The Value of Peering

ISP/IXP Workshops

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Last updated 5th May 2022
Acknowledgements

- This material originated from the Cisco ISP/IXP Workshop Programme developed by Philip Smith & Barry Greene
  - Appreciative thanks for the contributions from Kurt Erik Lindqvist, Mark Tinka, Nigel Titley, and other members of the peering community

- Use of these materials is encouraged as long as the source is fully acknowledged and this notice remains in place

- Bug fixes and improvements are welcomed
  - Please email workshop (at) bgp4all.com

Philip Smith
NSRC has made a video recording of this presentation, as part of a library of BGP videos for the whole community to use:

- https://learn.nsrec.org/bgp#value_of_peering
Network Operator Goals?

- Today, the vast majority of content and resources consumed by end-users is available by peering:
  - The multi-national content providers (Google, Facebook, etc)
  - The multi-national “cloud” providers
  - Private cross connects
  - Internet Exchange Points
- A network operator’s goal is to obtain as much peering as possible
- Transit is for the last resort, for any content not available by peering
Network Operator Goals?

- **Peering**
  - Locally by direct cross-connect with other providers
  - Locally at an Internet Exchange Point
  - Getting to the nearest IXP or other interconnect

- **Transit**
  - Relying on another network operator to get the rest of the Internet
  - Considered a last resort now
Other concerns for Network Operators

- More economies and regions worried about “data sovereignty”
- Data held at multi-national cloud operators could be anywhere on Earth
- Local peering and local interconnects mean:
  - Less “domestic” traffic going crossing national boundaries
  - Greater opportunity for domestic cloud/hosting providers
  - More responsive hosting and “cloud” services
  - More assurance about “data sovereignty”
  - Greater opportunity for creating a vibrant local Internet economy
The Internet

- Internet is made up of ISPs of all shapes and sizes
  - Some have local coverage (access providers)
  - Others can provide regional or per country coverage
  - And others are global in scale

- These ISPs interconnect their businesses
  - They don’t interconnect with every other ISP (over 73100 distinct autonomous networks) – won’t scale
  - They interconnect according to practical and business needs

- Some ISPs provide transit to others
  - They interconnect other ISP networks
  - Around 10300 autonomous networks provide transit to another AS
Categorising ISPs

Tier 1 ISP

Regional ISP

Access ISP

IXP

Tier 1 ISP

Regional ISP

Access ISP

IXP

Tier 1 ISP

Regional ISP

Access ISP

IXP

Regional ISP

Access ISP

IXP
Peering and Transit

- **Transit**
  - Carrying traffic across a network
  - Usually have to pay traffic charges
  - Example: Access provider connects to a regional provider

- **Peering**
  - Exchanging routing information and traffic
  - No traffic charges
  - Normally called *settlement free peering*
  - Example: Regional provider connects to another regional provider
Private Interconnect

- Two ISPs connect their networks over a private link
  - Private Network Interconnect (PNI)
  - Can be peering arrangement – “Private Peering”
    - No charge for traffic
    - Share cost of the link
  - Can be transit arrangement
    - One ISP charges the other for traffic
    - One ISP (the customer) pays for the link
Public Interconnect

- Several ISPs meeting in a common neutral location and interconnect their networks
  - Usually is a peering arrangement between their networks
  - This is called an Internet Exchange Point (IXP)
Types of Peering

- Private Peering
- Public Peering (at IXPs)
  - Bi-Lateral
  - Multi-Lateral
  - Mandatory Multi-Lateral
Private Peering

- Where two network operators agree to interconnect their networks, and exchange their respective routes, for the purpose of ensuring their customers can reach each other directly over the peering link

- Once operators interconnect:
  - **Settlement Free Peering**
    - No traffic charges
    - **The most common form of peering**
  - **Paid Peering**
    - Where two operators agree to exchange traffic charges for a peering relationship
    - *(Marketing name for Local Transit? 😊)*
Public Peering

- **Bi-lateral Peering**
  - Very similar to Private Peering, but usually takes place at a public peering point (IXP)

- **Multilateral Peering**
  - Takes place at IXPs, where operators all peer with each other via Route Servers

- **Mandatory Multilateral Peering**
  - Where operators are forced to peer with each other as condition of IXP membership
  - **Strongly discouraged: Has no record of success**
  - (But some are still determined to prove 30 years of industry experience wrong 😬)
Types of Operator Peering Policies

- **Open Peering**
  - Where a network operator publicly states that they will peer with all parties who approach them for peering.
  - Commonly found at IXPs where the member participates via the Route Server.

- **Selective Peering**
  - Where a network operator’s peering policy depends on the nature of the operator who requests peering with them.
  - At IXPs, the operator will not peer with the Route Server but will only peer bilaterally.

- **Restrictive Peering**
  - Where a network operator decides who its peering partners are, and is generally not approachable to considering peering opportunities.
The Peering Database

- The Peering Database documents network operator peering policies
  - https://www.peeringdb.com
- All operators with AS numbers are recommended to register in the PeeringDB
  - All operators who are considering peering or are peering must be in the PeeringDB to enhance their peering opportunities
  - Most major network operators will not peer with you unless you have a PeeringDB entry
- Participation in peering fora is encouraged too
  - Global Peering Forum (GPF) – for North American operators
  - Many Regional Peering Fora (including Europe, Middle East, Africa, Asia, Caribbean, Latin America)
  - Many countries now have their own Peering Fora
The IXP Database

- The IXPDB documents IXPs and their participants around the world
  - https://ixpdb.euro-ix.net/en/
- All Internet Exchange Point operators are recommended to register their IXP in the database
  - IXPs using IXP Manager (https://www.ixpmanager.org) will have this happen as part of the IXP Manager set up
  - Provides the LAN IP addresses of each member to facilitate automation

Welcome to the IXP Database

The IXP Database (IXPDB) aims to be an authoritative, comprehensive, public source of data related to IXPs. It collects data directly from IXPs through a recurring automated process. It also integrates data from third-party sources in order to provide a comprehensive and corroborated view of the global interconnection landscape. The combined data can be viewed, analyzed, and exported through this web-based interface and an API.
HKIX

Organization: Hong Kong Internet eXchange Limited
Long Name: Hong Kong Internet Exchange
City: Hong Kong
Country: HK
Continental Region: Asia Pacific
Media Type: Ethernet
Protocols Supported: Unicast IPv4, Multicast IPv4

Contact Information
Company Website: https://www.hkix.net/
Traffic Stats Website: https://www.hkix.net/hkix/stat/aggregates.html
Technical Email: noc@hkix.net
Technical Phone: +85239439000
Policy Email: info@hkix.net
Policy Phone: +85239438800

LAN
MTU: 1500
DOT1Q: 0
IPv6: 2001:7fa:0:1::64
IPv4: 123.255.88.0/21

Local Facilities
Facility: CUHK
Country: Hong Kong
City: Hong Kong
Facility: MEGA Two (Advantage Hong Kong)
Country: Hong Kong
City: Hong Kong
Facility: MEGA-i (Advantage Hong Kong)
Country: Hong Kong
City: Hong Kong

Peers at this Exchange Point

<table>
<thead>
<tr>
<th>Peer Name</th>
<th>ASN</th>
<th>IPv4</th>
<th>IPv6</th>
<th>Speed Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASGCNET, HKIX Peering LAN 24167</td>
<td>123.255.91.53</td>
<td>2001:7fa:0:1::ca8:a135</td>
<td>10G</td>
<td></td>
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<tr>
<td>Asia Pacific Telecom HKIX Peering LAN 17709</td>
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<td>2001:7fa:0:1::ca8:a156</td>
<td>10G</td>
<td></td>
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<tr>
<td>ASLINE HKIX Peering LAN 18013</td>
<td>123.255.92.13</td>
<td>2001:7fa:0:1::ca8:a20d</td>
<td>10G</td>
<td></td>
</tr>
<tr>
<td>AT&amp;T AP - AS2887 HKIX Peering LAN 2887</td>
<td>123.255.91.46</td>
<td>2001:7fa:0:1::ca8:a12e</td>
<td>10G</td>
<td></td>
</tr>
<tr>
<td>Automatic HKIX Peering LAN 2635</td>
<td>123.255.90.71</td>
<td>2001:7fa:0:1::ca8:a047</td>
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<td></td>
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<tr>
<td>Badoo Ltd HKIX Peering LAN 12678</td>
<td>123.255.90.220</td>
<td>2001:7fa:0:1::ca8:a083</td>
<td>2G</td>
<td></td>
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<tr>
<td>Baidu HKIX Peering LAN 55967</td>
<td>123.255.90.137</td>
<td>2001:7fa:0:1::ca8:a083</td>
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<tr>
<td>Baidu HKIX Peering LAN 55967</td>
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<td>2001:7fa:0:1::ca8:a13d</td>
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<td></td>
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<tr>
<td>Bayan Telecommunications Inc. HKIX Peering LAN 6648</td>
<td>123.255.91.45</td>
<td>2001:7fa:0:1::ca8:a12d</td>
<td>3G</td>
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<tr>
<td>BGP Network Limited HKIX Peering LAN 64050</td>
<td>123.255.91.177</td>
<td>2001:7fa:0:1::ca8:a1b1</td>
<td>10G</td>
<td></td>
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<tr>
<td>BIGHUB-ISP HKIX Peering LAN 137989</td>
<td>123.255.90.207</td>
<td>2001:7fa:0:1::ca8:a0cf</td>
<td>1G</td>
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<tr>
<td>BIGHUB-ISP HKIX Peering LAN 123.255.91.98</td>
<td>2001:7fa:0:1::ca8:a1b1</td>
<td>10G</td>
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### Public Peering Exchange Points

<table>
<thead>
<tr>
<th>Exchange</th>
<th>ASN</th>
<th>IPv4</th>
<th>IPv6</th>
<th>Speed</th>
<th>RS Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS-IX Chicago</td>
<td>16509</td>
<td>206.108.115.36</td>
<td>2001:504:38:1::a501:6509:2</td>
<td>100G</td>
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<tr>
<td>AMS-IX Hong Kong</td>
<td>16509</td>
<td>103.247.139.10</td>
<td>2001:df0:296::a501:6509:1</td>
<td>100G</td>
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<tr>
<td>BBIX Osaka</td>
<td>16509</td>
<td>218.100.9.24</td>
<td>2001:de8::2:1::6509:1</td>
<td>40G</td>
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</tr>
<tr>
<td>BBIX Tokyo</td>
<td>16509</td>
<td>218.100.6.52</td>
<td>2001:de8::18509:1</td>
<td>200G</td>
<td></td>
</tr>
<tr>
<td>BBIX Tokyo</td>
<td>16509</td>
<td>218.100.6.207</td>
<td>2001:de8::18509:2</td>
<td>200G</td>
<td></td>
</tr>
<tr>
<td>BCIX BCIX Peering LAN</td>
<td>16509</td>
<td>193.178.185.95</td>
<td>2001:78:19:1::407:d:1</td>
<td>200G</td>
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<tr>
<td>BIX BG Main</td>
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<td>193.169.198.87</td>
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<tr>
<td>RNIX</td>
<td>16509</td>
<td>144.177.177</td>
<td>144.177.177</td>
<td>1G</td>
<td>RNIX</td>
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### Private Peering Facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Country</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>151 Front Street West Toronto</td>
<td>Canada</td>
<td>Toronto</td>
</tr>
<tr>
<td>16509</td>
<td>Canada</td>
<td>Toronto</td>
</tr>
<tr>
<td>144.177.177</td>
<td>Canada</td>
<td>Toronto</td>
</tr>
</tbody>
</table>
Telia Carrier

Organization: Telia Group
Also Known As: TeliaSonera, Telia, TSIC
Company Website: http://www.teliacarrier.com/
Primary ASN: 1299
IRR as-set/route-set: RIPE::AS-TELIANET RIPE::AS-TELIANET-V6
Route Server URL:
Looking Glass URL: https://lg.telia.net/
Network Type: NSP
IPv4 Prefixes: 426000
IPv6 Prefixes: 40000
Traffic Levels: 1 Tbps-
Traffic Ratios: Balanced
Geographic Scope: Global
Protocols Supported: Unicast IPv4 Multicast IPv6 Never via route servers
Last Updated: 2020-02-05T11:43:25Z
Notes: IPv4 + IPv6 Prefixes above would be actuals, not proposed max- prefix values.
AS1299 is matching RPKI validation state and reject invalid prefixes from peers and customers. Our looking-glass marks validation state for all prefixes. Please review your registered ROAs to reduce number of invalid prefixes.
All trouble ticket requests or support related emails should be sent to carrier-coc@teliacompany.com.

Peering Policy Information
General Policy: Restrictive

Public Peering Exchange Points

<table>
<thead>
<tr>
<th>Exchange</th>
<th>IPv4</th>
<th>IPv6</th>
<th>Speed</th>
<th>RS Peer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
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</table>

Private Peering Facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Country</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>365 Data Centers Buffalo (BU1)</td>
<td>United States of America</td>
<td>Buffalo</td>
</tr>
<tr>
<td>365 Data Centers Detroit (DT1)</td>
<td>United States of America</td>
<td>Southfield</td>
</tr>
<tr>
<td>365 Data Centers Nashville (NA1)</td>
<td>United States of America</td>
<td>Nashville</td>
</tr>
<tr>
<td>365 Data Centers Tampa (TA1)</td>
<td>United States of America</td>
<td>Tampa</td>
</tr>
<tr>
<td>3U Rechenzentrum Berlin</td>
<td>Germany</td>
<td>Berlin</td>
</tr>
<tr>
<td>A10 Networks IT</td>
<td>Croatia</td>
<td>Zagreb</td>
</tr>
<tr>
<td>Borovaya 57</td>
<td>Russia</td>
<td>St. Petersburg</td>
</tr>
<tr>
<td>CE Colo Prague</td>
<td>Czechia</td>
<td>Prague</td>
</tr>
<tr>
<td>CINECA - DC NaMeX</td>
<td>Italy</td>
<td>Roma</td>
</tr>
<tr>
<td>CCO BM-16</td>
<td>Russia</td>
<td>St.Petersburg</td>
</tr>
<tr>
<td>Caldera21</td>
<td>Italy</td>
<td>Milan</td>
</tr>
<tr>
<td>CarrierColo Berlin Luetzow (I/P/B/ site B)</td>
<td>Germany</td>
<td>Berlin</td>
</tr>
<tr>
<td>Cologix MTL3</td>
<td>Canada</td>
<td>Montreal</td>
</tr>
</tbody>
</table>

Filter
ISP Goals

- **Minimise** the cost of operating the business

- **Transit**
  - ISP has to pay for circuit (international or domestic)
  - ISP has to pay for data (usually $ cost per Mbps)
  - Repeat for each transit provider
  - Significant cost of being a service provider

- **Peering**
  - ISP shares circuit cost with peer (private) or runs circuit to public peering point (one off cost)
  - No need to pay for data
  - Reduces transit data volume, therefore reducing cost
Transit – How it works

- Small access provider provides Internet access for a city’s population
  - Mixture of dial up, wireless and fixed broadband
  - Possibly some business customers
  - Possibly also some Internet cafes

- How do their customers get access to the rest of the Internet?
- ISP buys access from one, two or more larger ISPs who already have visibility of the rest of the Internet
  - This is transit – they pay for the physical connection to the upstream and for the traffic volume on the link
Peering – How it works

- If two ISPs are of equivalent sizes, they have:
  - Equivalent network infrastructure coverage
  - Equivalent customer size
  - Similar content volumes to be shared with the Internet
  - Potentially similar traffic flows to each other’s networks

- This makes them good peering partners

- If they don’t peer
  - They both have to pay an upstream provider for access to each other’s network/customers/content
  - Upstream benefits from this arrangement, the two ISPs both have to fund the transit costs
The IXP’s role

- Private peering makes sense when there are very few equivalent players
  - Connecting to one other ISP costs $X$
  - Connecting to two other ISPs costs 2 times $X$
  - Connecting to three other ISPs costs 3 times $X$
  - Etc... (where $X$ is half the circuit cost plus a port cost)
- The more private peers, the greater the cost
- IXP is a more scalable solution to this problem
The IXP’s role

- Connecting to an IXP
  - ISP costs: one router port, one circuit, and one router to locate at the IXP

- Some IXPs charge annual “maintenance fees”
  - The maintenance fee has potential to significantly influence the cost balance for an ISP

- Generally connecting to an IXP and peering there becomes cost effective when there are at least three other peers
  - The real $ amount varies from region to region, IXP to IXP
Who peers at an IXP?

- **Access Providers**
  - Don’t have to pay their regional provider transit fees for local traffic
  - Keeps latency and costs for local traffic low
  - ‘Unlimited’ bandwidth through the IXP (compared with costly and limited bandwidth through transit provider)

- **Regional Providers**
  - Don’t have to pay their global provider transit fees for local and regional traffic
  - Keeps latency and costs for local and regional traffic low
  - ‘Unlimited’ bandwidth through the IXP (compared with costly and limited bandwidth through global provider)
Who peers at an IXP?

- **Content Providers & Content Distribution Services**
  - Don’t have to pay their regional provider transit fees for local traffic
  - Keeps latency and costs for local traffic low
  - ‘Unlimited’ bandwidth through the IXP (compared with costly and limited bandwidth through transit provider)

- **Root, ccTLD and gTLD operators**
  - Adds to the resiliency of the global DNS system
  - Keeps latency and response time for local resolver traffic very low
The IXP’s role

- Global Providers can be located close to IXPs
  - Attracted by the potential transit business available

- Advantageous for access & regional providers
  - They can peer with other similar providers at the IXP
  - And in the same facility pay for transit to their regional or global provider
  - (Not across the IXP fabric, but a separate connection)
Connectivity Decisions

- **Transit**
  - Almost every ISP needs transit to reach rest of Internet

<table>
<thead>
<tr>
<th>Transits Chosen</th>
<th>Configuration Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>One provider</td>
<td>No redundancy</td>
</tr>
<tr>
<td>Two providers</td>
<td>Ideal for traffic engineering as well as redundancy</td>
</tr>
<tr>
<td>Three providers</td>
<td>Better redundancy, traffic engineering gets harder</td>
</tr>
<tr>
<td>More than three providers</td>
<td>Diminishing returns, rapidly escalating costs and complexity</td>
</tr>
</tbody>
</table>

- **Peering**
  - Means low (or zero) cost access to another network
  - Private or Public Peering (or both)
Transit Goals

1. Minimise number of transit providers
   - But maintain redundancy
   - 2 is ideal, 4 or more is hard

2. Aggregate capacity to transit providers
   - More aggregated capacity means better value
     - Lower cost per Mbps
   - 4x 1Gbps links to 4 different ISPs will usually cost more than having 2x 10Gbps links to 2 different ISPs
     - Yet bandwidth of latter (20Gbps) is greater than that of former (4Gbps) and is much easier to operate
Peering or Transit?

- How to choose?
- Or do both?
- It comes down to cost of going to an IXP
  - Free peering
  - Paying for transit from an ISP co-located in same facility, or perhaps close by
- Or not going to an IXP and paying for the cost of transit directly to an upstream provider
  - There is no right or wrong answer, someone has to work out what makes financial & operational sense
Private or Public Peering

- Private peering
  - Scaling issue, with costs, number of providers, and infrastructure provisioning

- Public peering
  - Makes sense the more potential peers there are (more is usually greater than “two”)

- Which public peering point?
  - Local Internet Exchange Point: great for local traffic and local peers
  - Regional Internet Exchange Point: great for meeting peers outside the locality, might be cheaper than paying transit to reach the same consumer base
Local Internet Exchange Point

- Defined as a public peering point serving the local Internet industry
- Local means where it becomes cheaper to interconnect with other ISPs at a common location than it is to pay transit to another ISP to reach the same consumer base
  - Local can mean different things in different regions!
Regional Internet Exchange Point

- Regional Internet Exchanges are NOT built from scratch
  - Even today, there are too many “well meaning” attempts to build so-called Regional IXPs
  - There have been several attempts since the 1990s, all have failed
  - Yet there are still entities determined to repeat the same mistakes thinking they can get a better outcome

- Definition: A Regional IXP is a Local IXP that has become so successful that it attracts members from outside its normal service area
Regional Internet Exchange Point

- Regional IXPs are also local IXPs:
  - Regional ISPs join and peer with each other
  - And show up at several of these Regional IXPs

- Local ISPs peer with ISPs from outside the locality
  - They don’t compete in each other’s markets
  - Local ISPs don’t have to pay transit costs
  - ISPs from outside the locality don’t have to pay transit costs
  - Quite often ISPs of disparate sizes and influences will happily peer – to defray transit costs
Which IXP?

- How many routes are available?
  - What is traffic to & from these destinations, and by how much will it reduce cost of transit?

- What is the cost of co-lo space?
  - If prohibitive or space not available, pointless choosing this IXP

- What is the cost of running a circuit to the location?
  - If prohibitive or competitive with transit costs, pointless choosing this IXP

- What is the cost of remote hands/assistance?
  - If no remote hands, doing maintenance is challenging and potentially costly with a serious outage
Value propositions

- Peering at a local IXP
  - Reduces latency & transit costs for local traffic
  - Improves Internet quality perception
  - Encourages local Internet economy (content, hosting, “cloud” services)

- Participating at a Regional IXP
  - A means of offsetting transit costs

- Managing connection back to home network

- Improving Internet Quality perception for customers
Summary

- Benefits of peering
  - Private
  - Internet Exchange Points
- Local versus Regional IXPs
  - Local services local traffic
  - Regional helps defray transit costs
The Value of Peering

ISP/IXP Workshops