Peering 101
and the Peering Simulation Game

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Excerpts from The Internet Peering Playbook: Connecting to the Core of the Internet

AfPIF 2
Accra, Ghana
August 8, 2001
Connecting to the Core of the Internet

The Emerging Ecosystem for Cloud Computing

The New Book

Playbook

10 yrs in the making
$500K Travel
500K freq flyer miles
Every continent
Every Internet Ops Forum
What is your working definition
- Of Internet Peering?
- Of Internet Transit?
What are the motivations to peer or not?
What are the peering processes?
Who do you peer with?
Who are the players?
What are the Peering Tactics?
WHEN DOES PEERING MAKE SENSE?
After White Paper walkthroughs
Resources to share back to the community

the Author of the Internet Peering White Papers
The Global Internet Peering Ecosystem

How ISPs choose an Internet Exchange Point

Some ISP Peering Playbook Tactics

Internet Transit with Bluff Issues
Traffic Manipulation

Divide and Conquer

The Cost and Value of an IXP

Diversity of Internet Peering

Migration
DrPeering.net Peering Resources

Internet Service Providers and Peering
A Business Case for Peering
About the White Paper Process
The Art of Peering - The Peering Playbook
The Art of Peering - The IX Playbook
Chief Technical Liaison
Ecosystems: 95th Percentile Measurement for Internet Transit
Asia Pacific Peering Guidebook
Evolution of the U.S. Peering
Emerging Video Internet Ecosystems
European vs US Internet Exchange Points
Internet DataCenter Build vs Buy Decision
Internet Service Providers and Peering

Internet Transit Pricing Historical and Projections
Modeling the value of an Internet Exchange Point
NANOG History
Peering: Motivations to Peer
A Study of 28 Peering Policies
Peering Simulation Game
Peering: Top 10 Ways to Contact Peering Coordinators
Peering: Top 10 Reasons NOT to peer
Public vs Private Peering - the Great Debate
The Folly of Peering Ratios
Top 9 IX Selection Criteria
Video Internet - The Next Wave of Massive Disruption to the U.S. Peering Ecosystem

All freely available
Peering 101

Connecting to the Edge of the Internet (aka Internet Transit)
Connecting to the Core of the Internet (aka Internet Peering)
The Economic Benefits of Peering

IXP Operators - Let's talk off-line - lots of material to share
Connecting to the Edge of the Internet

• **Definition:** *Internet Transit* is the business relationship whereby an Internet Service Provider provides (usually sells) access to the global Internet.

• **Definition:** An *Internet Service Provider (ISP)*, also called a "Transit Provider/' is an entity that provides (usually sells) access to the Internet.
Internet Transit Service Mode

Routing Advertisements

ISP A
Meter
5-minute samples for 1 month.

monthly bill = 95th percentile measure * transit fee

Graphical notation
Equivalent Notation for Transit

Metering – 95th percentile
Internet Transit Billing Calculation
(95th Percentile Measurement)

Metered Internet Transit Service

Upstream (Transit) Provider

5-minute samples

Highest 95th Percentile Sample (Mbps) * Internet Transit Price ($/Mbps)

Lowest

= Monthly Cost of Internet Transit

Trends: Transit Price Drops
Internet Transit Prices (1998-2015)

Source: DrPeering.net
Connecting to the Core of the Internet

Internet Peering
Why Peering?

"Internet Transit is so inexpensive, why do we need anything else?"

![Graph showing monthly transit fees over time with drops and growth in traffic volume. Where is that traffic going?]
Costs of Peering

1) DirectCosts
2) Co-location
3) Equipment
4) Peering Fees

Global Internet

Internet Transit Service

Direct interconnect=peering
Definition: **Internet Peering** is the business relationship whereby two companies reciprocally provide access to each other's customers.
internet Peering notation

3 key notions about peering
3 Key points about Internet Peering

1) Internet Peering is not a transitive relationship
2) Internet Peering is not a perfect substitute for internet Transit
3) Internet Peering is typically settlement-free
Top Five Motivations for Peering

Reduce Transit Costs
Better End-User Experience
Control Over Routing
Make more $$ - Usage Based Billing
Marketing Benefits of Peering

Comes down to business: Let's talk $$$. motivation
The Business Case for Peering

- Transport: $6000/mo
- Colocation: $1000/mo
- Equipment: $2000/mo
- Peering Port: $2000/mo

Source: 2010 DE-CIX Member Meeting discussions
## Cost of Peering

<table>
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<tr>
<th>Mbps</th>
<th>Peering Cost per Mbps</th>
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<tr>
<td>100</td>
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<tr>
<td>200</td>
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<tr>
<td>2000</td>
<td>$5.50</td>
</tr>
<tr>
<td>2100</td>
<td>$5.24</td>
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**Assumptions**

- **Transport into IX:**
  - Far: $6,000 per month
- **Colocation Fees:**
  - Far: $1,000 per month
- **Peering Fees:**
  - Far: $2,000 per month
- **Equipment Costs:**
  - Far: $2,000 per month

**Total Cost of Peering:**

Far: $11,000 per month

"If you can peer 1000Mbps for free, but it costs you $11,000 per month to build into the Internet Exchange Point, the cost of peering is $11,000/1000Mbps=$10/Mbps.”
### Assumptions

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## Peering Break-Even Point

Unit Peering Cost = Price of Transit

## Effective Peering Bandwidth

Transit Price

## Effective Peering Range
Some context:
The Internet Peering Ecosystem

Internet viewed as a Global Internet Peering Ecosystem
Def: Global Internet Peering Ecosystem consists of a set of interconnected internet regions (countries).

Global Internet Peering Ecosystem

Characteristics of these Ecosystem Organisms?
Ecosystem Member: Tier 1 ISP

**Def:** A Tier 1 ISP is an ISP that has access to the ENTIRE Internet Region Routing Table solely via Free Peering Relationships 

(Doesn't buy transit from anyone to reach any destination in the Internet Region.)

**Motivation:** Is NOT motivated to Peer in region to reduce transit fees, Is NOT motivated to peer with anybody else.

**Behavior:** “Restrictive” Peering 

*def:* Policy
Ecosystem Member: Tier 2 ISP

**Def:** A Tier 2 ISP is an ISP that has to purchase Transit to access some part of the Internet Region.

**Motivation:** Is motivated to Peer in region to reduce transit fees.

**Behavior:** “Open” Peering or “Selective” Peering Policy
Active in Peering Forums
Content Providers

**Def:** A Content Provider focuses on content development and does not sell access to the Internet.

**Motivation:** SLAs w/well known ISP

**Behavior:** "No Peering" Policy
Internet Peering Ecosystem

Tier 1 ISPs

Tier 2 ISPs

Traffic and $ flow up

Active Peering Groups
Peering Forums
IX Meetings

Content Providers

Test: Apply defs.
2) Definition of Peering:

3) Definition of an “Open” Peering Policy:
4) Definition of a “Selective” Peering Policy: _
5) Definition of a “Restrictive” Peering Policy:
Apply Defs: Peering Dynamics & Motivations

Internet Peering Ecosystem

Tier 1 ISP X

Tier 2 ISP A

No, I already hear your routes for FREE!

Tier 1 ISP Y

Tier 2 ISP B

Content Provider

Synch Point:
You have all the definitions needed to predict behavior in the Peering Ecosystem.
The Peering Simulation Game

Let's exercise these definitions
The Players

Internet Service Provider A
- Peering Coordinator

Internet Service Provider B
- Peering Coordinator

Internet Service Provider C
- Peering Coordinator

Internet Service Provider D
- Peering Coordinator
3 Helpers

Transit Provider X
Transit Provider Y
Exchange Point Operator
The Peer\textsubscript{ing} Game

Transit Provider $Y$

ran it Provider

B

X

D

X

Y

E
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 for each customer square you own.
   - Gain transit revenue of $200 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 negotiate who covers the costs of peering.
   - Peering ISPs do not have to pay transit for each others squares starting the next turn.
A rolls 5,

**Wants to peer w/B – moves to IXN**

Receives revenue on 6 squares: \((6 \times $2000)\)

Pays Transit on others squares: \((3 \times $1000)\)

\[ \$12,000 - \$3,000 = \$9,000 \]
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
D rolls 1,

Late entrant heading to IXE

Receives revenue on 2 squares (2*$2000)
Pays Transit on others squares (17*$1000)

$4000 - $17000 = -$13000
Scoreboard after Round 1

ISP A: $9,000
ISP B: $0
ISPC: $3,000
ISPD: -$13,000
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!
A Position
9 Revenue squares
1 lost turn
Peering w/C
reduced cost $8000/turn

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

We want to hear your thought process and peering negotiations

Winner-prize

WINNER: At 5:25 PM we will stop and assume that every roll was a "3" from that point on out to 12 rounds.
Play the Peering Simulation Game...