

The Asia Pacific Internet Peering Guidebook

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Abstract

*How does Internet Peering work in Asia? How is it different from Peering in the U.S. or Europe? If International Peering is different across the globe, what does one **need to know** before expanding a network into a new country? Internet Peering in Asia has largely been undocumented, with the popular perception in the Internet Operations community that Internet Peering in Asia is “just different”. This research provides a framework for comparing Internet Ecosystems with a little more specificity, based on conversations with about one hundred International Peering Coordinators that have built into and within Asia. These International Peering Coordinators shared ten specific lessons they wish they had learned prior to their Asian expansion.*

This White Paper begins by introducing the Internet as a set of loosely connect Internet Ecosystems (countries typically), each with at least three categories of players. We define each category of player, their position in the “Internet Ecosystem” along with their corresponding motivations that explains their peering behaviors.

In the process of the research we identified the “Foreign Tier 1 Peering Dynamic.” This dynamic is not limited to Asia but indeed exists globally, where Tier 1 ISPs in one Internet Peering Ecosystem are relegated to Tier 2 ISPs as they expand into a foreign Internet Peering Ecosystem. We explain why this occurs by applying the aforementioned definitions and motivations.

To apply these definitions and share some of the more interesting country-specific insights shared by the Peering Coordinators, we have identified the key players in four specific Internet Peering Ecosystems; Japan, Singapore, Australia and Hong Kong. We apply the “Business Case for Peering” methodology using current transit and peering costs in each Peering Ecosystem.

We then share five reasons the Peering Coordinators said that they expanded into and within Asia, along with four strategies for interconnecting within Asia. Ten “Lessons Learned” finish up the section of collective knowledge from the group. In this section we also present rough transport/colo/transit pricing figures so the reader can better appreciate the differences in Internet Ecosystems across Asia. This is necessary to understand the financial sides to the peering-transport-transit equation.

Introduction: The Global Internet Ecosystem

The Internet is best described as a network of networks. An Internet Operations view of this system reveals sets of players, each with motivations and observed behaviors in common within geographical areas that I will call **Internet Peering Ecosystems**.

Definitions. Within each of these Internet Peering Ecosystems we find at least three categories of players:

- **Tier 1 ISPs** (ISPs that have access to all the Internet Peering Ecosystem routes solely through free peering relationships),
- **Tier 2 ISPs** (that must buy transit from someone to reach routes within the Internet Peering Ecosystem), and
- **Content Providers** who don't sell access to the Internet but offer content.

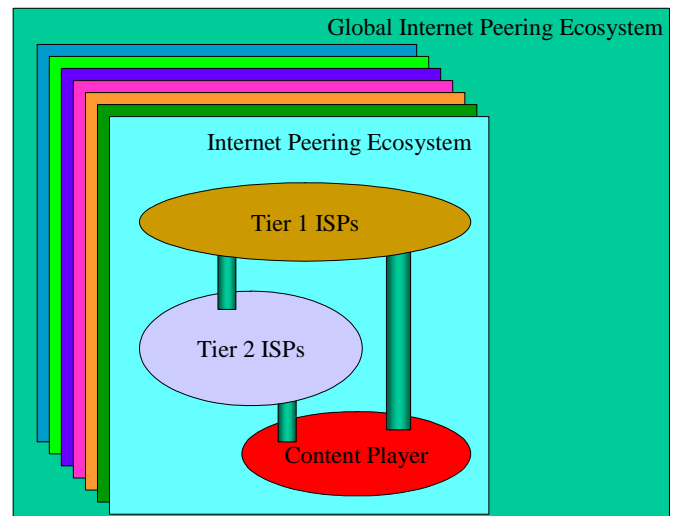


Figure 1 - The Global Internet Peering Ecosystem

These rough classifications and definitions are important because they help us understand each player's motivations as reflected in their observed behavior.

Motivation and Behavior. Tier 1 ISPs do not need to buy transit since by definition they can reach all the networks in the Internet Peering Ecosystem solely

through free peering relationships. Stated most eloquently by Waqar Khan (Qwest, a Tier 1 ISP in the U.S.), “We have all the peering we need.” It is not surprising that Tier 1 ISPs see the rest of the players in the Internet Peering Ecosystem players as potential customers, and do not seek peering with them. In fact, James Spenceley (Comindico) went through the process of negotiating peering with the Tier 1 ISPs in Australia and described the Tier 1 peering negotiation tactics in a one word acronym: MILD: Make It Long and Difficult¹. This reflects the ISP’s underlying Peering Inclination, perhaps articulated in their Peering Policy discussed next.

Peering Policies

Definition: A **Restrictive Peering Policy** is an articulation of an inclination **not** to peer. A Tier 1 ISP may have a posted peering policy indicating that they will peer with ISPs of similar size and scale that meet them in a large number of locations in a certain number of countries with a certain large traffic volume. In this research, several Tier 2 ISPs have expressed frustration that once they met these stated requirements, the requirements were immediately adjusted upwards just out of reach. This demonstrates the Restrictive Peering Policy underlying foundation - an inclination **not** to peer.

Definition: A **Selective Peering Policy** is an articulation of an inclination to peer, but with some conditions. A Selective Peering Policy details prerequisites that must be met, and when met, will generally lead to peering. Some ISPs for example require multiple interconnect points across a country with a minimum amount of traffic in order for it to be worth the engineer’s time to set up the peering session. Large Tier 2 ISPs often have Selective Peering Policies; they want to peer, but have a threshold to pass in order for it to be worthwhile. The difference between the Selective and the Restrictive peering policy is somewhat subjective but is based on the underlying intent; a restrictive peer does not want to peer with anyone else so sets requirements arbitrarily high such that almost no one is qualified to peer with them.

Definition: An **Open Peering Policy** is an articulation of an inclination to peer with anyone. Brokaw Price from Yahoo! calls this “**pulse peering**; if you have a pulse we will peer with you!” Content Players and most Tier 2 ISPs seek to reduce their

transit fees by peering broadly by announcing to the peering community that they have an Open Peering Policy.

While these broad categories of players and their peering policies do not capture all facets of the markets, they do provide the broad strokes needed to understand some of the International peering interplay that we will discuss in this paper.

The rest of this paper focuses on several Asia Pacific Peering Ecosystems. First we will start with some observations common across the Asia Peering Ecosystems, some interesting peering behaviors that we haven’t documented in the research to date. We then finish this section with an overview of four Internet Peering Ecosystems: Japan, Singapore, Australia and Hong Kong, highlighting the key players, recent trends and disruptions in the peering ecosystems, and the Business Case for Peering in each Peering Ecosystem using recent prices for transport, transit, collocation and Exchange Point fees.

Editor’s Notes: To illustrate points made in this paper we polled people for estimated prices of local loops, transit, transpacific transport, etc. All prices shown are in U.S. Dollars (unless otherwise indicated), and should be assumed to be volatile and for illustration and comparison purposes only.

Example: The Foreign Tier 1 Peering Dynamic

Some International ISPs described the Asia Pacific Peering Ecosystems as “mysterious”, with the only discernable behaviors exhibited being those of protection of the domestic market.

“Protection of turf is much stronger in Asia than in the U.S. or Europe.” – Large European ISP

Conversations with both in-country and foreign Peering Coordinators however reveal that there are two sides to this story. This interplay is described next as the “Foreign Tier 1 Peering Dynamic.”

Definition: The **Foreign Tier 1 Peering Dynamic** occurs when a Tier 1 ISP in one Internet Peering Ecosystem expands into another Internet Peering Ecosystem and is relegated to a Tier 2 ISP status in that foreign Internet Peering Ecosystem.

This dynamic is illustrated in the example figure below, where UUNet (a Tier 1 ISP in the U.S.) expanded into Japan in the mid-1990’s.

¹ James presented this at the APRICOT 2004 Peering Track in Kuala Lumpur March 26th.

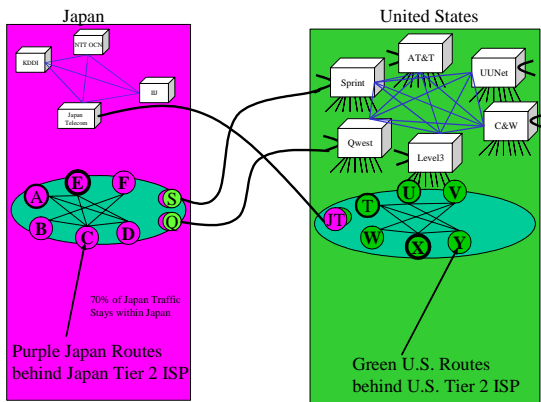


Figure 2 - Foreign Tier 1 Peering Dynamic

To demonstrate this dynamic, consider this Peering Coordinator's story. Several years ago over a dinner in Tokyo, the author was told that "UUNet is one of the largest ISPs in the world, but we can't get peering with any of the Tier 1 ISPs here in Japan, and have a hard time even getting Peering with the Tier 2 ISPs!"

What is going on here?

Understanding the Request for Peering with the Foreign Tier 1 ISP. In this scenario, when UUNet asks the Japanese Tier 1 ISP to peer, it is asking the Japanese Tier 1 ISP to

- 1) **give away** that which is a strong competitive differentiator (Tier 1 Status in the region helps transit sales)
- 2) **give away** a cost minimizing function (since Tier 1 ISPs by definition don't pay transit fees within their Internet Peering Ecosystem) to a competitor, and
- 3) **lose a transit revenue opportunity** (by not selling transit to you!), and finally,
- 4) **enable a powerful foreign competitor** to come in and undercut their business with free (peering) access to their customers.

It is understandable that the in-country Tier 1 ISP (like NTT) would not be motivated to peer with a foreign ISP (like UUNet) entering the market. It would take something very large in return for this play to make sense to the in-region Tier 1 ISP.

Global Routes or Regional Routes? At the same time, UUNet may not want to peer all of its U.S. and European routes and

- 1) **pay the cost to haul all of its U.S. customer traffic** to Japan,

- 2) **make it easier for NTT to sell** access to the UUNet international customer base,
- 3) **pay the cost to haul all of this Japan traffic** around the world!²

As a result the UUNet negotiating position is likely to be that they will only bring their Asia Regional routes for peering in Japan, and not their large number of desirable U.S. and European customer routes. Since peering NTTs relatively large number of routes with UUNets relatively small number of regional routes doesn't make business sense for NTT, the deal is unlikely to go through.

In some cases, the discussion of "reciprocal in-country peering" comes up (you peer with me in your country and I'll peer with you in mine), but the negotiations often get mired in definitions and perceptions of "equal benefits". It is not surprising that these reciprocal peering deals don't occur very often.

To continue with our example, in this scenario, UUNet also has difficulty getting peering with the Tier 2 ISPs. Let's look at the incentive/disincentive for the Tier 2 ISPs to peer with this foreign (U.S.-based) Tier 1 ISP.

In-Country Tier 2 Peering with Foreign Tier 1 ISP. Tier 2 ISPs are motivated to reduce transit costs, but in the case of Japan, as with many parts of Asia, only a small percentage (5%³) of its traffic is destined to and from the U.S. Only those Tier 2 ISPs with enough Japan-U.S. traffic have sufficient financial motivation to accept peering. If UUNet doesn't provide U.S. routes, then there may not be enough of a UUNet Japan customer base footprint to make them a strong peering player.

There are of course other motivations for peering. For example, performance related improvements may be sufficient for some Japanese Tier 2 ISPs to peer with

² Note that much of the traffic is pulled from the U.S. Much of this traffic is pornographic content, or to be politically correct, is "Content that transcends the language barrier." By law, this content may not be hosted in Japan. There was a similar problem in the U.S. Internet during the NSFNET era (1987-1994) when much of the U.S. government-funded Internet capacity from Europe was used up with traffic of this type.

³ Conversation with Fumio Terashima (Japan Telecom). Note that the total volume of traffic still is about 3Gbps as of June 2003

the foreign Tier 1 ISP. Also, for some ISPs, turning up peering is an easy task so they adopt an “Open” policy. For them, UUNet simply has to interact with the right person at the right time in the right language.

The Foreign Tier 1 Peering Dynamic is observed in the other direction as well; Japan Telecom is peering in the U.S. with a subset of the Tier 2 ISPs, with little luck getting peering with the Tier 1 ISPs.

The Foreign Tier 1 Peering Dynamic is seen Globally. If we illustrate this dynamic this across several Internet Peering Ecosystems, we see the effect as shown in the diagram below. With the exception of NTT/Verio, who acquired Tier 1 status in the U.S. Internet Peering Ecosystem through acquisition of Verio, few Tier 1 ISPs have been able to successfully build in and reach Tier 1 status in a foreign country. (Those that did used some combination of the tactics documented in “The Art of Peering: The Peering Playbook”, freely available from the author.)

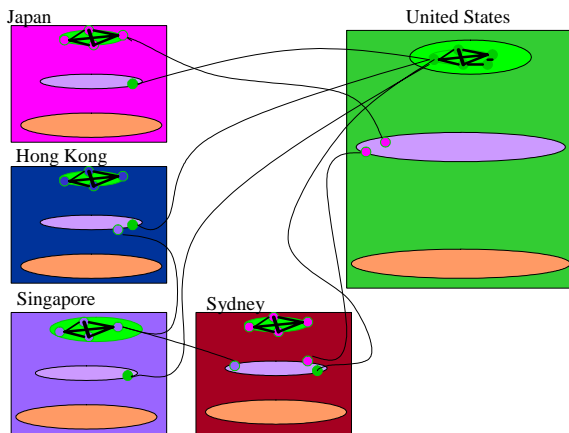


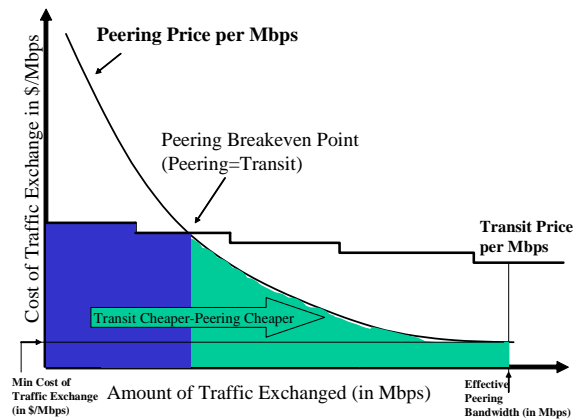
Figure 3 - The Generalized Foreign Tier 1 Peering Dynamic

We found one notable exception to the Foreign Tier 1 Peering Dynamic in mainland China. Both China Telecom and China Netcom, the two Tier 1 ISPs in China, have signaled their preference to openly peer their routes with foreigners, and do so in China! The stated motivation was to reduce costs of accessing the rest of the Internet, and to demonstrate openness as they deregulate the China Telecommunications sector. They would prefer not to pay the cost of backhauling all the Internet traffic for all of its customers back to China. It remains to be seen if China Telecom’s Asia Pacific Internet Exchange (APIX) concept in Shanghai takes off.

The Business Case for Peering: Peering vs. Transit

We will make the Business Case for Peering in each of these Peering Ecosystems. We do this by comparing the cost of peering against the unit cost of buying transit⁴. First we plot the cost of peering at an exchange point against the amount of traffic peered. We then plot the transit cost and find the intersect point, called the **Peering Breakeven Point**. We cap the peering at the **Effective Peering Bandwidth**, which is the maximum bandwidth available for peering after taking into account layer 2 framing and port limitations. Then we can compare the cost of peering against the cost of transit, taking into account all costs of peering (except for equipment costs).

When it costs less to send traffic to an upstream transit provider, ISPs should rationally prefer to do so⁵. When the unit cost of sending traffic to an IX is less, ISPs should prefer to use an IX to offload this transit traffic. Beyond the **Peering Breakeven Point**, all peering costs (circuit into the IX, router, rack, port fees) are completely covered by the cost savings of peering. This is shown in the figure below, highlighting a few points of interest to the Peering Coordinator community.



Over the past few years, transit prices have dropped dramatically, sending the breakeven point

⁴ We are using the same methodology follow in the Business Case for Peering white paper previously released.

⁵ Assuming that performance is not an issue with the upstream provider.

out and to the right. One needs to peer more traffic these days for peering to make sense. We will apply this framework to find the business case for peering in each Peering Ecosystem.

Four Internet Peering Ecosystems

We now continue the discussion of Internet Peering Ecosystems with specific data points from the Japan, Singapore, Australian and Hong Kong Peering Ecosystems.

The Japanese Internet Peering Ecosystem

Japan is one of the most vibrant Peering Ecosystems in Asia, with several healthy domestic peering points exchanging over 30Gbps of traffic, a Tier 1 ISP population exchanging an estimated 100Gbps⁶, and several thousand Tier 2 ISPs⁷ including a notable Broadband Player (Yahoo! Broadband also known as Softbank Broadband) causing massive disruption to the Japanese Peering Ecosystem.

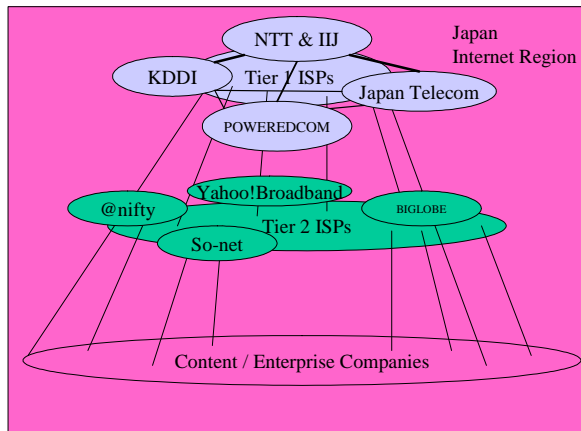


Figure 4 - The Japanese Peering Ecosystem

In Japan, the set of Tier 1 ISPs include

- Japan Telecom (JT Open Data Network (ODN)),
- NTT (and Internet Initiative Japan (IJ)),
- KDDI, and

⁶ Source: Akinori Maemura (France Telecom) as the APRICOT 2004 Peering Track.

⁷ Source: ITU 2001

- POWEREDCOM,

who collectively service Japan's Internet Traffic. Because Japanese Eyeballs generally want to view Japanese Content, about 80% of all Japanese Internet Traffic stays within Japan⁸. There is comparably smaller amounts of traffic destined to the U.S.; Fumio Terashima (Japan Telecom) estimates that less than 5% of all Japanese traffic is destined to/from the U.S. today⁹, and that this 5% is between three and four Gigabits per second. This makes Japan one of the more self-contained self-sustaining Peering Ecosystems in Asia.

Massive Broadband Disruption

The Tier 1 ISPs in Japan generally own the Cable and DSL infrastructure so there is no substrate of open peering Cable and DSL providers in Japan as we have seen in the U.S. Ecosystem¹⁰. There is however a major disruption in the Japanese Peering Ecosystem with Yahoo!Broadband (aka Softbank Broadband).

Softbank Broadband is offering DSL modems with capacity up to 40Mbps to the household for less than \$50USD/month¹¹. Fiber to the Home (FTTH) is also widely available in this ecosystem¹² for \$100/mo. As of February 2004, Softbank Broadband is sinking about 48Gbps of traffic and sourcing 28Gbps¹³. This volume of traffic has become a problem for some ISPs, with up to 70% of the traffic being Peer2Peer traffic. Those ISPs not well peered are paying the transit fees in Japan well beyond expectations and are rapidly seeking to peer with Softbank Broadband. Softbank Broadband's recently purchased Japan Telecom, making them a Tier 1 ISP in Japan. It will be interesting to see if the Tier 1

⁸ Fumio Terashima (Japan Telecom) and Patrick Gilmore (Akamai)

⁹ About 70% stays within Japan, 5% goes to the U.S. and the remaining 15% goes mostly within the AP Region. Tatsuo Sato (KDDI America) agrees. This amounts to about 2-3 Gbps of transpacific traffic for KDDI, and 2-3 Gbps for Japan Telecom.

¹⁰ See "Evolution of the U.S. Peering Ecosystem" white paper for details. Freely available from the author.

¹¹ Update:
<http://neasia.nikkeibp.com/wcs/leaf/CID/onair/asabt/news/321661>

¹² From U's Communications

¹³ Presented at NANOG 30 Peering BOF in Miami.

status takes hold or if the other Tier 1 ISPs deeper them. It will also be interesting to see if Softbank Broadband takes this opportunity to restrict its peering and sell transit to ISPs.

Note: After word got out that the police raided a predominant Peer-2-Peer computer file sharer, a noticeable drop in network traffic occurred [14]. The news of the raid caused people to turn off their computers and perhaps even de-install the file sharing software.

Voice over IP is taking off in Japan as well, with Yahoo! Broadband providing free on-net¹⁵ phone calls. The metered charge for off-net phone calls is nominal.

Peering Cost Drivers

In late 2002 DSL providers made a significant market push in Japan with a \$20-\$30/month 8-40Mbps DSL offering¹⁶. The number of subscribers doubled in the last year as a result¹⁷.

With 49 Million Internet Users, Japan has the highest Internet penetration rate (39% of the population) of Asia¹⁸.

The result of these initiatives is shown in the table,

Broadband Service	Japan Customers (2002) ¹⁹
DSL (8-10Mbps)	5,645,728
Fiber To The Home (FTTH)	206,189

Figure 5 - Broadband & FTTH Penetration in Japan

¹⁴ JPNAP Presentation at APRICOT 2004.

¹⁵ With other Yahoo!Broadband customers. Source: Jonathan Chou (Equinix)

¹⁶ Jim Weisser cited SoftbankBB fees: ADSL fee: 990Yen, ISP fee: 1290Yen, Modem Rental: 690Yen, NTT Copper Rental: 168Yen. Service capacity varies.

¹⁷ Japan: Ministry of Home Affairs, Public Administration, Post & Telecommunication: "A Comparative Study of Broadband in Asia." Paper available on-line:

<http://www.anr.org/web/html/output/2002/bbasia0929.pdf>

¹⁸ NUA 2002 Internet Survey. <http://www.nua.com>

¹⁹ Toru Takahashi (IA Japan) at APRICOT Meeting in Taipei, Taiwan Feb 2003.

with the broadband customer based expected to grow to 35M by 2005.

Streaming applications are huge in Japan; instead of using 300Kbps rates for streaming video they are using 1Mbps rates, largely spurred by the DSL capacity now available to the home. Yahoo! Broadband has made great strides in deploying broadband using NTT copper²⁰. Streaming media in Japan includes live news feeds, video-on-demand applications, interactive adult and other video chatting, horse racing sporting events.

Content companies in Japan generally collocate with and buy transit from Tier 1 ISPs, so there is no evidence of the evolution of Japanese Network Savvy Large Content group that engages in peering either as we have seen in the U.S. Peering Ecosystem.

Japan Interconnect Regions. Japan has a relatively small land mass with a high concentration of people with a high Internet adoption rate. This results in a huge amount of Internet traffic concentrated in a small area, a necessary prerequisite for peering to make sense financially. At the same time however, there is currently concern among the government and Internet operators that too much of the Japan Internet traffic is concentrated and exchanged in Tokyo at the Otemachi building. As a result, there were some initiatives announced at the APRICOT 2003 meeting to distribute peering more broadly across Japan. As of this writing there are still only two Interconnect Regions where Tier 1 ISP fully mesh their interconnection: Tokyo (Otemachi and Shinjuku²¹) with over 60% of the country's peering traffic, and increasingly Osaka.

²⁰ This required government intervention. The Telecom Ministry has been involved in getting unbundled access. Softbank largely drives this initiative from the Yahoo! partnership perspective, providing financing, equipment, etc. Source: Jonathan Chou (Equinix) and Darrin Divinia (Yahoo!)

²¹ Fumio Terashima (Japan Telecom). Both of these are KDDI Buildings: Otemachi Building in Tokyo and the _____ building in Shinjuku.



Figure 6 – One Interconnect Region in Japan

Japan Surprises. One of the surprises pointed out by Nigel Titley was that there are 3 Internet Exchange points in Tokyo! The larger exchange points in Tokyo are JPIX²², NSPIX2²³ (aka DIXIE) and JPNAP²⁴, each at or beyond critical mass. Selecting one presents a challenge which leads nicely to the next section.

The Value of an Internet Exchange

In this section we will focus on critical peering data needed to quantify the health of a Peering Ecosystem, identifying among other things, the value of a Public Internet Exchange Fabric.

Definition: The Value of a Public Internet Exchange Fabric can be estimated by measuring the cost savings realized by the IX participants. First, we multiply the amount of traffic peered across the IX and the price of transit. The result is the total dollar volume of traffic sent across peering instead of transit interconnects. If you then divide by the number of participants and subtract the cost of participation, you have the average value derived by the participants of the IX as shown in the formula below:

$$V_{IX} = \frac{(v_{Peering} t_{Price})}{n_{Peering}} - p_{Cost}$$

where

V_{IX} = ValueOfIX

$v_{Peering}$ = VolumeOfIXTraffic

$n_{Peering}$ = NumberOfIXPeers

t_{Price} = Avg PriceOfTransit

p_{Cost} = CostOfPeeringAtIX

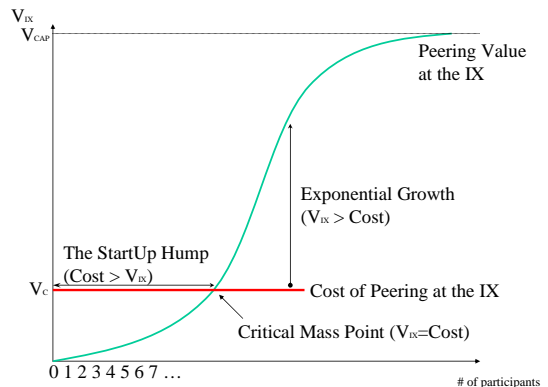
²² See <http://www.jpix.co.jp>.

²³ <http://nspixp2.wide.ad.jp>

²⁴ <http://www.jpnap.net>

Some variables in this equation may be difficult to obtain. Many Internet Exchange Points make the aggregate peering traffic volume available to the public, but some do not. Further, private peering exchanges often utilize cross connects making it impossible to assess the total amount of traffic traversing their private exchange. This formula is therefore more accurately described as the value of a *Public* Internet Exchange fabric to the participants. To calculate the value of the Internet exchange, one would need to include not only the public peering fabric, but also the benefits of private peering and buying/selling transit in an environment where interconnection cross connects is less expensive than with local loops.

All Internet Exchange Points go through a “Startup Hump” during which time the cost of participation is greater than the value derived from participation. This is shown in the graphic below. As the number of participants (and therefore presumably peering routes and traffic) increases, so does the value of the exchange. When the value exceeds the cost, the IX experiences an exponential growth in value.



IX operators understand this network effect well, and use several tactics to encourage participation at the IX. For example, if the financial justification is needed, an IX operator can decrease or waive some fees for the first participants. This, in effect, decreases the critical mass point, the point where peering is financially viable.

There a couple of caveats here. First, it needs to be reemphasized that we are only noting the financial benefits of peering; there are significant performance benefits to peering that for some, dwarf the financial benefits of peering. Next, some companies that built into a colo to buy or sell transit, have no incremental local loop cost for peering; for them, the cost of peering is significantly lower. Finally, we are ignoring the capital costs of peering for this analysis;

the necessary equipment varies widely so estimates for costs here vary widely as well.

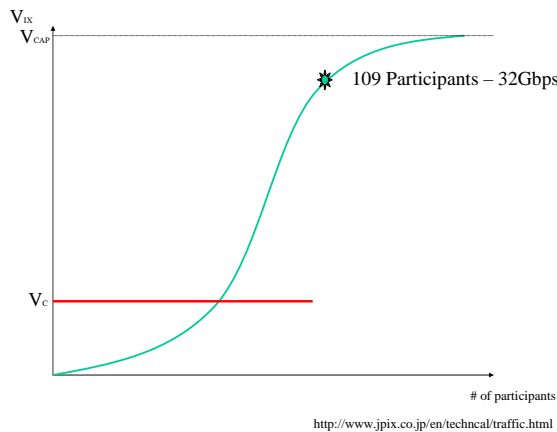
Domestic Peering Points in Japan. Taking a look at the three large public internet exchanges in Japan, we see a relatively high cost of participation, but also a large associated value. For example, at the JPIX, on average a participant saves \$4,096 per month by sending peering traffic to the IX as opposed to sending this traffic through an upstream transit provider.

Japan Domestic Exchange Points

Name	#Mbps Peered	# Peers	Cost	IX Value
JPIX	34000	109	\$ 11,500	\$ 4,096
JPNAP	30000	38	\$ 13,000	\$ 761
NSPIXP2	18000	100	\$ 5,000	\$ 3,257

²⁵ <http://www.jpix.co.jp/en/service/price.html>

We can see the JPIX value in the IX peering value graph below.



During the research one additional surprise that was that cross connects bypassing the JPIX switch need to be explicitly approved by KDDI. This decision is based on KDDI's interests and cross connects have been denied to competitors²⁶.

Other Japanese Peering Drivers

Metro fiber in Tokyo is inexpensive. From NTT to customer building (already on NTT network), one can

²⁵ Here we assume that a Rack and gigE port are purchased from the JPIX, and that the customer has as an alternative, a gig commit at \$50 per Mbps. Note in this calculation that we ignore local loop cost and the cost of peering equipment.

²⁶ I've heard this from several sources but I need an source on the record.

expect to pay about \$300/month US for a fiber loop! There are many dark fiber options available now in metro areas²⁷.

Japan is largely a Bi-lateral Peering Agreement environment, and it is reported to be somewhat difficult to get peering without a local (human) presence²⁸. Transit prices approach those in the US as commits increase.

A Business Case for Peering in Japan

In the table below we see that the transit prices in Japan drop dramatically as the level of commit increases. Given these aggressive transit prices, does peering make sense in Japan?

Transit Pricing in Japan

Commit (in Mbps)	\$ per Mbps (USD)
1	\$490
10	\$150
100	\$110
1000	\$50

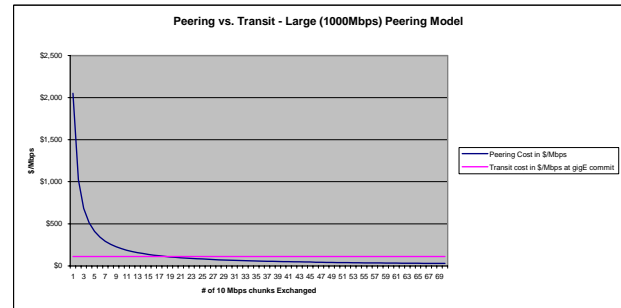
First we will discuss peering using a Fast Ethernet (FastE henceforth) 100Mbps interface at an IX. Ethernet is very efficient but does not provide a full 100Mbps capacity – there are some framing costs that limit the interface to 94% of the 100Mbps. Further, Peering Coordinators understand that when the interface averages 75% utilized, the peaks are probably reaching the capacity of the link. Therefore, we apply the 75% rule against the 94 Mbps to obtain an Effective Peering Bandwidth of 70.5Mbps. Beyond this point, the Peering Coordinator will typically upgrade the peering interconnect.

The business case for peering is tough to make at low peering volumes, mostly due to the cost of local loops and the relatively high cost of IX participation (\$9,500 per month including local loop). We see in the analysis below that using a FastE for peering at the JPIX, with only 70.5 Mbps available for peering yields a minimum cost of peering of \$134.75 per Mbps. This is the best cost of traffic exchange that the peer can hope for. When compared against transit pricing of \$110 per Mbps for a 100Mbps commit, the business case for peering fails. It does not make sense (financially) to peer at the JPIX at FastE speeds.

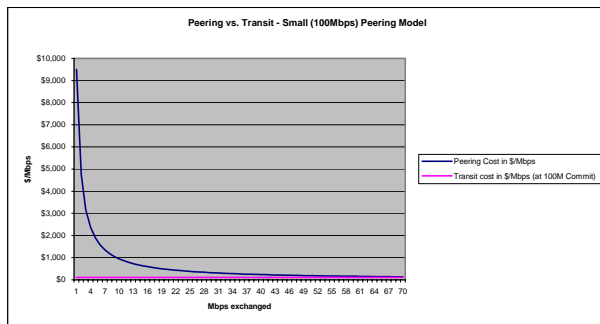
²⁷ Jonathan Chou (Equinix)

²⁸ Jonathan Chou (Equinix)

The Cost of Peering in Japan (100M peering model)		
Assume NTT Local Loop STM-1 or 100M ethernet into Otemachi colo		
	\$2,500	per month
Colocation costs for a rack		
	\$2,500	per month
FastE Port		
	\$4,500	per month
Total Cost of Participation at IX		
	\$9,500	per month
Effective Peering Bandwidth	75% * 94Mbps	70.5 Mbps
Minimum peering cost of traffic exchange	\$134.75	per Mbps
-----compared to -----		
Transit Price (at 100Mbps commit)	\$110	per Mbps
Peering Break Even Point	86	Mbps



We see in the graph below that the cost of peering is greater than the cost or transit, assuming of course that the full 100Mbps commit on the transit pipe is met and the real unit cost of transit is \$110 per Mbps.



When we consider the larger peering model we fare much better. We assume that an ISP is bringing in a GigE local loop and purchasing a gigE port for peering is probably also buying transit at a gigabit Ethernet commit pricing of \$50 per Mbps. While the cost of this larger model peering is substantially more than the previous case (now \$20,500 per month), we see a break even point of 410 Mbps, which is substantially below the Effective Peering Bandwidth of 705 Mbps.

The Cost of Peering in Japan (gigE peering model)		
Assume NTT Local Loop STM-12 into Otemachi colo		
	\$9,000	per month
Colocation costs for a rack		
	\$2,500	per month
gigE Port		
	\$9,000	per month
Total Cost of Participation at IX		
	\$20,500	per month
Effective Peering Bandwidth	75% * 940Mbps	705 Mbps
Minimum peering cost of traffic exchange	\$29.08	per Mbps
-----compared to -----		
Transit Price (at 1000Mbps commit)	\$50	per Mbps
Peering Break Even Point	410	Mbps

If an ISP can peer at least 410 Mbps then we can prove that it makes sense financially to peer there. This **Effective Peering Range**, the range between the Peering Breakeven Point and the Effective Peering Bandwidth, shows the “Sweet Spot” for peering at this IX. We can see the breakeven point graphically in the graph below.

Open Questions

- 1) Can ISPs burst above their commits, and if so, is it the same price as the commit price? Or Higher or Lower?
- 2) How can domestic access for retail customers be \$50 for a 40M DSL line, and still \$2500 for an STM-1 into the KDDI JPIX?
- 3) What % of JP traffic can be picked up at the JPIX?
- 4) Data points in this section were taken across several years, presumably during time they changed. Are there resources on the net that track these parameters continuously?
- 5) Given the BW requirements of JP Peering, has private peering emerged as a follow up to public peering as is done in the U.S.?
- 6) Has remote peering taken hold at JPIX or the other IXes?

The Singaporean Internet Peering Ecosystem

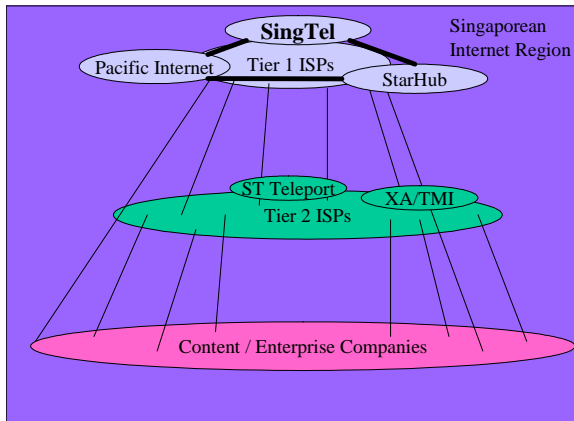


Figure 7 - Singapore Peering Ecosystem

The Tier 1 ISPs in Singapore are sometimes referred to as “The Holy Trinity” of

- SingTel,
- Pacific Internet, and
- StarHub.

SingTel is the incumbent state-owned telephone company that still connects the largest set of telephone and Internet customers and is considered the 800-pound gorilla among the Tier 1 ISPs in Singapore²⁹.

Singapore is called “Business Friendly” by Microsoft, which listed this as one of the drivers to make Singapore the core distribution point for all Microsoft content across Southeast Asia³⁰. One example of this “Business Friendly” environment is that the tax rates in Singapore are closer to 10% as compared with Tokyo at 40%.

Singaporean Government Proactive on Telecom Reform. The Singaporean government is proactive in deregulating the Internet market and trying to encourage the development of a richer Internet Ecosystem in Singapore, but has not been entirely successful, as indicated by the dearth of Tier

²⁹ Called Leased Line Charges (LLC) in Singapore terminology. Conversation with Jonathan Chou (Equinix), June 11, 2003.

³⁰ Christian Nielson at the APRICOT 2004 Peering Track.

2 ISPs. Efforts are being made to lower the barriers to peering including pressuring SingTel to lower their local loop prices by 20%-40%³¹, and by the recent allocation of wireless spectrum to facilitate bypassing SingTel for Local Loops among other things³², and through the recent U.S.-Singapore Free Trade Agreement.

Traffic Patterns are exactly the opposite from Japan; 20% of the Singaporean traffic stays within Singapore. The rest goes elsewhere, reflective of the relatively small size of the market and the diversity of the population³³.

Whether seen as proactive in deregulating or invasive in company affairs, the government has a stake in so many commercial ventures that it wields considerable power in the Singaporean Peering Ecosystem. There was some hesitancy in this community to talk discuss frankly about the Singaporean government role in interconnections.

Emerging Broadband Peering Players. The broadband eyeballs in Singapore are owned by SingTel and StarHub (which acquired the CableVision Cable-based Internet subscribers). There is no incentive for either of these two Tier 1 ISPs to peer freely. We see no emerging competitive Broadband market in Singapore as we see in Japan, nor do we see disruptions as when the cable companies peer openly in the U.S.

Network Savvy Large Scale Content Players. There are few large-scale content companies in Singapore due to several contributing forces: a) the low degree of Internet penetration, and b) the Singaporean government has been very strict relative to Internet content³⁴ in Singapore. For these reasons the volume of content traffic volume may not be sufficient to explore peering directly with the Tier 2 ISPs.

There is one interconnect region in Singapore, and

³¹ E-mail conversation with Keok Choon Seah (Singapore Economic Development Board). kcseah@edb.gov.sg

³² Conversation with James Seng (IDA) at APRICOT 2004.

³³ According to James Seng (Singaporean IDA) this number is surprising. The author received this stat from an anonymous source and seeks additional data points.

³⁴ For example, the Singaporean government does not allow pornography to be hosted in Singapore. Jonathan Chou (Equinix Singapore)

peering is generally accomplished using a state-built (now commercialized) ATM backbone called 1-Net built to facilitate peering between the players and bring Internet access to the broader Singaporean area. Note that 1-Net is no longer perceived as being neutral. There is however a university-sponsored non-profit initiative to facilitate peering across a switch called the Singaporean Open Exchange (SOX)³⁵ as well as a commercial Internet Exchange Point (Equinix-Singapore).

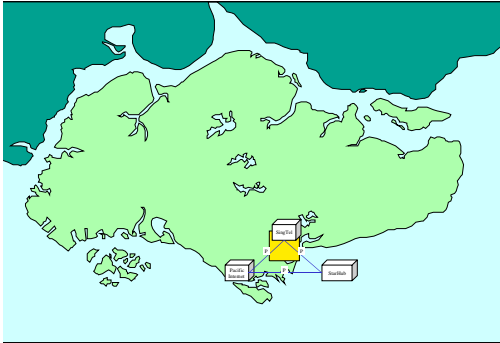


Figure 8 - Singapore Interconnect Regions

Transit is expensive. A T1 of transit costs \$700/Mbps (US\$), and the unit price decreases only when a DS3 is purchased yielding a \$400-\$500/Mbps price point. If you purchase paid peering / transit from the STIX it can cost up to \$1400/Mbps (USD) for a 1 Mbps commitment and \$892/Mbps-\$1200/Mbps for a 10Mbps commitment³⁶.

Transit Pricing is Discriminatory. At APRICOT 2004 Peering Track, many people pointed out that the price of transit depends who you are. Within the Singaporean government and among a network of sponsored companies, the price for transit is much lower³⁷. Prices for 1Mbps of transit vary from \$450/Mbps up to \$625/Mbps³⁸.

Local Loops are expensive. There is relatively little traffic between Singaporean ISPs, and when combined with the expense of getting into an IX, makes it very difficult to make the business case for

Peering. This has led to a very difficult business case for peering (since the cost of getting to a peering point is expensive) as well as making it difficult for ISPs to compete against SingTel using SingTel local loops. The cost of an STM-1 local loop from SingTel or Starhub might cost \$9K/month, or from Global Switch or Chai Chee \$6K/month³⁹, where the same STM-1 in Hong Kong would cost around \$4K/month⁴⁰.

The infancy of the Singaporean Internet Ecosystem is reflected in the relatively small # of ISPs, expensive local loops, dominance and lack of aggressive competition among the ISPs. There are only 42 ISPs in Singapore⁴¹ which may be understandable given that it is a small country with only a few million people.

Singaporean Surprises. Among the surprises peering in Singapore, many Peering Coordinators cited the STIX Internet Exchange as a misnomer. The STIX is a SingTel operation that sells transit to various AP countries at a price approaching the price of SingTel transit, which is among the highest transit prices in the world. Further, there is an AS in between the ISP and the “peers” reachable via the STIX. Since most Peering Coordinators see Peering as a Direct, Free and unmetered service, the STIX is seen by many in the Peering Coordinator community as a it service named as an IX.

A Business Case for Peering in Singapore

As stated earlier, Singapore has one of the most expensive transit markets in the region. It also has very expensive local loops, which provide a hurdle for the business case for peering.

Transit Pricing in Singapore

Commit (in Mbps)	\$ per Mbps
1	\$625
10	\$350
100	\$210
1000	\$115

The largest component of the business case for peering is the local loop. For example, if an ISP builds into the Equinix Singapore IX using an STM-1, one can assume a local loop cost of \$9,000 per month. This represents the largest chunk of the

³⁵ James Seng (Singapore IDA)

³⁶ Price quotes from customer.

³⁷ Source: Anonymous citation from Singaporean Tier 1 ISP at APRICOT 2004.

³⁸ Sample price quotes from the field as seen by Equinix sales reps in the U.S. and Singapore.

³⁹ Sample price quote from Andrew Oon (Equinix).

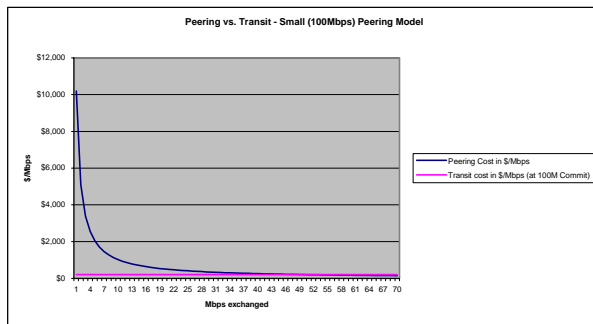
⁴⁰ Anonymous comparative quote from the APRICOT 2004 Peering Track.

⁴¹ Source: ITU 2001

peering costs as shown below.

The Cost of Peering in Singapore (100M peering model)		
Assume SingTel Local Loop STM-1 or 100M ethernet into Equinix Singapore		\$9,000 per month
Colocation costs for a 1/2 rack		\$450 per month
FastE Port		\$750 per month
Total Cost of Participation at IX		\$10,200 per month
Effective Peering Bandwidth	75% * 94Mbps	70.5 Mbps
Minimum peering cost of traffic exchange	-----compared to-----	\$144.68 per Mbps
Transit Price (at 100Mbps commit)		\$210 per Mbps
Peering Break Even Point		49 Mbps

At the same time, expensive transit leads to a strong business case for peering in Singapore. We see in the analysis that the Effective Peering Range is 49 Mbps to 70.5 Mbps. Within this narrow range, peering is less expensive than simply purchasing transit as shown below. A rational ISP would build in if the peering traffic volume is expected to fall within this range, shown graphically below.



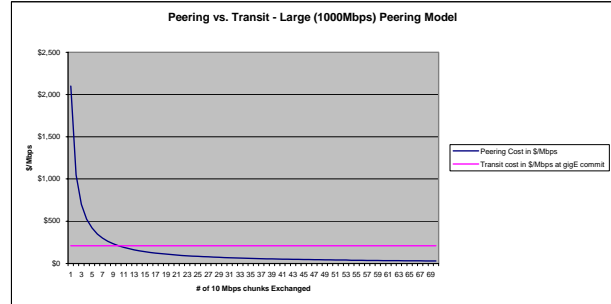
The challenge in Singapore is building critical mass at the IX so that participants can exchange this much traffic. Beyond this 70.5 Mbps, peering capacity must be upgraded.

Interviews with players in Singapore indicated that gigabit level peering is not an option in Singapore since there are not many Tier 2 ISP, and maybe none could peer a Gbps of traffic! Just the same, below we provide a guesstimate of the business case for Gigabit peering in Singapore. You can see, once the volume of peering traffic grows, it is quite compelling.

The Cost of Peering in Singapore (gigE peering model)		
Assume SingTel Local Loop STM-12 into Equinix Singapore		\$18,000 per month
Colocation costs for a rack		\$1,000 per month
gigE Port		\$2,000 per month
Total Cost of Participation at IX		\$21,000 per month
Effective Peering Bandwidth	75% * 940Mbps	705 Mbps
Minimum peering cost of traffic exchange	-----compared to-----	\$29.79 per Mbps
Transit Price (at 1000Mbps commit)		\$115 per Mbps
Peering Break Even Point		183 Mbps

If one can peer 183 Mbps of traffic in Singapore, then peering is less expensive than transit at the gigabit per

second commit levels. One will continue saving money up to the Effective Peering Bandwidth of 705 Mbps where the Minimum cost of Peering approaches \$144.68 per Mbps.



Very few ISPs exist in Singapore. It was difficult to obtain prices on higher commits since so few had purchased that much transit.

Domestic Peering Points in Singapore. While these transit prices might lead one to believe that Peering is a reasonable approach to reduce costs, Peering in Singapore is at the very early stages of development. The National University of Singapore and government have backed the Singapore Open Exchange (SOX) for several years with only a handful of takers. Recently Equinix has entered the market launching Private and Public Peering and interconnect environments for peering and transit services as well.

High local loop costs affect both of these Internet Exchange Points in Singapore; the local loops to get into a peering point are expensive (twice the cost of the same transport service in Hong Kong for example⁴²). This leads to a very expensive per Mbps peering cost as compared with transit. It is not surprising that peering points in Singapore have not been widely adopted.

Open questions:

- 1) It is not clear where the transit break points are for Singapore. Do you get a price break at 2Mbps commit? At 10Mbps commit?
- 2) What future event(s) will grow the Peering Ecosystem to support multiple gigabits of peering traffic in Singapore?

⁴² Data point presented at the APRICOT 2003 Peering Track.

The Australian Internet Peering Ecosystem

The Tier 1 ISPs in Australia, called by the Peering Coordinator Community the “Gang of Four”, include:

- Telstra
- Optus (now owned by SingTel),
- MCI (formerly OzeMail), and
- Connect.com (owned by Telecom New Zealand)⁴³.

These last three are all small in comparison to the 51% state-owned Telstra. The eight hundred pound gorilla in the Australia Peering Ecosystem is the majority state-owned Telstra⁴⁴.

Australia is one of the few countries that has ventured into regulating Peering. In 1997 Telstra was forced to peer with Optus, Ozemail and Connect.com by the regulator (ACCC⁴⁵). Interestingly, once the decree was made, these three Tier 1 ISPs were quickly acquired by foreign Tier 1 ISPs. This is a cautionary tale for other countries – a move intended to open up the markets ultimately only enable foreign competitors into the market !

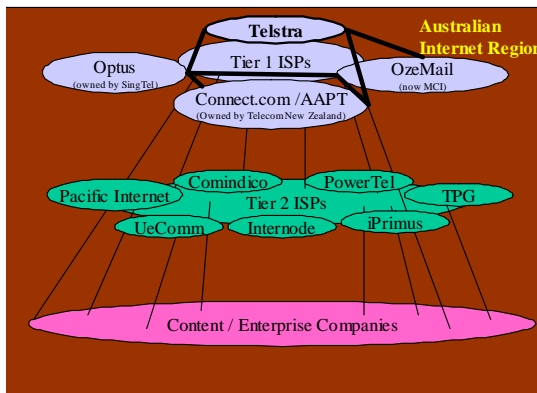


Figure 9 - The Australian Peering Ecosystem

Restrictive Peering. The Tier 1 ISPs in Australia have restrictive Peering Policies. Telstra for example requires a 622Mbps interconnect capacity in each state, which is more capacity than can be supported by the entire state⁴⁶. James Spenceley (Comindico) said that they built a network to meet these stated requirements of an STM-4 into most major capitals at a cost of \$420 million over 4 years⁴⁷. This allowed them to “try” for peering but faced the MILD (Make It Long and Difficult) peering negotiations approach described earlier.

James Spenceley (Comindico) and Gavin Tweedie (WAIX) shared their difficulties gaining peering with the Tier 1 ISPs in Australia at the APRICOT 2004 Peering Track. The “MILD” approach caused the delay of peering meetings with Telstra for 12 months, and with Optus 6 months. Rather than disclosing the Tier 1 peering policies and prerequisites, ultimately the focus of the discussions were Comindico’s currently deployed architecture and utilization. The view from Comindico was that this approach allowed the Tier 1 ISPs to specify prerequisites tailored to exclude the candidate peer! This is the definition of Restrictive Peering – the unstated intent is to deny peering⁴⁸.

Few Emerging Network Savvy Large-Scale Content Players. There are few of these players evident in Australia. Contributing reasons include a) the lack of Internet penetration, b) the disincentive to download content (volume-based billing) and c) the Australian government does not allow pornography to be hosted in Australia which has led to a burgeoning market for off-shore hosters for this type of content⁴⁹. For these reasons the volume of content traffic may not have been sufficient to explore peering directly with the Tier 2 ISPs.

Australia Interconnect Regions.

Australia is best characterized as an Island the size of the U.S., similarly sparsely populated as Canada, but with scorching heat instead of brutal cold. Internet Services tend to be concentrated at four population centers (Sydney, Melbourne, Brisbane,

⁴³ Communications Day, June 16, 2003. Issue 2084, page 1 “Agile Communications seeks Tier 1 status, dumps Telstra transit links”

⁴⁴ Partially divested, but the sale of the remaining shares of Telstra has been delayed so the government still owns the majority of Telstra.

⁴⁵ Australian Competition and Consumer Commission: <http://www.accc.gov.au>

⁴⁶ Gavin Tweedie (WAIX) over dinner in Sydney before the AP Peering Forum, June 18, 2003.

⁴⁷ APRICOT 2004 Peering Track

⁴⁸ First presented in the “Evolution of the U.S. Peering Ecosystem” white paper.

⁴⁹ Jonathan Chou (Equinix, Singapore)

Perth) as shown below with practically nothing but kangaroos and desert in between.

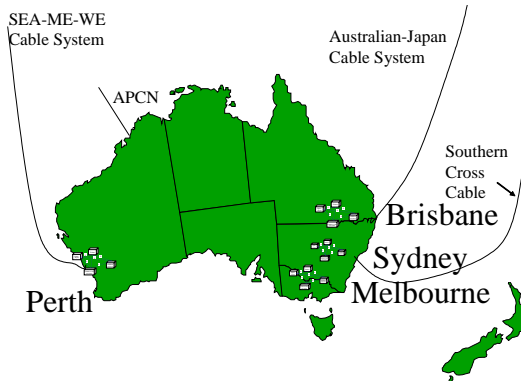


Figure 10 - Australian Interconnect Regions

The Tier 2 ISPs operate in metro areas where transport capacity is inexpensive. Long haul transport is still very expensive and dark fiber is not widely available in Australia. As a result, the Tier 2 ISPs tend to cluster their peering in one (maybe two) of the four interconnect regions. Examples of the Tier 2 ISPs are PowerTel, UeComm, inet, Agile Communications, NetSpace, Primus, Comindico⁵⁰. There are peering sessions between a few of the large Tier 2 ISPs and a couple of the Tier 1 ISPs.

Local Loops Expensive in Australia. Recent price quotes for a 4M Telstra local loop were \$3375 retail (\$2250 wholesale). At these prices, local loops are a major component of Australian peering costs.

The billing for retail Internet transit in Australia is predominately volume-based billing, although 95th percentile now also available for ISPs.

Volume Billing Unique to Australia. Transit customers are billed for Internet traffic based on the volume of traffic downloaded, as compared with the 95th percentile 5-minute sample (or flat-rate) billing that is common in most parts of the world. This leads large ISPs to buy in bulk MB from the Tier 1 ISPs, and do the math to determine when/if it makes sense to get that volume of traffic from other places.

“It is often cheaper to get Australian routes in the U.S.” – James Spenceley (Comindico)⁵¹

⁵⁰ Steve Baxter (PIPE Networks) over lunch in Sydney, June 18, 2003. James Spenceley describes Comindico as a Tier 1.75, with only one more Tier 1 peering to go.

⁵¹ Conversation at dinner before the AP Peering Forum,

The required analysis to compare buying transport to the U.S. and buying 95th percentile transit as compared against downloaded traffic volume is shown in Appendix A.

Note: A related Peer-to-Peer story⁵² involves a grandmother in Australia that had her grandkids over during the holidays. In Australia, end users are charged for Internet access on a per-Megabytes-downloaded basis. When the grandkids wanted to hear the latest Britney Spears song on grandma’s computer, they installed Kazaa and downloaded the song. By default Kazaa shares all files it downloads, and soon grandma’s computer became the preferred source for the Britney Spears songs! Grandma’s bill from Telstra was several hundred dollars as opposed to the usual \$25 she pays per month! In the U.S. where broadband is typically a flat fee there is no such disincentive to use all the bandwidth available.

Other Australia Peering Drivers

- Relatively low traffic volume (200Mbps of traffic between Tier 1 and Tier 2 ISPs would be a stretch)
- Tier 3 ISPs segment purchase 8-10 Mbps of transit traffic from one or more Tier 2 / Tier 1 ISPs
- Very Expensive Transit Market (\$700 /Mbps for 1Mbps commit) from Telstra
- Internet Pornography is not allowed to be hosted in Australia leading to a market for offshore hosting, adding to the already imbalanced traffic ratios.
- Transpacific capacity has dropped in price dramatically.
- Tier 2 ISPs and hosters are losing deals to Telstra who is bundling cheap transport with cheap colo, and increasing price to competitors buildings
- The ACCC is currently exploring ways to regulate peering⁵³ again.

Sydney June 18, 2003. James Spenceley <jrs@comindico.com.au>

⁵² Read about this story on the web at: <http://www.smh.com.au/articles/2003/06/16/1055615717838.html>

⁵³ Pjil Tsakaros (Pacific Internet AU) presentation at the AP Peering Forum, June 19, 2003 “An Efficient Industry Approach to Peering”

James Spenceley (Comindico) claims that 40-50% peering is possible in Australia with 10 POPs and a national backbone network. He also claims that 25% peering in Australia requires only a modest effort. Is the effort worth it financially? Perhaps not. James estimates that Comindico spent \$1.7M per year to build out in order to save \$1.5M per year.

A Business Case for Peering in Australia

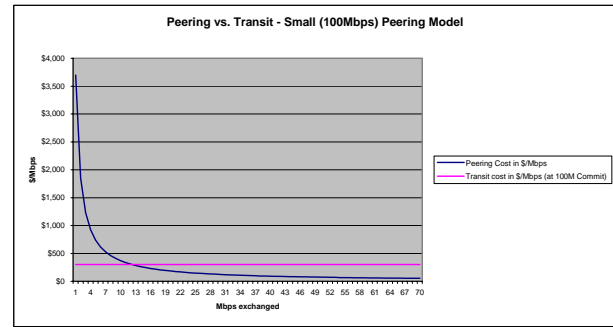
The business case for peering in Australia is pretty solid. This is largely due to the high expense of transit, the highest among the Internet Peering Ecosystems we explored.

Transit Pricing in Australia	
Commit (in Mbps)	\$ per Mbps (USD)
1	\$700
10	\$400
100	\$300
1000	\$200

Consider the example below of peering in Sydney at the Equinix IBX. Ethernet is the MAN media of choice for local loops.

The Cost of Peering in Australia (100M peering model)		
Assume Local Loop 100M ethernet into Equinix colo		\$2,500 per month
Colocation costs for a 1/2 rack		\$450 per month
FastE Port		\$750 per month
Total Cost of Participation at IX		\$3,700 per month
Effective Peering Bandwidth	75% * 94Mbps	70.5 Mbps
Minimum peering cost of traffic exchange		\$52.48 per Mbps
-----compared to -----		
Transit Price (at 100Mbps commit)		\$300 per Mbps
Peering Break Even Point		12 Mbps

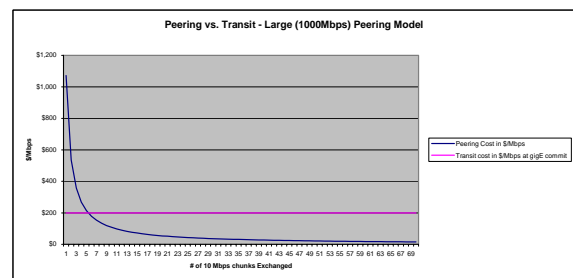
In the analysis above, we see that the total cost of peering at Equinix Sydney with a FastE might cost \$3,700 per month including a local loop at \$2,500 per month. If we assume the ISP or Content player is buying transit in Australia at 100 Mbps commit pricing of \$300 per Mbps, we see a breakeven point of 12 Mbps where an ISP is indifferent between peering and transit. From that point until the Effective Peering Bandwidth of 70.5 Mbps, the ISP saves money by sending traffic to the peering point until the Minimum Cost of Peering Traffic Exchange is reached at \$52.48 per Mbps. If an ISP can send at least 12 Mbps of peering traffic to peers at the IX, we can prove financially that it is advantageous to do so. This is shown in the graph below.



Peering at the gigabit level shows even more promise. If we assume that the ISP or Content company is coming in on a gigabit Ethernet with a cost of \$7,500 per month we have a total monthly cost of peering of \$10,720 per month. With an Effective Peering Bandwidth of 705 Mbps we see the ISP can possible get to a Minimum cost of Peering of \$15.21 per Mbps, substantially below the cost of transit at a gigabit commit level of \$200 per Mbps.

The Cost of Peering in Australia (gigE peering model)		
Assume Local Loop gigabit into Equinix colo		\$7,500 per month
Colocation costs for a rack		\$720 per month
gigE Port		\$2,500 per month
Total Cost of Participation at IX		\$10,720 per month
Effective Peering Bandwidth	75% * 940Mbps	705 Mbps
Minimum peering cost of traffic exchange		\$15.21 per Mbps
-----compared to -----		
Transit Price (at 1000Mbps commit)		\$200 per Mbps
Peering Break Even Point		54 Mbps

This is shown graphically below. Note that the cost of peering is below the cost of transit once the ISP can send 54 Mbps to the peering point. This provides the greatest Effective Peering Range in the regions we studied; from 54 Mbps to 705 Mbps the ISP is saving money by peering.



Domestic Peering Points in Australia. Australia is geographically the largest Peering Ecosystem we

cover, and is unique in that

- 1) Australia is “at the end of the earth”, so is not on the way to anywhere⁵⁴. Therefore all traffic sent to and pulled from Australia is Australian traffic and no aggregation benefits are possible with other traffic sources and sinks, and
- 2) Australia is about the size of the U.S. but it consists of really five population centers with sufficient traffic to justify offering internet services.

As a result, we see

1. regional ISPs and domestic peering points distributed and operating in these five population centers (Sydney, Brisbane, Melbourne, Adelaide, Perth) and
2. the price of transit appears to asymptotically approach the cost of transport across Southern Cross. According to John Hubbard⁵⁵, about 70% of all Australian downloads (currently about 200 Terabytes per month) are from the U.S., so a price slightly higher than the cost of the Southern Cross submarine cable system (estimated to be around \$300/Mbps) provides a small margin of profit on these large transit sales. For this reason, some Peering Coordinators at the Sydney Peering Forum II posited that transit in Australia may asymptotically approach, but not go below, the Southern Cross pricing.

Transport within these metro areas is reasonably inexpensive, while transport between these major population areas remains quite expensive. It is not surprising therefore that one sees a different set of players at these regional IXes, with few connecting to multiple IXes.

⁵⁴ Quote from Geoff Huston.

⁵⁵ John did Internet transport capacity research for the ITU and presented preliminary findings at the Sydney Peering Forum 2 July 28, 2004. Hibbard Consulting, jhibbard@bigpond.com

The Hong Kong Internet Peering Ecosystem

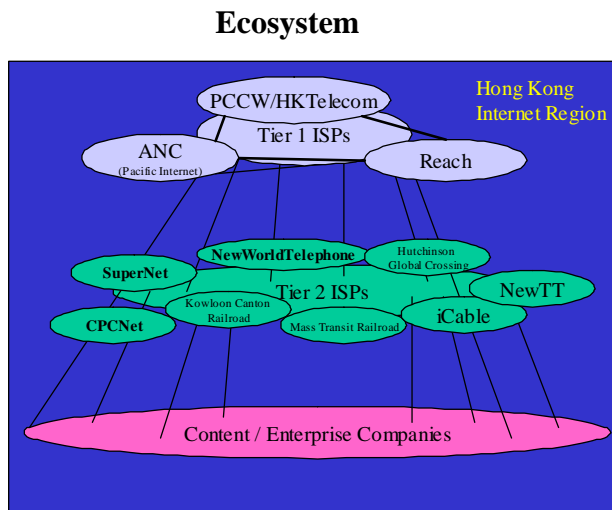


Figure 11 - The Hong Kong Peering Ecosystem

Tier 1 ISPs in Hong Kong include

- PCCW
- ANC (acquired Pacific Internet), and
- Reach

Peering Coordinators when asked for surprises mentioned that the Hong Kong Internet Exchange (HKIX) was an Multi-Lateral Peering Exchange (MLPA) IX but did not give access to all of Hong Kong traffic. More importantly, none of the China routes were available at the HKIX⁵⁶, and one needed to buy transit from Asia Netcom or China Telecom to get to China. In fact, many HKIX participants exchange relatively few routes across the HKIX peering sessions. Still, to get any of these routes one had to agree to peer with everyone there. Particularly large regional and global ISPs have a problem with this approach, as they tend to favor the control of bi-lateral private peering⁵⁷.

Other Hong Kong Peering Drivers

⁵⁶ Source: Nigel Title (FLAG Telecom) 2/1/2004

⁵⁷ Erasmus Ng mentioned this at the APRICOT Peering Track, however, the author has heard this sentiment from Qwest, Reach, AT&T, TeleGlobe, NTT, MCI, France Telecom, and most large ISPs.

- License required to operate an ISP
- With 900,000 DSL customers at 3Mbps Hong Kong has a potential of 2.7 Terabits/second of Internet traffic! The price of DSL access in Hong Kong is about \$25/month U.S.⁵⁸ A 6Mbps feed is \$50/month.
- There are 650,000 Internet Subscribers on PCCW Netigator, the PCCW ISP.
- There are 258 ISPs licensed to operate in Hong Kong⁵⁹.
- Broadband Penetration has grown dramatically in the last few years. In December 2001, 623,000 Internet subscribers, in August of 2002, 820,000 were installed, representing a 31% growth in 9 months. This is about 1/3 of the households in Hong Kong⁶⁰.

Local Loops are inexpensive on this small island, charged on a flat rate (distance insensitive) basis across Hong Kong.

A Business Case for Peering in Hong Kong

The price of transit in Hong Kong is very competitive as shown in the chart below, partly due to the ease of obtaining access to Hong Kong routes via free peering at the HKIX.

Transit Pricing in Hong Kong

Commit (in Mbps)	\$ per Mbps
1	\$185
10	\$100
100	\$80
1000	\$50

In Hong Kong the local loops are competitively priced lowering the hurdle for peering. For example, a FastE into the Hong Kong IBX outside of the Central Business District to the HKIX is \$1,140 per month. When added to the cost of a rack and port we have a participation cost at two IXes (Equinix and the

⁵⁸ Conversation with Lionel Taylor (Reach) at the ITU Telecom Asia forum in Hong Kong in Fall 2002. Lionel lives in Hong Kong.

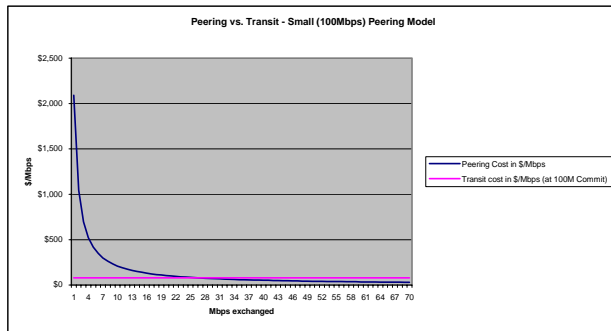
⁵⁹ Source: ITU 2001

⁶⁰ "A Comparative Study of Broadband in Asia", Izumi Aizu.

HKIX) for \$2,090 per month. (This is a promotional bundle but can still be used for illustration purposes.)

The Cost of Peering in Hong Kong (100M peering model)		
Assume <provider> Local Loop STM-1 or 100M ethernet into Equinix colo		\$1,140 per month
Colocation costs for a 1/2 rack		\$450 per month
FastE Port		\$500 per month
Total Cost of Participation at IX		\$2,090 per month
Effective Peering Bandwidth	75% * 94Mbps	70.5 Mbps
Minimum peering cost of traffic exchange		\$29.65 per Mbps
-----compared to-----		
Transit Price (at 100Mbps commit)		\$80 per Mbps
Peering Break Even Point		26 Mbps

In this example we assume the ISP in question is buying transit at a 100M commit for \$80 per Mbps. Even at these low prices, the breakeven point, where peering is less expensive than transit, is 26 Mbps. If an ISP can send 26 Mbps or more of peering traffic, it is financially reasonable to do so. At full capacity, the Minimum cost of Peering in this scenario is \$29.65 per Mbps, a far cry less than \$80 per Mbps for transit.

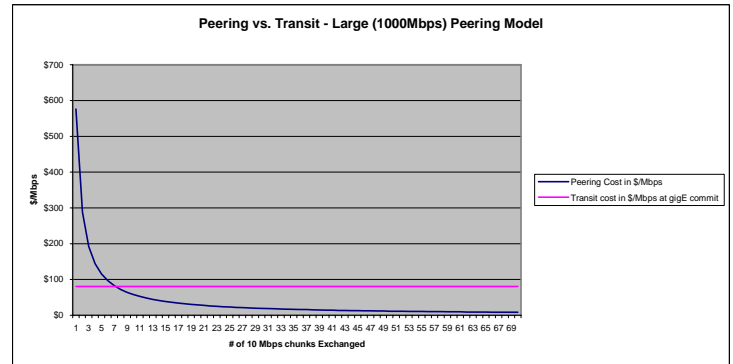


Once we grow past the 70.5 Mbps we need to explore the next sized peering model up. To continue the example, we upgrade the FastE to a gigabit Ethernet (at \$4,000 per month) and we find a total cost of participation of \$5,760 per month for both the Equinix IBX and the HKIX.

The Cost of Peering in Hong Kong (gigE peering model)		
Assume <provider> Local Loop STM-12 into Equinix colo		\$4,000 per month
Colocation costs for a rack		\$400 per month
gigE Port		\$1,360 per month
Total Cost of Participation at IX		\$5,760 per month
Effective Peering Bandwidth	75% * 940Mbps	705 Mbps
Minimum peering cost of traffic exchange		\$8.17 per Mbps
-----compared to-----		
Transit Price (at 1000Mbps commit)		\$50 per Mbps
Peering Break Even Point		115 Mbps

In this gigabit example, we see the breakeven point of 115 Mbps, where the cost of peering exactly equals the cost of transit (\$50 per Mbps). From this point to

705 Mbps, peering is cheaper than transit, even in this most competitive transit market!



The issue with all of these Peering vs. Transit discussion is determining if there is sufficient traffic to send to the peering point.

Domestic Peering in Hong Kong. The original Hong Kong Internet Exchange (HKIX) is a Mandatory Multi-Lateral Peering Agreement IX, meaning that everyone has to peer with everyone else via a Route Server. There is substantial traffic traversing the HKIX as shown in the chart below, leading to a substantially successful and valuable IX.

Hong Kong Domestic Exchange Points

Name	#Mbps Peered	# Peers	Cost	IX Value
HKIX	17000	72	\$1,140	\$ 10,666

Note that the HKIX is a free IX; ISPs connecting to it only pay the cost of the local loop. Also, local loops are distance insensitive and inexpensive. This helps make the value of the IX very high. The expense an ISP does face is the collocation of their networking equipment, and for this there seem to be three choices: Equinix, mega-iAdvantage and Sino Favor. The last two are in the Central Business District (CBD) while the latter is out of downtown. Since local loops are distance insensitive, the physical distance from the HKIX tends not to be an issue.

5 Motivations for Network Extensions into and within Asia

Conversations with Peering Coordinators and Network Architects revealed five reasons to extend into and within the Asia Pacific Region:

- 1. Incumbent Tier 1 ISPs to peer their routes outside their home market.** As shown in the previous section, the Incumbent Tier 1 ISPs sell transit in their home market and must interconnect to the rest of the Internet somehow, but they rather not support in any way a competitor in their home market. As a result, Tier 1 ISPs do not want to nor see the need to peer with anyone else domestically. However, there is no threat to their home market if they peer those same domestic routes in another country like the U.S.: this is a common practice in Asia. As John Milbourne put the comparative values mathematically at APRICOT 2004: *ProtectingMarket > InCountryPeeringBenefits*
- 2. Meet U.S. Tier 1 Peering Prerequisites.** Sprint for example requires a 5Gbps capacity network into Asia for peering in at least three AP countries with a 300Mbps backbone within this region⁶¹. Other Tier 1 ISPs in the U.S. have lower requirements, with STM-4⁶² into Asia and Europe as shown below. Paying \$70,000 per month to save \$75,000 per month in paid peering expenses makes sense.⁶³

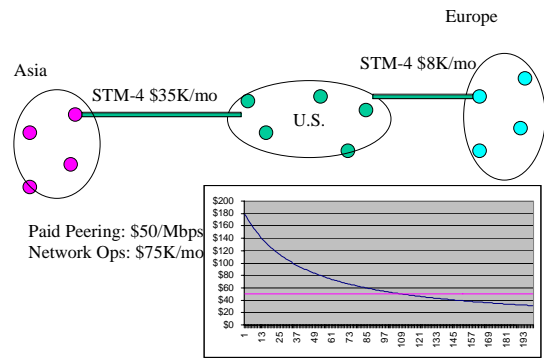


Figure 12 - The Business Case for meeting U.S. Tier 1 Peering Prerequisites

- 3. Customers want them in Asia.** Several ISPs say that their customers have needs for better and larger capacity into and throughout the AP region⁶⁴. For example, the VPN market has grown significantly as corporations extend in to Asia. This has led to increased capacity and coverage across Asia in order to win enterprise customer business. Further, massive broadband traffic growth is driving traffic exchange volume, which leads to increased motivation to peer (for free) with the Asian ISPs to get this traffic. With customers connected in Korea using 26 Mbps DSL connections for \$35/month⁶⁵, it is not surprising that Korea is emerging as a hot Internet Ecosystem for peering.
- 4. Global Marketing Benefits.** ISPs with a large global backbone into and within Asia are better positioned to sell transit and other services to customers exchanging traffic with Asian entities. Marketing literature often cites capacity and growth plans in Asia to attract customers with similar growth plans in Asia. As Marcellus Nixon (XO Communication) puts it “A strong Asian and European network presence better positions an ISP as a serious network

⁶¹ Anonymous from two sources. Note that the Sprint Policy also requires a 10Gbps backbone interconnecting in 16 markets in the US and at least 7 countries in Europe. AT&T has a lower barrier to peering but does require STM-4 capacity into Asia.

⁶² An STM-4 is a 622Mbps circuit, and an STM-1 is a 155Mbps circuit.

⁶³ Marcellus Nixon (XO Communication) shared this motivation. Even if more expensive, the free peering, if delivered, effectively underwrites the cost of Asia expansion.

⁶⁴ Marcellus Nixon (XO Communications) and Stuart Deane (AT&T) among others shared these comments.

⁶⁵ Breakfast conversation with John Milbourne, formerly of DACOM in Korea.

player⁶⁶.”

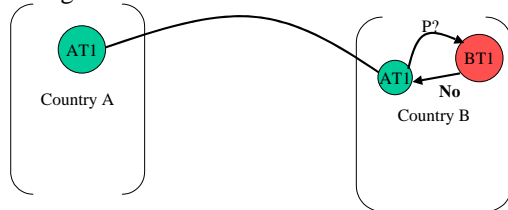
5. **Sell Transit into a high cost transit market.** Later in this paper we will see a wide disparity in transit prices across the Asia and a correspondingly lower price in the U.S. This may be the weakest motivation; in some markets the cost of the local loops and the market size makes transit sales expensive to provision and unprofitable in the near term. Still, extending into Asia does provide an opportunity to sell transit into an emerging market less brutalized by spiraling transit prices than the U.S.

It is unlikely that any one of these singularly lead to expansion into Asia, but a combination of these motivations seems to be the motivation. To illustrate, a large ISP in Australia commented on the free U.S. peering granted to ISPs that meet AT&T’s Asian and European peering prerequisites: *“Well if AT&T is going to subsidize the ISPs expansion into Asia, the ISP is probably going to and might as well go after some market share while they are there!”*⁶⁷

Four International Peering Strategies

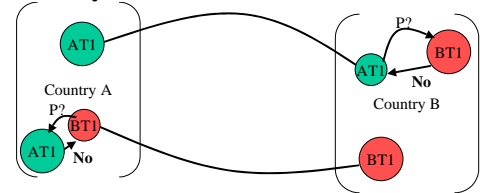
The Peering Coordinators identified four ways to extend peering Internationally:

1. **Extend into foreign country.** This strategy has the failings as described earlier; Tier 1 ISPs rarely peer with foreign invaders.



Even Yahoo! needed to overcome the “We are seen as competitors” perception in order to obtain peering with some domestic ISPs⁶⁸.

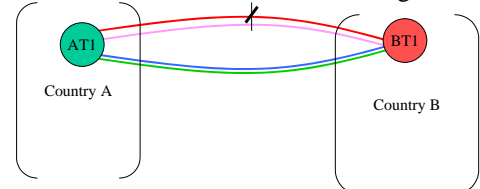
2. **Reciprocally peer in each others’ country.**



This rarely works as the benefits to peering rarely balance exactly. One or both parties feel the deal is inequitable and leave the negotiation.

Peter Cohen (Telia) points to reciprocal peering working in Europe; France Telecom and Telia expanded into each others’ region and peer locally with each other. In some cases, a competitor expanding into your region is not taken as a serious threat. In some cases, the relative market size is asymmetrical in the foreign ISPs advantage. In the France Telecom-Telia case, both sides determined that, in this peering relationship, they were receiving the better deal.

3. **Half-Circuit Peering.** This is traditional telco interconnection where both parties peer without establishing a presence (and therefore without competing directly) in each other’s regions.



When two ISPs have no intention of building into each other’s country, they can set up a dedicated peering point-to-point circuit. The costs are split, making this a so-termed “half circuit.”

Some example peering sessions of this flavor include Etisalat (PTT/ISP for the UAE) peering with VSNL (PTT/ISP in India)⁶⁹, Japan Telecom peering with HKTelecom and PCCW connecting router-to-router over DS3 half-circuits⁷⁰. Another example in

⁶⁶ Conversation at NANOG 30 in Miami, FL.

⁶⁷ Anonymous. This discussion took place over breakfast Feb 23, 2004 at APRICOT 2004 in Kuala Lumpur.

⁶⁸ Brokaw Price (Yahoo!) made these comments at the APRICOT 2004 Peering Track in Kuala Lumpur, Feb 26, 2004.

⁶⁹ Saleem al Balooshi (Etisalat, EMIX) conversation at RIPE 45 in Barcelona, May 2003

⁷⁰ Fumio Terashima (Japan Telecom) conversation at NANOG 28 in Salt Lake City.

the Middle East is Qatar Telecom peering with Kuwait Telecom and the Bahrain Tier 1 ISP using half circuits⁷¹. For low inter-country traffic volumes, and where a local presence is not required, this peering approach is effective.

Even though the half circuit approach sounds like an easy solution, Majdi Abbas (Lattice.Net) points to the shared control challenges of maintaining and upgrading half circuits. As shown in the diagram below, there are up to five parties that need to be on the phone when the peering circuit fails, needs maintenance or upgrading. On the other hand, if a local router is present in the foreign country, the demarcation point is clear; if you can reach your equipment in the other country, the International circuit is fine and you can concentrate on the remote peering fabric. Fewer parties involved means less trouble.

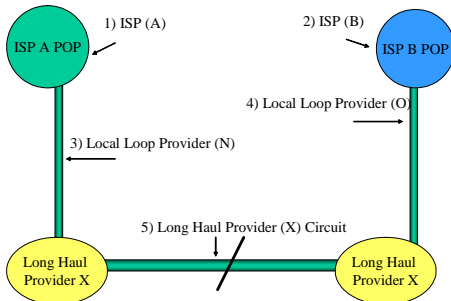


Figure 13 - Entities involved in Half Circuit Peering

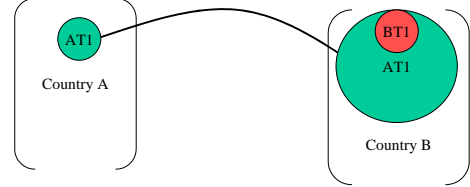
Majdi further points out, “Occasionally peering disputes occur over the *cost* of maintaining, upgrading and coordinating the timing of the upgrade of the components of the interconnection. This is particularly true if one or the other owner of the half circuit is currently in bankruptcy.”

The alternative to this method of half circuits is to have each ISP pay for alternating interconnections. This often takes the form of one ISP paying for the East interconnection, the other pays for the West, and so on.

Half circuit interconnection also fails to deliver economies of scale. Point to Point circuits scale linearly; as more interconnection bandwidth is required, more circuits need to be ordered. On the other hand, meeting in a foreign country to peer your routes allows an ISP to substantially aggregate traffic

as shown in the “Interconnection Strategies for ISPs⁷²” math.

4. **Buy an ISP with Tier 1 peering in the foreign region.**



While not an interconnection strategy per se, this approach is very effective in gaining in country peering. There are many examples of this strategy. NTT bought Verio to get Tier 1 status in the U.S., as did UUNet when it purchased Ozemail and when SingTel purchased Optus in Australia. Telecom New Zealand purchased AAPT in Australia, and Telstra purchased Clear in New Zealand. Level 3 in the early days purchased several Tier 2 ISPs for their legacy peering with the U.S. Tier 1 ISPs.

5. **Peer in an adjacent Peering Ecosystem.** This has been attempted several times through the last decades. One motivation to peer regionally outside of ones’ home country is to improve the performance of peering in the U.S. while still protecting ones home turf. However, an additional nationalistic obstacle has emerged; not wanting to reinforce another Asian countries position as the “core of the Asian Internet”. By building into another Asian peering point reinforces that countries position as the topological core of the Asian Internet. This in turn decreases the need for other ISPs to come into the Tier 1 ISPs home country, and makes it more expensive for its citizens to get its traffic to the “topological core” country. It is thought to be better to exchange in the U.S. than to give this advantage to a neighboring country. In this vein, Joe Zhu (China Telecom) points to its rivalry with China Netcom and China Unicom as being smaller than the rivalry with NTT,

⁷¹ Sameer Muhammed (Qatar Telecom)

⁷² This is the basis for U.S. Tier 1 Interconnections. Peering in a central point using cross connects. This white paper is freely available from the author.

SingTel, and other foreign ISPs and initiatives.

Asia Pacific Peering Lessons Learned

We next list the lesson learned by Peering Coordinators that have built into and throughout Asia.

Lesson #1 – Tier 1 ISPs Do Not Want to Peer in their Internet Peering Ecosystem

As explained in the Foreign Tier 1 ISP Dynamic, there is an inherent motivation to protect ones market position. Peering in an adjacent or at least nearby Internet Peering Ecosystem is one way to overcome the “protect the home turf” issue and peer Tier 1 routes.

Lesson #2 - There are Several Challenges Peering in Asia

Conversations with dozens of Asian, U.S. and European Peering Coordinators have revealed several general challenges building networks into and throughout Asia.

1. **Peering Process is different.** Sending e-mail to peering@<ispdomain>.net typically does not work. There is typically NOT a dedicated Peering Coordinator that handles Peering requests; the process is either handled by a team or as part of a network engineers’ job.
2. **Many Language Zones.** The diversity of languages across the Asia Pacific region presents at least two classes of dynamics: a) language-based peering interactions, and b) intra-language zone traffic patterns.
 - a. **Language-based peering interactions.** In China for example, Nigel Titley (FLAG Telecom) found that the word “Yes” *may* mean “agreement”. He found it may *instead* mean “I understand you.” It may *alternatively* mean “I don’t agree or understand, but please keep talking anyway.” Anecdotes like this came up in many forms. Nigel also found that several IXes in the region had only local language web sites, making it difficult to

establish peering there. It should be noted that the author found it very difficult to collect information on the Japanese Peering Ecosystem, not being a Japanese speaker. Akinori Maemura (France Telecom) said that he has spent time translating negative responses to peering requests with some of the International ISPs; he had to translate them into “kinder, more polite Japanese.” This point is not to demonize, but rather to point out that Peering Coordinators have said that language has proven to be a barrier to peering.

- b. **Intra-language zone Internet traffic patterns.** Internet traffic tends to stay within “Language and Cultural Zones⁷³,” which explains why 80% of the Japan Internet traffic tends to stay within the Japanese Internet Peering Ecosystem. One would expect traffic between China, Taiwan and Hong Kong, another Language Zone in Asia, as well as to Vancouver where a large immigrant Chinese population lives.
3. **Asia is spread across time zones** further amplifying the interaction, coordination, and operations challenges. Someone is going to be on conference calls late at night.
4. **Asia is spread across oceans,** so transport capacity between Asia countries is expensive. This expense was seen as a primary inhibitor to peering between countries. Comparably, capacity to the United States is relatively inexpensive as shown in the spreadsheet below (a larger version of this is in Appendix B). This leads to the relatively common practice of Asian ISPs peering with each other in the U.S.

⁷³ Language and Cultural zones is a phrase I first heard from Barry Greene (Cisco).

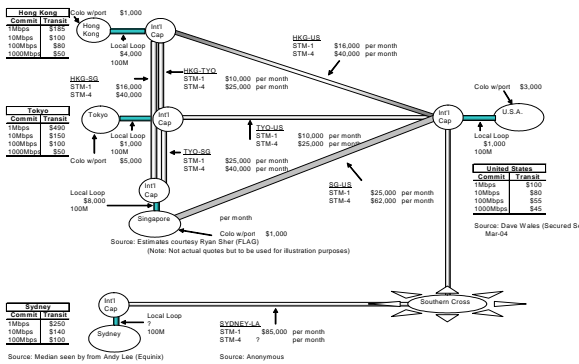


Figure 14 - Asia Peering Pricing Estimates

Due to the distance between countries in Asia, Internet traffic that traverses the transpacific circuits introduces substantial latency. So, an Australian ISP interconnecting to the U.S. through Singapore and then Japan will introduce upwards of 100 milliseconds of incremental latency over going directly across the Southern Cross cable system for example.

5. **Local Loop Costs** in many of the Asian Peering Ecosystems we explored are a large component of the in-region peering costs. Brokaw Price (Yahoo!) claims that high local loop prices between data centers and IXes force Yahoo! to deliver content from overseas. Microsoft made a similar statement at the Singapore Peering Forum in Feb. 2003. Erasmus Ng (T-Systems) claimed this Local Loop expense made it very difficult to make the business case for Peering in some parts of Asia. Gavin Tweedie (WAIX) claims the cost for a circuit across Australia is now as high as a circuit across the Pacific Ocean to Los Angeles using the Southern Cross transoceanic cable systems! Incumbent carriers, unless pressured to do so, generally enjoy high margins for their deployed infrastructure. Refer to the spreadsheet above for sample local loop costs.

6. **Transit costs⁷⁴ are highly variable and**

⁷⁴ Estimates only: Local 1Mbps commit Equinix sales quote from Tier 1 ISPs in each country, comments from Kok-Hoou Wong (Pacific Internet), Gavin Tweedie (WAIX), Jonathan Chou (Equinix)

in some cases highly discriminatory across Asia:

Commit	Hong Kong	Tokyo	Singapore	Sydney	US
1Mbps	\$185	\$490	\$625	\$1,030	\$100
10Mbps	\$100	\$150	\$350	\$500	\$80
100Mbps	\$80	\$100	\$200	\$400	\$90
1000Mbps	\$50	\$50			\$50

Figure 15 - Asia Pacific Transit Prices Highly Variable

In Singapore, the price of transit depends on who you are⁷⁵. In New Zealand, ISPs separate out domestic and international transit prices based on traffic analysis and the effect on the network backbone. Since 80% of the traffic is from the U.S., content delivery in the other direction is essentially free. As a result, transit prices are very low in New Zealand for international content players.

Combining the high cost of inter-Asia transport and highly variable cost of transit we see the opportunity for arbitrage. Compared to the U.S. where 1Mbps of transit can be purchased for \$100 from some Tier 1 ISPs, we see a potential motivation for Asian ISPs to expand to the U.S. for free peering and to purchase inexpensive transit.

Lesson #3 – Some Creative Peering Deals

Nigel Titley (Flag Telecom) and James Spenceley (Comindico) shared that negotiating peering in Asia often includes “deals” beyond just swapping access to each others traffic⁷⁶. In some cases, transport capacity or other such bargaining leverage was required in order to obtain peering with some of the larger ISPs in the Internet Peering Ecosystem. Akinori Maemura points to the practice in Japan of combined Peering and Transit deals. In Korea, part of the peering agreements often state that the peered Korean traffic can not be re-announced within Korea. Further, the peered ISP can not peer with any of the in-country ISPs downstream customers. In Australia several creative deals were constructed to obtain Tier 1 peering. These anecdotes further support the notion that peering has value and that large ISPs can and do extract concessions for peering. (Note: The “Art of

⁷⁵ Several anonymous sources at APRICOT 2004.

⁷⁶ APRICOT 2004 Peering Track.

Peering⁷⁷” white paper documents these types of tactics as “Peering as part of a Broader Business Arrangement” and as ultimately being highly effective.)

Lesson #4 - International Peering Gotcha: “Tromboning” Traffic through the U.S.

One topic that popped up multiple times during the research was “tromboning”, or inadvertently sending Internet traffic across the ocean when a better (more direct) path exists. The Border Gateway Protocol (BGP) performs route selection automatically based on the number of Autonomous Systems (AS) hops. When two ISPs peer with each other, the path is the shortest and preferred. However, there may be an ocean between the ASes, causing the shortest AS path to traverse an ocean have terrible latency.

Example: Consider a large ISP in Japan that peers locally with a large ISP in Korea. This is an effective direct interconnection.

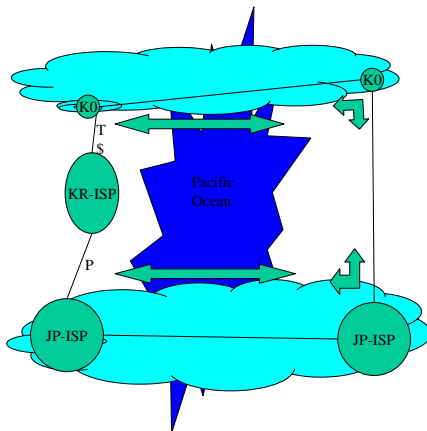


Figure 16 - Tromboning - Asia Peering in the U.S.

Next assume that the Korean ISP has a downstream customer that expands to the U.S. and peers with the same large Japanese ISP in the U.S. The traffic between this customer and the Japanese ISP will prefer the short direct path with each other in the U.S. instead of the longer AS path across the lower latency direct Korean ISP-Japanese ISP path. Peering in the U.S. may be the least costly path

⁷⁷ This white paper is freely available from the author and documents the “Tricks of the Trade” Peering Coordinators have used to get peering where they otherwise would not be able to.

(peering being free) but it is clearly not the best performing⁷⁸.

Lesson #5 - Local Presence Required

One common theme from the experience Peering Coordinators is that “having a local presence in the country for peering is required.” Zwickey Cheung (Asia Netcom) expands “You must find the right person and the right moment to approach peering discussions.” According to Zwickey, these peering negotiations may take two to six months before peering is established⁷⁹ depending on where you are.

Beyond being a way to overcome the time zone barrier and potentially overcoming the cultural barrier, having a local presence provides the opportunity to people network with the other Peering Coordinators in the Internet Peering Ecosystem. As Nigel Titley put it “In Asia, it’s all about who you know. Intermediaries are very helpful when e-mail to peering@<ispdomain.net> doesn’t get answered. It is almost like we are in old England; It is who you know; it wouldn’t be proper to speak before being introduced.” In this environment, having legs on the ground expedites peering and therefore speeds the ISP to the Peering Breakeven Point⁸⁰ for their peering infrastructure.

Lesson #6 - Separation of International Transit and Domestic Transit

In New Zealand, the cost of transporting bits across the ocean is so large (STM-4 \$100K/month translates to about \$170/Mbps for transport capacity!) ISPs have historically done everything possible to keep local traffic local. To these ISPs, of course New Zealand-New Zealand traffic is peered. There is therefore a separate price (and in fact separate pipes) for International and Domestic transit. For example, Jamie Baddeley from FX Networks in New Zealand shares that a 500 Mbps commit of domestic transit will cost between \$40,000 and \$50,000 New Zealand dollars per month (about \$100/Mbps), while international transit is closer to \$2000/Mbps per

⁷⁸ Source for this example: Nigel Titley (Flag Telecom) and Toshikazu Saito (POWEREDCOM)

⁷⁹ APRICOT 2004 Peering Track in Kuala Lumpur.

⁸⁰ The Peering Breakeven Point is where the cost of peering exactly equals the cost of transit. See “Do ATM-based Internet Exchange Points make sense Anymore?” from the author.

month. The same dichotomy is common in Australia and Hong Kong, where \$10/Mbps for domestic transit is balanced with \$100/Mbps for International transit⁸¹.

In this example, 80% of the traffic in New Zealand is destined to or coming from the U.S. In some other Peering Ecosystems (Japan and Australia), there were cases where separate prices given for International than for Domestic transit. We need further research to see how prevalent this pricing method is in the other Peering Ecosystems across Asia.

Lesson #7 - Content that Transcends the Language Barrier

One commonality across Asia is the ban on hosted pornography, or to state it politically correctly, the hosting of “Content that Transcends the Language Barrier.” As a result, this content is typically hosted overseas, often in the U.S. We mention this content type because pornography has historically represented a large percentage of traffic (anonymous estimates that upwards of 20% of all Australia traffic is of this type) and therefore helps explain the traffic patterns observed in the Asia Pacific Ecosystems.

Lesson #8 – No True Regional Content in Asia

As in South America, few Asian countries are the source of content for other Asian countries. The exceptions to this are the Contiguous Language Zones of China, Taiwan and Hong Kong where they share a common (almost) language⁸².

Lesson #9 – Content Peering in Asia Works

Microsoft and Yahoo! have both deployed content successfully around Asia and found that providers will peer with them. Microsoft has used some significant lures to sweeten the pot. Specifically, Microsoft Update, the latest Windows XP Service pack update in particular, is a 100MB update per user downloadable file that is made available over a peering session with Microsoft. If not delivered over a free local peering session, Microsoft will deliver the updates from overseas, most likely sending that

traffic across the ISPs transit connection from the U.S. Part of the pitch from Microsoft is that delivery of the MS Update over a free peering session also help increase the traffic flow to the customers, increasing the 95th percentile measurement and the therefore increase revenue for the ISP.

Lesson #10 – Understand the Internet Ecosystem

There are significant players in each Internet Peering Ecosystem, with practices and policies that will dictate the ISPs peering strategies, successes and challenges. It is critical that as many of the logistical details get uncovered early on in the expansion planning as possible. For example, it may seem appealing to expand into Singapore or Australia where transit is sold for as much as \$1000/Mbps, but you better understand the price of local loops and the current turmoil that is shaking these nascent peering ecosystems.

The appendix of this document lists specific data points of interest to Peering Coordinators associated with the Internet Peering Ecosystems of Japan, Singapore, Australia and Hong Kong that may be of value in this regard. Each country Ecosystem is presented in turn, identifying the Tier 1 players, and points that the Peering Coordinators said were significant as they expanded into or within the country.

Additional Research Topics

Follow up research topics include the following questions:

- 1) Is there a way to value Peering Ecosystems? Can we say that a specific Internet Peering Ecosystem is more advanced than another? If so, then what would be the parameters that contribute to making one “more advanced” than the other? Number of Tier 1 ISPs, Number of Tier 2 ISPs, number of IXes, type of peering policies, amount of traffic exchanged between the players, etc. It appears that Japan’s Peering Ecosystem is thriving. How do we prove that?
- 2) There appears to be some rivalry between countries for the claim to “being the core of the Asian Internet”. How would being the “core of the Asian Internet” help the country, and why would one want to make that claim?

⁸¹ Jeremy Deutsch (Equinix)

⁸² Erasmus Ng (T-Systems)

- 3) Are there foreseeable events that would change the peering ecosystems discussed?

Summary

We introduced some usable definitions for Tier 1 ISP, Tier 2 ISP and Content Provider. They are usable definitions because they help explain motivations and observed behavior in the Internet Peering Ecosystems.

The Foreign Tier 1 Peering Dynamic occurs when a Tier 1 ISP in one Internet Peering Ecosystem tries to obtain peering in another Internet Peering Ecosystem and is relegated to Tier 2 status. There are several reasons why in-country Tier 1 ISPs do not want to peer with foreign competitors; most significant are commercial interests to protect their own turf.

Four Asia Pacific Peering Ecosystems were explored including Japan, Singapore, Australia and Hong Kong. There is no singular Asian Peering Ecosystem; rather, there is a set of independent Peering Ecosystems in various stages of evolution. We presented the business case for peering for each ecosystem, including the prices of transit and the costs of peering using current market prices.

Peering Coordinators identified five Motivations for Network extensions into and within Asia and four International Peering Strategies. There seemed to be a blend of motivations that led to Asian deployments, and there are pro's and con's with each of the International Peering Strategies listed. There were ten main lessons shared regarding peering in Asia.

Acknowledgements

This has been the most difficult white paper on peering so far. Authoritative sources have been difficult to find and in many cases unwilling to freely share information. Some of the difficulty may be rooted in the language issues, and being monolingual made the population of experts to draw on very small. This may in itself be an interesting data point for the Asia Peering Ecosystem.

Having said that, I am grateful for the invaluable help from the following people who either provided data points, insights, experiences, or let me babble through the early drafts in their presence: Lionel Taylor (Reach), Ren Nowlin (SBC), Brokaw Price (Yahoo!), Christian Nielson (Microsoft), James Spenceley (Comindico), Geoff Huston (Telstra), John Milbourne (Newton Technology Partners), Tom Vest (formerly of AOL Asia), Zwickey Cheung (Asia

Netcom), Nigel Titley (FLAG Telecom), Joe Abley (ISC), Norman Hoy (MCI), Gavin Tweedie (WAIX), Ryan Sher (FLAG Telecom), Marcellus Nixon (XO Communications), Stuart Deane (AT&T Asia), Sylvie Laperriere (TeleGlobe), Peter Cohen (Telia), Bill Woodcock (PCH), Phil Koen (Equinix), Jonathan Chou (Equinix Asia), Bob Berger (MetroFi), Toshikazu Saito (POWEREDCOM), Lam Hon Kit (Asia Netcom), Akinori Maemura (France Telecom), Fumio Terashima (Japan Telecom), Dorian Kim (NTT/Verio), Christina Chu (NTT/Verio), James Seng (Singapore IDA), Steve Baxter (PIPE Networks), Marty Gauvin (Hostworks), Phil Tsakaros (Pacific Internet), Sean Carlin (Microsoft), Randy Whitney (MCI), Joe Zhu (China Telecom USA), Joe Provo (RCN), Terry Manderson (APNIC, formerly Optus), Dave McGaugh (PCCW/BTN), Philip Smith (Cisco), Keith Mitchell (XchangePoint), Patrick Gilmore (Akamai), Phil Grasso (NTT), Chris Chaudry (Comindico), Lloyd Taylor (Keynote Systems), Tatsuo Sato (KDDI America), Sam Habash (SuperNews), Joe McGuckin (via.net), Mike Leber (Hurricane Electric), Peter Jufferholz (T-Systems, formerly TeleGlobe), Jeremy Deutsch (Equinix), Sameer Muhammed (Qatar Telecom), Rob Seastrom (ClueTrust), Mike Hatfield, Guy Tal (Global Crossing), Jerry Murray (Global Voice Network), Jamie Baddeley (fx.net.nz).

About the Author



Mr. Norton's title is Co-Founder and Chief Technical Liaison for Equinix. In his current role, Mr. Norton focuses on research on large-scale interconnection and peering research, and in particular scaling Internet operations using optical networking. He has published and presented his research white papers ("Interconnections 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 Exchange Points Make Sense Anymore?") in a variety of international operations and research forums.

From October 1987 to September 1998, Mr. Norton served in a variety of staff and managerial roles at Merit Network, Inc., including directing national and international network research and operations activities, and chairing the North American Network Operators Group (NANOG) Internet industry forum. Mr. Norton received a B.A. in computer Science and an M.B.A. from the Michigan Business School, and has been an active member of the Internet Engineering Task Force for the past 15 years.

About the White Paper Series - Network Operations Documents (NODs)

The Network Operations Documents (NODs) identify a critical but undocumented area of Internet Operations. We research that area with the Operations Community to document the area definitions, motivations, strategies, etc. The initial drafts are reviewed in "walk throughs", where Internet Operators provide their views, their data points, their criticisms, and their experience. These are credited in the Acknowledgements section and footnoted where appropriate for the next walk throughs. After enough

walk throughs, the responses tend to migrate from constructive feedback to nods of acceptance, at which time a draft to is made available to the broader Internet Operations community. The papers are never "done" but rather are considered living documents, evolving with input from the community, hopefully reflecting the current practices in the previously undocumented area. Here are the NODs available from the author:

1. **Interconnection Strategies for ISPs** documents two dominant methods ISPs use to interconnect their networks. Over 200 ISPs helped create this white paper to identify when Internet Exchange Points make sense and the Direct Circuit interconnect method makes sense. Financial Models included in the paper quantify the tradeoffs between these two methods. All relevant data points are footnoted as to source.
2. **Internet Service Providers and Peering** answers the questions: "What is Peering and Transit? What are the motivations for Peering? What is the ISP Peering Coordinators Process for obtaining peering? What are criteria for IX selection?"
3. **A Business Case for Peering** builds upon the previous white papers but focuses on the questions important to the Chief Financial Officer: "When does Peering make sense from a financial standpoint? When do all the costs of Peering get completely offset by the cost savings?"
4. **The Art of Peering: The Peering Playbook** builds on the previous white papers by asking the Peering Coordinators to share the "Tricks of the Trade", methods of getting peering where otherwise they might not be able to get peering. These 20 tactics range from the straight forward to the obscure, from the clever to the borderline unethical. Nonetheless, Peering Coordinators might be interested in field-proven effective ways of obtaining peering in this highly controversial white paper.
5. **The Peering Simulation Game** finishes up my half day Peering Tutorial by engaging the audience in the role of the Peering Coordinator. Each ISP in turn rolls the dice, expands their network, collects revenue for each square of customer traffic, and pays transit fees to their upstream ISP. They quickly learn that if they peer with each other, the costs of traffic exchange are much less, but they need to negotiate how to cover the costs of the interconnect. ISP Peering

coordinators have commented on how close the peering simulation game is to reality in terms of the dialog that takes place.

6. **Do ATM-based Internet Exchange Points Make Sense Anymore?** Applies the “Business Case for Peering” financial models to ATM and Ethernet-based IXes using current market prices for transit, transport, and IX Peering Costs.
7. **The Evolution of the U.S. Peering Ecosystem**, introduces and focuses on several fundamental changes in the Peering Ecosystem spurred by several events following the telecom collapse of 1999/2000.
8. **The Art of Peering: The IX Playbook** follows the same tact as The Peering Playbook; we first introduce the framework theory of how and why IXes are valuable from an economic perspective. We then enumerate about a dozen tactics IXes use to get over the “Start Up Hump”, to build a strong critical mass of participants, and finally, defense tactics to maintain that population. (To be released at a future date.)
9. **The Asia Pacific Peering Guidebook** follows the “Evolution of the U.S. Peering Ecosystem” by exploring the Asia Internet environment from a peering perspective. What did Peering Coordinators find as counter-intuitive? What are the challenges peering in Tokyo, Hong Kong, Sydney and Singapore? This paper provides insights into these and related questions.

References

The following documents were used to research this white paper.

- 1) “ISPs restless on peering”, Kate Mackenzie, The Australian, Nov 4, 2003, <http://www.theaustralian.news.com.au/printpage/0,5942,7759337,00.html>
- 2) “AP Peering Forum Notes from the Field”, William B. Norton, Equinix documents the 1st Sydney Peering Forum presentations by Phil Tsakaros (Pacific Internet) regarding the regulatory environment in Australia.
- 3) APRICOT 2004 Peering Track papers and presentations, <http://www.apricot.net/apricot2004/papers.htm>
- 4) Telecommunications & Broadcasting, Asia Regional Market Brief, Spring 2004 by Asia

Now, U.S. Dept. of Commerce.

- 5) The Asia Pacific Internet Market Imperatives of Network Infrastructure Position Paper by ITU Regional Office for Asia and the Pacific, K.K. Gunawardana, Presented at Infocomms Forum Communic Asia 2001.
- 6) The Economics of IP Networks – Market, Technical and Public Policy Issues Relating to Internet Traffic Exchange”, by wik-Consult, Study for the European Commission received from europacom.org web site
- 7) “The Winds of Change in the Bandwidth Market; Developments in Asia’s Bandwidth Market are expected to hot up”, Asia Pacific Development Report 9, GDS Publishing Ltd, 2001
- 8) “Measuring International Internet Bandwidth”, pg 14-15, ITU News No 10. December 2002
- 9) Factbook on the Telecom and IT Industry in Asia, January 2002, by TelecomAsia and wirelessAsia for the Infocomm Development Authority of Singapore
- 10) Good general Asia Internet website: East and South East Asia: An Annotated Dictionary of Internet Resources: <http://newton.uor.edu/Departments&Programs/AsianStudiesDept/>
- 11) Another Asia Portal that was valuable: <http://www.tricity.wsu.edu/soc418/links.htm>

Appendix A – Comparing Australia Internet Volume Charging System against Mbps Pricing

The required analysis compares buying transport to the U.S. and buying 95th percentile transit and peering there as shown in the math calculation in Appendix A.

$$V = \text{VolumeDownloadedPerMonth}$$

$$R = \text{PricePerMByteDownloaded}$$

$$\text{AussieMonthlyTransitFee} = R * \frac{\text{VolumeDownloaded}(V)}{\text{Month}}$$

$$\text{TrafficRate} = \frac{V}{\text{Month}} * \frac{\text{Month}}{30\text{days}} * \frac{\text{Day}}{24\text{hours}} * \frac{\text{Hour}}{60\text{min}} * \frac{\text{Min}}{60\text{sec}}$$

$$\text{USCapacity} = \frac{\text{TrafficRate}}{\text{Second}} * 8 \frac{\text{bits}}{\text{byte}} = \text{Mbps}$$

$$t = \text{U.S.Transit Provider PricePerMbps}$$

$$\text{IXFee} = \text{Monthly U.S. Internet Exchange Point}$$

$$\text{U.S.MonthlyTransitFee} = \text{U.S.TransportFee} + (\text{TrafficRate} * t) + \text{IXFee}$$

$$?: \text{AussieMonthlyTransitFee} > \text{U.S.MonthlyTransitFee}$$

Figure 17 - Australian Transit compared against expanding to U.S. to buy U.S. transit

Let’s consider an example to see when expanding to the U.S. makes sense.

Expand to the U.S. for Cheap Transit: The average retail price for transit in Australia is \$0.15 (Australian dollars used throughout this example) per downloaded Megabyte (MB)⁸³. If an ISP averaged 100,000 Mbytes per month he would pay \$0.15 * 100,000 = \$15,000 per month in Australian Transit Fees.

To compute the costs to buy transit in the U.S. we need to convert this volume into Megabit per second at the 95th percentile. If 100,000 Megabytes were downloaded, assuming that all of this traffic was coming from the United States⁸⁴, this traffic volume averages to 0.0386 Mbps⁸⁵. Sam Habash (SuperNews) has empirically found that the 95th percentile measure is about 1.75 times that of the average. Applying this adjustment to our case, we find the 95th percentile measure should be about

⁸³ Geoff Huston (Telstra), Terry Manderson (APNIC, formerly from Optus) said prices are generally \$0.15 down to \$0.12 (Australian Dollars) per downloaded Megabytes.

⁸⁴ Simplifying assumption to make the math easier.

⁸⁵ This really should be done as a 95th percentile measure, but for simplicity we will take an average measure.

0.0675 Mbps. Rounding up, let’s call that 1Mbps.

Can an ISP get 1 Mbps to the U.S. cost effectively? Once in the United States, the average cost for a small amount of transit is around \$375 per Mbps (AU\$), so this traffic costs about \$375 per month as compared with \$15,000 /month ! We can estimate the Exchange Point fees to be \$4,500 /month for a rack and cross connects to a peering switch and transit provider in the U.S.⁸⁶. The transport cost to get across the ocean to the U.S.⁸⁷ might cost \$2,250 /mbps yielding \$2,250 per month. Adding all of these costs (\$7,125 per month), we have a obtained a substantially lower price than the Australian Transit Provider Fee of \$15,000 per month, saving the ISP \$7,875 per month! The financial models used to construct this analysis are shown below⁸⁸.

	AUS		U.S. Dollars
Australian Transit Fees	\$0.15	per Megabyte downloaded	
Transport to the U.S.	\$2,250	per Mbps to U.S. IX	\$1,500
U.S. IX Fees	\$4,500	per month	\$3,000
U.S. Transit Rate	\$375	per Mbps AU-USExch	1.5 \$250

Monthly Downloaded MB	Monthly AU Transit Fee	Avg Mbps	95th Percentile	Monthly U.S. Transit Fee	IX Fees	Transport To US	Monthly Cost	Monthly Cost Savings
1,000	\$150	0.0004	0.0007	\$375	\$4,500	\$2,250	\$7,125	(\$6,975)
10,000	\$1,500	0.0039	0.0068	\$375	\$4,500	\$2,250	\$7,125	(\$5,625)
100,000	\$15,000	0.0386	0.0675	\$375	\$4,500	\$2,250	\$7,125	\$7,875
1,000,000	\$150,000	0.3858	0.6752	\$375	\$4,500	\$2,250	\$7,125	\$142,875
10,000,000	\$1,500,000	3.8580	6.7515	\$2,532	\$4,500	\$15,191	\$22,223	\$1,477,777
100,000,000	\$15,000,000	38.5802	67.5154	\$25,318	\$4,500	\$151,910	\$181,728	\$14,818,272

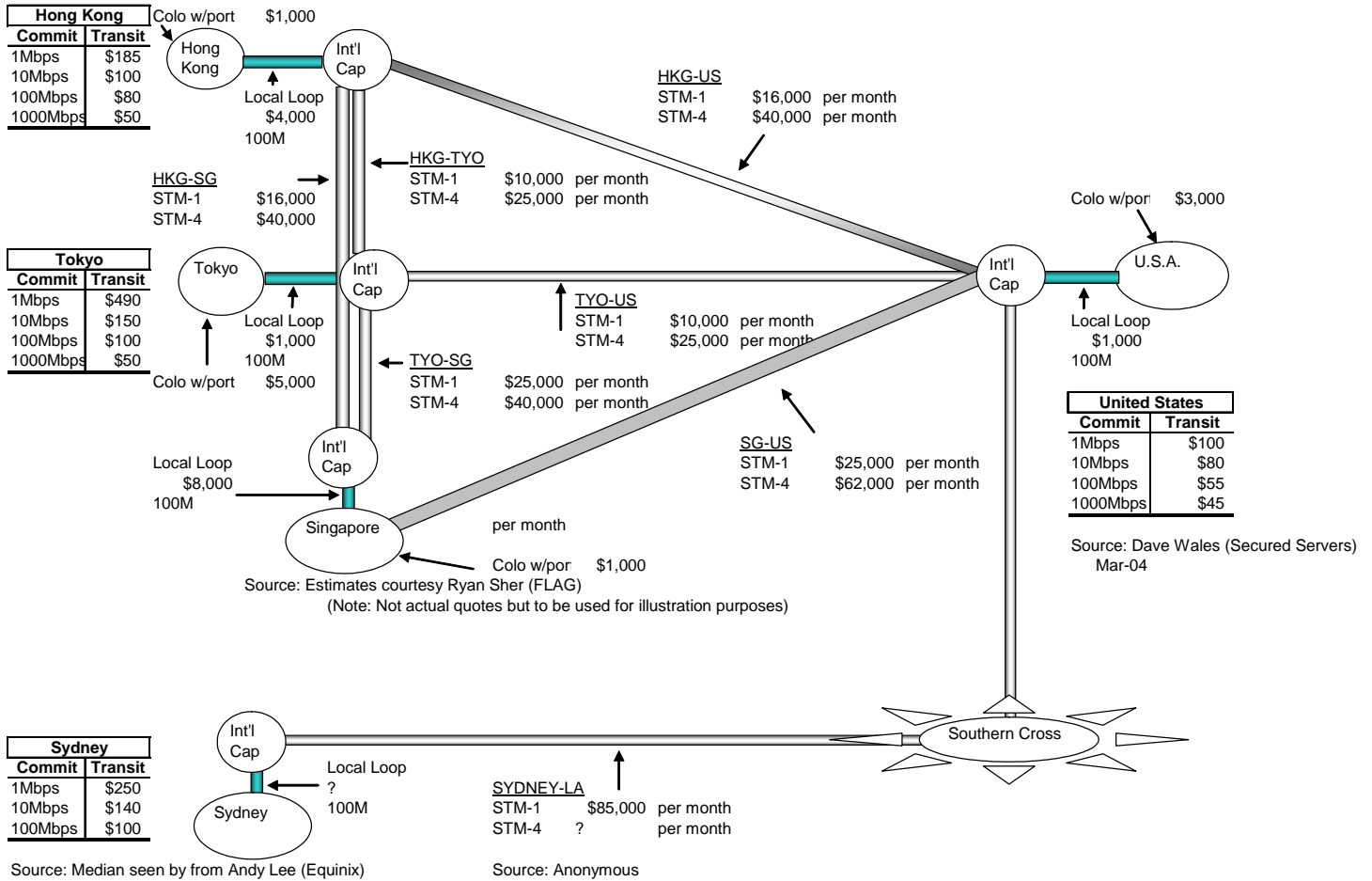
Figure 18 - Translation of Australian Volume Based Pricing

⁸⁶ Sample price for demonstration purposes. Equinix Exchange Pack I used here, including a Fast Port in Los Angeles IBX.

⁸⁷ Assuming in Australia the ISP is collocated in Equinix Sydney, and that Qwest / Reach / etc. multiple providers will provide transport at this price.

⁸⁸ Note that Equipment costs are not included in this calculation.

Appendix B – Transpacific and Local Loop Cost Estimates



Appendix C – Miscellaneous

This section of the appendix provides a place to share miscellaneous data points picked up in the field. For example, here we will share information about other Internet Peering Ecosystems not covered.

We learned from a Pakistani ISP and an operator from Mongolia that Internet Service Providers in these countries have methods of replacing content provider banner ads with their own banner ads, allowing the ISP to get the click through revenue.