coordinators Contact Target ISPs

1. face-to-face at informal meeting in an Internet Operations forum like NANOG, IETF, RIPE, GPF, APNIC, AFNOG, etc.,

2. face-to-face at Commercial Peering Forums like Global Peering Forum (you must be a customer of one of the sponsoring Ixes)

3. face-to-face at IX Member Meetings like DE-CIX, LINX, or AMS-IX member meetings.

4. introductions through an IX Chief Technical Liaison or a peer that knows the right contacts
Top 10 ways seasoned Peering Coordinators Contact Target ISPs

5. via electronic mail, using the pseudo standard peering@ispdomain.net or a personal contact,

6. from contacts listed on an exchange point participant list, or peeringdb registrations,

7. with tech-c or admin-c from DNS or ASN registries,

8. Google for peering contact $ASN peering ,

9. from the target ISP sales force, at trade show or as part of sales process,

10. from the target ISP NOC.
Hello kind sir,

It has recently been purchased to my attention that at this moment in time both of our companies are present at the LINX in London England and that we do not at this moment in time have an agreement between our companies such that we may interchange the traffics of our people and customers over this LINX in London England but that we exchanges our traffics in other manors that are detriment to our combined interests.

Please may it be that you are in reply to my email which I write with great satisfaction that we are to be setting the configuration up of the peerings at LINX in London England.

Please be in reply to this email if you are in agreement.

I am available of the email address peering@internetserviceprovidings.in

Peering Department

Internet Service Providings India

What problems do you see with this peering request?

Missing Information

AS Number?

Traffic Volume?

Peering Requirements (if any?)

Other Peering Locations?

URL to backbone maps, website?
Hello,

Norton Associates (666) is connected to the EQIX-ASH and is interested in establishing a peering session with AS7007.

We have a Selective peering policy and ARE willing to sign contracts.

Currently we exchange 1900Mbps of traffic at EQIX-ASH

Our details are as follows:
- IPv: 192.62.198.22
- AS: 666
- AS-MACRO: AS-NORTON-666
- Interface: gigE
- prefixes announced: 2
- MD5 password: YES
- peering email: peering@nortonassoc.com
- peering coordinator phone: DrPeering
- peering coordinator fax: 800-123-2121
- OC email: noc@nortonassoc.com
- OC phone: 800-123-4567
- OC fax: 800-123-4567
- OC mail address: PO Box 1, Ann Arbor, MI 48103
- Peering agreement: http://www.nortonassoc.com/peering/

Additional information about our network:

We carry over 30Gbps of transit.

We are present at the following IXPs:

EQIX-ASH: 192.62.192.22
Phase 2 – Initial Discussion

- NDAs may be signed
- BLPAs examined
- Discussion of prerequisites and policies
- Exchange of backbone maps
Phase 3 – Implementation Discussion

- **Direct Circuit**
  - Metro Area Direct Circuit Peering

- **Exchange Point**
  - Internet Exchange Point
  - Private Peering across a cross connect
  - Public Peering across the switch
  - Direct-Circuit Peering

Transoceanic Half-Circuits

- ISP A POP
  - Direct-Circuit Peering
  - Router

- ISP B POP
  - Router
Direct Circuit Approach

- Exactly two parties connected
- Cost: circuit cost

IX Approach

- Many parties connected across peering fabric
- Cost: Transport, router, colo, peering port
**Paid Peering Aside**

- **Definition:** A *Paid Peering* relationship is a peering relationship but with an exchange of compensation from one party to the other.

  Metered: $/Mbps

  Or Barter for services

  ~ Asymmetric allocation of costs of peering relationships
Challenges

1. “If I peer with A, B, and C, won’t my peers start sending their traffic to each other through my network? (A→C, A→B)”

2. In Australia we tax barter. . . How is Internet Peering like or unlike barter?

3. Draw the network diagram using the peering and transit notation for the following scenario: ISP A and ISP B purchase transit from ISP C who peers with ISP D and ISP E. ISP D sells transit to ISP X and ISP E sells transit to ISP Y.

4. In #3, would ISP C likely be interested in peering with ISP A?

5. Should paid peering be priced the same as Internet Transit? What is the case for it being priced cheaper than transit, and what is the case for pricing is higher than the price of transit?
Questions?
The Business Case for Peering

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Overview of this section

- “For the CFO, keep it simple”
- When does peering make sense financially?
- Don’t convince, prove.
- “Tell me again why I should burn a port for free peering when I could make revenue off of it?”
- Bryan Garrett (BellSouth) story
  - Used internally
  - Reviewed quarterly
  - External expertise
The Cost of Peering in 2010

Assumptions

<table>
<thead>
<tr>
<th>Far</th>
<th>Transport into IX:</th>
<th>$6,000 per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colocation Fees:</td>
<td>$1,000 per month</td>
<td></td>
</tr>
<tr>
<td>Peering Fees:</td>
<td>$2,000 per month</td>
<td></td>
</tr>
<tr>
<td>Equipment Costs:</td>
<td>$2,000 per month</td>
<td></td>
</tr>
<tr>
<td>Total Cost of Peering:</td>
<td>$11,000 per month</td>
<td></td>
</tr>
</tbody>
</table>

Transport into DE-CIX
$2000/mo local
$4000/mo nearby
$6000/mo far

Colocation $1000/mo
Peering Port $2000/mo 10G
POP
Transport $6000/mo 10G
## Cost of Internet Peering

### Assumptions

<table>
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<tr>
<th></th>
<th>Far</th>
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</thead>
<tbody>
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<td>Transport into IX:</td>
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</tr>
<tr>
<td>Total Cost of Peering:</td>
<td>$11,000 per month</td>
</tr>
</tbody>
</table>

### Mbps Exchanged vs. Peering Cost

<table>
<thead>
<tr>
<th>Mbps Exchanged</th>
<th>Peering Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Mbps</td>
<td>$110.00 per Mbps</td>
</tr>
<tr>
<td>200 Mbps</td>
<td>$55.00 per Mbps</td>
</tr>
<tr>
<td>300 Mbps</td>
<td>$36.67 per Mbps</td>
</tr>
<tr>
<td>400 Mbps</td>
<td>$27.50 per Mbps</td>
</tr>
<tr>
<td>500 Mbps</td>
<td>$22.00 per Mbps</td>
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<tr>
<td>600 Mbps</td>
<td>$18.33 per Mbps</td>
</tr>
<tr>
<td>700 Mbps</td>
<td>$15.71 per Mbps</td>
</tr>
<tr>
<td>800 Mbps</td>
<td>$13.75 per Mbps</td>
</tr>
<tr>
<td>900 Mbps</td>
<td>$12.22 per Mbps</td>
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<tr>
<td>1000 Mbps</td>
<td>$11.00 per Mbps</td>
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<tr>
<td>1100 Mbps</td>
<td>$10.00 per Mbps</td>
</tr>
<tr>
<td>1200 Mbps</td>
<td>$9.17 per Mbps</td>
</tr>
<tr>
<td>1300 Mbps</td>
<td>$8.46 per Mbps</td>
</tr>
<tr>
<td>1400 Mbps</td>
<td>$7.86 per Mbps</td>
</tr>
<tr>
<td>1500 Mbps</td>
<td>$7.33 per Mbps</td>
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</tbody>
</table>

Cost of Peering allocated across the amount of traffic peered for free.
4 Internet Peering Metrics

All of these metrics are variants of **Does Peering make sense?**

1. How much traffic do I have to peer for free to save enough money to cover the cost of peering?

2. When I max out peering, what will be the best case scenario cost of peering?

3. What is the maximum amount of traffic I can realistically push through peering infrastructure?

4. Where is the peering sweet spot, when peering proves financially rational?
**Definition:** The **Peering Break Even Point** is the point where the unit cost of peering exactly equals the unit price of Internet Transit.

\[
\text{CostOfPeering} = \frac{\text{MonthlyCostOfPeering}}{\# \text{MbpsExchanged}}
\]

\[
\text{PeeringBreakEvenPoint} = \frac{\text{MonthlyCostOfPeering}}{\text{Unit PriceOfTransit}}
\]
Application of Peering Breakeven Point

“If you can peer 3143Mbps I can prove to you it makes sense to build in”

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Far</th>
<th>Near</th>
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<td>Transport into IX:</td>
<td>$6,000 per month</td>
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<td>Colocation Fees:</td>
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<td>Equipment Costs:</td>
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<tr>
<td>Total Cost of Peering:</td>
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<td>$7,000 per month</td>
</tr>
<tr>
<td>market price at origin</td>
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<td>$3.50 per Mbps</td>
<td>$3.50 per Mbps</td>
</tr>
<tr>
<td>market price at dest</td>
<td>$2.00 per Mbps</td>
<td>$2.00 per Mbps</td>
<td>$2.00 per Mbps</td>
</tr>
<tr>
<td>peeringBreakEven (Mbps)</td>
<td>3143 Mbps</td>
<td>2571 Mbps</td>
<td>2000 Mbps</td>
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<tr>
<td>minCostOfTraffic ($/Mbps)</td>
<td>$1.57</td>
<td>$1.29</td>
<td>$1.00</td>
</tr>
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</table>
**Effective Peering Bandwidth**

- **Definition:** The Effective Peering Bandwidth is the maximum amount of traffic that can be safely transported (without packet loss) across peering infrastructure.

\[ \text{EffectivePeeringBandwidth} = 70\% \times 10\text{Gbps} = 7000\text{Mbps} \]
Definition: The Minimum Cost for Traffic Exchange is the lowest unit cost obtainable in a peering infrastructure deployment.

\[
\text{minimumCostOfTrafficExchange} = \frac{\text{costOfPeering}}{\text{effectivePeeringBW}} = \frac{\$11,000 \text{ perMonth}}{7000 \text{ Mbps}} = $1.57 \text{ perMbp}
\]
Definition: The Effective Peering Range is the range of peering traffic exchange that makes sense financially.
Non-Financial Motivations for Peering

- Low Latency
- Control Over Routing
- Redundancy
- Aggregation benefits w/peering and Transit at IX
- Make more money with lower latency and loss
Non-Financial Motivations for Peering

- ISP relationships
- Marketing benefits
- Network reliability
Challenges with Peering

- Network Expertise Required
- Admin startup costs
- Peering not always granted
- Greater operational overhead
- Peering process may be slow
- Peering may not be granted
  - Hence the Peering Playbook
Challenges: Build into an IX?

1. What is the monthly bill if you buy 1.5Gbps of transit at $2/Mbps and peer 1Gbps at an IX with a monthly peering cost of $5000/month?

2. You have 5 Gbps of video traffic to push and your price of transit is $2 per Mbps with a 2G commit. Does it make sense to build into Sandeep's Internet Exchange if the circuit in costs $3000/mo, colo costs $1000/mo, the 10Gbps peering port costs $3000/mo and you think you can peer away 2Gbps for free at the IX?

3. You have 6 Gbps of video traffic to push and the price of transit is $2 per Mbps with a 2G commit. Does it make sense to build into Manning's Internet Exchange if you can peer 2Gbps with the only cost being port costs $2000/mo for a 10 gig port.
The Peering Simulation Game

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Goals

- Apply the lexicon
- Live the life of a peering coordinator
- Invented@Telephony Conference
- “When I place a call from my browser to Yahoo!, how are the intermediary ISPs compensated for their part of the transaction?”
30 Runs of the Peering Simulation Game

- Across Africa – Train the Trainers
- New Zealand Social
- With Regulators (FCC)
- APRICOT, NANOG, RIPEs, etc.
- Strikingly similar to real life
- Couldn’t be done…Simplifications
Transit Provider X  The Peering Game

The Peering Game is a strategic game between two transit providers, X and Y. Each provider has two IXPs (Internet Exchange Points) labeled IXN and IXS. The game involves decisions on peering agreements and routing policies to optimize network connectivity and traffic distribution between the providers.
3 Rules

1. **Goal:** Maximize bank holdings. Make money by acquiring customers and reduce transit costs by peering.

2. **Play:** Roll the dice and expand your network by selecting that many adjacent “squares” of customers.

   Gain transit revenue of $2000 for each customer square you own.

   Pay transit fees of $1000 for each square of traffic that other ISPs own.

3. If at Exchange Point, two ISPs can negotiate peering:
   - $2000 recurring cost and loss of 2 turns, ISPs negotiates who covers the costs of peering.
   - Peering ISPs do not have to pay transit for each others squares starting the next turn.

Quick round…
A rolls 5,
Wants to peer w/B – moves to IXN
Receives revenue on 6 squares (6*$2000) Pays Transit on others squares (3*$1000) $12,000 - $3,000 = $9,000
Transit Provider X

A A A A A

A

A

Transit Provider Y

B A A A B

A

A

A

$12,000 - $3,000 = $9,000

B rolls 3,
Going to IXE

Receives revenue on 4 squares (4*$2000)
Pays Transit on others squares (8*$1000)
$8,000 - $8,000 = $0
C rolls 6,
Can get to IXW, likes IXS
Receives revenue on 7 squares (7*$2000)
Pays Transit on others squares (11*$1000)
$14,000 - $11,000 = $3,000
Transit Provider X

<table>
<thead>
<tr>
<th>A</th>
<th>A</th>
<th>A</th>
<th>A</th>
<th>A</th>
<th>IXN</th>
<th>B</th>
</tr>
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<tbody>
<tr>
<td>A</td>
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<td>I X</td>
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<td>X</td>
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<td>X</td>
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<tr>
<td>Y</td>
<td>C</td>
<td></td>
<td></td>
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<td>IXW</td>
<td>Y</td>
</tr>
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</table>

Transit Provider Y

<table>
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<tr>
<th>IXN</th>
<th>IXE</th>
<th>IXS</th>
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<tbody>
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</table>

D rolls 1, Late entrant heading to IXE
Receives revenue on 2 squares (2*$2000) 
Pays Transit on others squares (17*$1000) 
$4,000 - $17,000 = -$13,000
Scoreboard after Round 1

- ISP A: $9,000
- ISP B: $0
- ISPC: $3,000
- ISPD: -$13,000
<table>
<thead>
<tr>
<th></th>
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<td>D</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transit Provider X

A rolls 3, Attaches to IXW
Receives revenue on 9 squares (9*$2000)  
Pays Transit on others squares (13*$1000)  
$18,000 - $13,000 = $5,000

Wants to peer with C – split costs?  
YES: -$1,000 + both lose a turn  
Neither has to pay transit to each other!

Transit Provider Y
### Transit Provider X

**A Position**  
- 9 Revenue squares  
- 1 lost turn  
- Peering w/C  
- reduced cost $8000/turn

- **A rolls 2,** attaches to IXW  
  - Pays Transit on others squares (13*$1000)  
  - Receives revenue on 8 squares (8*$2000)  
  - $16,000 - $13,000 = $3,000  
  - Wants to peer with C – split costs?  
    - YES: -$1,000 both lose a turn  
    - Neither has to pay transit to each other

- **Wants to peer with A – split costs?**  
  - NO: You pissed me off,  
  - Yes: if $0 & B lose both turns  
  - Both walk away

### Transit Provider Y

- **B rolls 6,** attaches to IXE*IXN  
  - Receives revenue on 10 squares (10*$2000)  
  - Pays Transit on others squares (21*$1000)  
  - $20,000 - $21,000 = -$1,000  
  - Wants to peer with A – split costs?  
    - NO: You pissed me off,  
    - Yes: if $0 & B lose both turns  
    - Both walk away
Let’s play!

WELCOME TO BILLAND

4 ISPs that have never played before

Open Board

$35,000 VC Funding

$25,000 VC Funding – HARD Economic Times

We want to hear your thought process and peering negotiations
### Play Game

**Internet Service Provider**

**Starting Point**

- Cost $2000 revenue for each square you own
- Pay $1000 transit fee to your upstream for each square others own

**Internet Exchange Point East**

Reduce transit fee by peering with other ISPs at exchange point, $2000 per round and loss of 2 turns, split how ISPs see it

### Peering Array

<table>
<thead>
<tr>
<th>Round</th>
<th>Player A</th>
<th>Player B</th>
<th>Player C</th>
<th>Player D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Note:**
- Can only move adjacent or diagonally
- Hint: Calculate cost of NOT peering vs. Cost of peering
- At end of game we assume all roll a 3 for remaining rolls
- Winner is the ISP with the largest bank account at the end

### Pay for Transit to:

- A
- B
- C
- D

**Sum of Transit $500 paid to X**

<table>
<thead>
<tr>
<th>Player</th>
<th>Pay for Transit to A</th>
<th>Pay for Transit to B</th>
<th>Pay for Transit to C</th>
<th>Pay for Transit to D</th>
<th>Sum of Transit $500 paid to X</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$3,000</td>
<td>$6,000</td>
<td>$3,000</td>
<td>$6,000</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>$9,000</td>
<td>$12,000</td>
<td>$9,000</td>
<td>$12,000</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>$15,000</td>
<td>$18,000</td>
<td>$15,000</td>
<td>$18,000</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>$21,000</td>
<td>$24,000</td>
<td>$21,000</td>
<td>$24,000</td>
<td></td>
</tr>
</tbody>
</table>

**Calculated Values**

<table>
<thead>
<tr>
<th>Player</th>
<th>Pay for Transit to A</th>
<th>Pay for Transit to B</th>
<th>Pay for Transit to C</th>
<th>Pay for Transit to D</th>
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<tr>
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</tr>
</tbody>
</table>
Observations about the Peering Simulation Game

- Similar to real world
- Personality clashes
- Effective Teaching tool – use the language
  - Kenya - Relationships
  - Kuala Lumpur – Microsoft
  - Audience Engagement
  - Diagonal Strategy
- Sometimes, players don’t do the math.
- Unlimited rolls, peering always makes sense
How the game is different from reality

1. The board is veiled allowing for gaming and bluffing during peering negotiations

2. ISPs move serially in the game, while in the real world action is parallel.

3. The meaning of the board squares is severely overloaded to mean regional coverage and corresponding revenue, a quantum of traffic generated, and a quantum of traffic transited to all others. All customers are not equal in revenue, traffic.

4. Customer transit revenue gained does not cause any additional financial load for the ISP in the game.

5. Traffic quantum is a vague notion that ignores the asymmetric nature of traffic today.
How the game is different from reality

6. Shared squares should cause revenue and costs to be divided

7. Everyone starts with the same number of squares.

8. Everyone is financially backed to support infinite periods of financial loss. Well, that may reflect reality for some period of Internet time.

9. If ISPs fail to peer they must pay transit to get access to these squares. In reality, content multi-homes allowing alternative paths to the same content.

10. Business motivations to sell transit instead of peer are an ignored dynamic in the game.
Questions?
If there is time....

William B Norton,
Executive Director, DrPeering.net
http://DrPeering.net
Research “The Art of Peering”

- Follow up to the first three white papers.

Q: When e-mail to peering@<ispdomain>.net generates no response, what do Seasoned Peering Coordinators do?

- Smartest Peering Coordinator: “Tricks of the Trade”

- 20 Tactics successfully used to obtain Peering where you otherwise might not be able to.

Disclaimer: These are NOT recommended tactics…I am simply documenting what has been successfully used in the field to obtain peering.
Graphical Notation of Tactics

To Portray Peering Plays Pictorially…

P?=Peering Request w/ Peering Coordinator

Peering Negotiation

T?=Transit Request To Sales Person

Transit Negotiations

Larger Circle=More Customer Prefixes
Thicker Lines=More Traffic
Transit and Peering Sessions

T=Established Transit Session
(Selling Access to entire Internet)
Size indicates effective size of transport
Supporting the session

P=Established Peering Session
(Reciprocal Access to each others customers)
Size indicates effective size of transport
Supporting the session

Graphical Display of Routing Announcements

Represents “the rest of the Internet”
Traffic over Transit and Peering Sessions

Traffic showed as directed lines

Thickness of line indicates amount of Traffic in relevant direction

Other Variations

$P \rightarrow T$ = Transition of Relationship

$P | T$ = Either Peering or Transit apply

= Traffic destined anywhere

= Fictitious Traffic

= Packet Loss ridden Traffic

= Traffic destined to green network

= Traffic destined to brown network
Other Graphical Symbols

Exchange Point, Telco Hotel

Indicates two or more Elements tied with relationship

Indicates a ordering: a sequence to be followed in the Peering Tactic
1) The **Direct Approach** uses peering@<ispdomain>.net, phone calls, face to face meetings, or otherwise direct interactions with Peering Coordinators to establish peering.

\[ P? = \text{Peering Request} \]
To Peering Coordinator(s)

Peering Negotiation

Leading to

Peering Session

\{null\} -or- \{“No”,null\}
2) The **Transit with Peering Migration** tactic leverages an internal advocate to buy transit with a contractual migration to peering at a later time.

Transit Negotiations with Sales leads to Peering

(...if peering prerequisites be met...)
3) The **End Run Tactic** minimizes the need for transit by enticing a direct relationship with the target ISP’s largest traffic volume customers.
4) In Europe the **Dual Transit/Peering** separates the peering traffic from the transit traffic using separate interface cards and/or routers.

Why do this?
So it appears you are peering with bigger players
Sue “Like paying for a prom date.”
Only the two of you know
there is a cash payment at the end of the evening.
5) Purchasing Transit *Only* from Large Tier 2 ISPs is an approach to reduce the risk of being a customer of a potential peer on the road to Tier 1 status.

Since A peering with any Tier 1 won’t affect transit revenue with Tier 1s, there is no financial consequence to peering. (One less barrier to overcome during peering negotiations.)
6) **Paid Peering** as a maneuver is positioned by some as a stepping stone to peering for those who don’t immediately meet the peering prerequisites.
7) In the **Partial Transit** tactic, the routes learned at an exchange point are exchanged with the peer for a price slightly higher than transport costs.
The Nature of Web Traffic

- Asymmetric Traffic

Client (Browser, Peer2peer client) → Small Requests → Service (Web Server, Peer2peer client) → Generate Large Responses
9) In the **Traffic Manipulation** tactic, ISPs or content players force traffic along the network path that makes peering appear most cost effective.

1 MONTH LATER

CH ISP
i.e. Yahoo!

B hears A’s route ‘for free’ through Peer L

Over B’s transit

A forces traffic

1 MONTH LATER
Contact PC-We should Peer!
9b) For Access Heavy Guys…In the **Traffic Manipulation** tactic, Access ISP

*a*) stop announcing routes, or  
b) insert Target AS# into announcement to trigger BGP Loop Suppression to force traffic along the network path that makes peering appear most cost effective.

---

**Diagram:**

- **Access ISP** (i.e. Verizon)
  - **A**
  - **B**
  - **L**
  - **G**

- **PC** (B) hears **A**’s route ‘for free’ through **Peer L**
- **A** forces traffic **Over B**’s transit
- **1 MONTH LATER**  
  - Contact **PC**-We should Peer!
10) The **Bluff** maneuver is simply overstating future traffic volumes or performance issues to make peering appear more attractive.

Overstating Traffic Futures “You better peer with me now cause… Lots of transit fees coming otherwise!”

Fictitious Performance Problems
19) The **False Peering Outage** tactic involves deceiving an ill-equipped NOC into believing a non-existing peering session is down.

**ANOC**: Hey – Emergency!
**ANOC**: Our Peering Session with you Went Down!
**BNOC**: Strange. <looks on router> I don’t see it configured.
**ANOC**: It was. Don’t make me escalate to <famous person>
**BNOC**: Ah – I bet is was that last config run that trashed it.
**BNOC**: Give me a few minutes to fix it on both ends.
20) The Leverage Broader Business Arrangement takes advantage of other aspects of the relationship between two companies to obtain peering in exchange for something else.
21 – Overseas Pressure Play

- Video and gaming
- Latency sensitive traffic
- Large volume
- Forced over transit $$$ service

**Overseas Pressure Play**

1. Build into an open market for Internet Transit
2. Send traffic to local upstream via its international transit service
3. Disconnect from upstream provider...
   Pressure upstream to peer locally
22 – Construct Peering from Transit

Q: Why do this?
A: So it appears you are peering with bigger players

Sue “Like paying for a prom date.”
Only the two of you know there is a cash payment at the end of the evening.

Most ISPs do not have a paid peering product

Transit is sometimes cheaper than paid peering
Tactics that do not work

- Give content only if you peer at WAIX
- Swagger like you are a Tier 1 in other market
- Threaten litigation
- Public name calling
- Blind request peering of large peers first
- Demonstrate lack of local knowledge
- Refusal to register in route registry
Summary

- These are some of the “Tricks of the Trade”
- Comments/Additions welcome!
- Copies of the “Art of Peering: The Peering Playbook” are freely available
  - Send e-mail to wbn@DrPeering.net or
  - Or <google search “William B. Norton”>
Questions?