International Charging Arrangements for Internet Services,

Module 1

Chapter Four

INTERNET TRAFFIC ANALYSIS: ESTABLISHING A WORKABLE METHODOLOGICAL FRAMEWORK

4.1 Internet Cost Elements

The preceding section has identified issues and questions relating to Internet traffic flows and the potential that, as a result of changed circumstances, some ISPs believe they mayincur an inequitable and disproportionate financial burden under current settlement procedures. However, as noted within the deliberations of the ICAIS Seminar and Task Force Meetings at APECTEL 19, this issue can only be addressed within the wider context of the various ICAIS cost elements, such as the following:

- International Private Line (IPL) charging arrangements, both trans-Pacific and intra-regional
- Private Line, Access, market openness and internal cost considerations within APEC economies
- Assessment of Internet traffic trends, e.g. types of traffic exchanged and bandwidth requirements; growth of domestic and intra-regional traffic versus trans-Pacific traffic.

Unlike the traditional "minutes of use" measurement for telephony traffic, the scope and nature of the Internet presents formidable obstacles to the construction and implementation of an Internet traffic assessment. Attempts to measure Internet traffic in this manner, for example by using Gbps/Kbps over a given time period, may only tell a partial story, given the nature of Internet best efforts routing and the daisy-chaining of separately owned networks.

4.1.1. Traffic Flows and the Nature of Internet Capacity Requirements

As noted in chapter 2, Internet traffic does not flow in a point-to-point manner. It is difficult to identify and measure Internet traffic over an identifiable and discrete set of possible routings between two points:

> The Internet is turning traditional point-to-point communication models on their head. For example, in the world of public switched telecommunication networks (PSTN), there was generally a correlation between the amount of traffic exchanged between two countries and the amount of capacity allocated by infrastructure providers for this route. For the Internet, the points of origin and termination of packets of data have very little relationship either to the traffic that may be carried over a given route or to traditional PSTN traffic patterns.[1]

Under a traditional telephony traffic forecasting model, one could extrapolate future transmission capacity needs based on existing, measured traffic volume. The transmission capacity allocated for a particular route, e.g., Singapore-Canada would be based on traditional measurements like bandwidth, e.g., number of OC-3/STM-1(155 megabits per second corresponding to 2,430 equivalent 64 kilobit per second, uncompressed voice grade circuits), or the measured minutes of telecommunication traffic (MiTT) as applied in financial settlements of accounts between international carrier correspondents.

A fundamental feature of the Internet is the absence of measured minutes of use and therefore the future sizing of the transmission links needed to accommodate predicted traffic growth does not occur on this basis. First, ISPs, which are frequently not a subsidiary or affiliate of the incumbent telecommunication operator, make their own transmission capacity deployment decisions. ISPs base their capacity forecasts on how much simultaneous bandwidth is being used , and minutes of use have no relevance.

Second, ISPs typically network engineer as a function of where they have secured peering arrangements and which routes offer the lowest transmission costs. Third, a single ISPs network operates as one piece of an integrated network of networks such that traffic is routed on the fly rather than on the basis of a strict and hierarchical algorithm. As shown in Chapter 2, the ISP is especially concerned with the delivery of traffic to the NAP/IXP. Beyond that point, any given traffic between two points will take any one of a number of possible routes. The concept of routing leads to entirely results than does the concept of switching.

Accordingly, traffic traversing any particular link, such as between Singapore and Canada, might constitute a portion of a route not just to Canadian locales, but any number of adjacent or even distant points. While telecommunication carriers use transiting, alternative and least cost routings, the Internet is designed for ad hoc and somewhat unpredictable routings beyond interconnection at the first peering point.

A recently conducted OECD study of Internet traffic exchange reported that PSTN traffic between Singapore and Canada constituted only one percent of the total volume of international traffic for each nation. [2] Under such circumstances it would logically follow that telecommunication carriers

would have allocated only a quite small portion of the available international transmission capacity to handle such small requirements. In fact the bandwidth earmarked for the Singapore-Canada route is quite substantial in view of peering decisions made by ISPs in Singapore and Canada. In 1997, nearly half of the entire international Internet transmission capacity used to satisfy Singapore Internet access to the rest of the world is deployed between the two economies. [3]

It is to be expected that no correlation exist between conventional telecommunications and Internet traffic patterns. Accordingly, existing telecommunication traffic statistics have limited utility for our purposes, despite their greater availability. What is vitally important for tracking Internet traffic is knowing the percentage allocation between telecommunications and Internet traffic. Knowing the total bandwidth available for a particular route, coupled with a measured or estimated allocation between telecommunication and Internet traffic, can provide a key baseline measurement for our purposes. From that baseline follow-on module consultants should endeavour to identify the interconnection locations and the peering/access arrangements executed by Asia-Pacific ISPs. A proliferation of interconnection Points of Presence, particularly if they are situated in-region and closer to subscribers, may mean that more traffic will take a more predictable and rational routing as opposed to ones transiting peering points thousands of miles away even when the client and server are perhaps only a few miles away.

The OECD study acknowledges the importance of having traffic tracking capabilities and the dearth of information currently available. [4] Follow-on modules to this project should provide data appropriate for the goal of better understanding the nature of traffic flows between and among users in APEC member nations. For this module, we will identify the issues involved in that process and make suggestions as to an appropriate framework for the collection of data.

4.1.1. Limited Utility of Existing Internet Traffic Measurement Techniques

There is a growing literature describing and analyzing current Internet traffic measurement techniques[5]. It is undeniable that ISPs do in fact have the technology within routers to track the exact deployment and direction of Internet traffic. Larger ISPs employ monitoring technologies such as Cisco System's NetFlow or the RTFM Working Group's NeTraMet.

These technologies have limited macroeconomic usefulness for a study of ICAIS arrangements. The purpose of measurement methods such as NetFlow is largely for the following:

- To acquire network connectivity information
- To collect round-trip time (RTT) and path data (i.e. "traceroutes")
- To analyze the frequency and pattern of routing changes

- To visualize the network, eg construct topological and geogrpahical representations of connectivity

On an individualized basis, ISPs use this kind of information to determine network growth requirements and future equipment investment. However, as a result of the competitive nature and disparate growth of the ISP market there is no industry-wide ability to track or evaluate traffic. To the extent that information is gathered – and smaller ISPs with simple connectivity issues may not collect any detailed router data – that data will be specific to a particular ISP.

This specificity of data raises another vital point. Detailed Internet traffic flows reveal a great deal more about the ISP and its customers than do "common carrier" telecommunications traffic data. And it must be remembered that even telecommunications traffic data are almost never revealed beneath the general, macroeconomic level. This sort of detailed information is unavailable for two primary reasons:

(1) Commercial sensitivity. Specific micro-level Internet traffic information can reveal which websites are most commonly accessed and by whom. This information can be analyzed and cross-analyzed by the ISP on the basis of customer income levels, geography, ethnicity and many other criteria. ISPs can then use this information to develop their business models, including targeting of marketing efforts, development of pricing and billing plans, promotions, etc. This information has an immense commercial value – and sensitivity.

(2) Privacy Issues. "NetFlow" and other types of detailed measurement systems can divulge information about specific customers, including e-mail correspondence information and websites accessed by individuals. This has the same privacy implications as reading an individual's itemized telephone bill. All APEC economies regard the unauthorized collection of such information as an unacceptable violation of privacy norms.

These considerations also exist for telecommunications traffic, as noted above. However, because Internet charging arrangements are not, largely, usage-sensitive (see Chapter 3 above), governments and regulatory authorities do not require ISPs to divulge even general information about Internet traffic flows, even at a broad level. Moreover, the economic value of studying Internet traffic flows *per se*, as opposed to an overall macroeconomic analysis of ICAIS, is not as clear-cut or obvious as that of past studies of settlement-based telecommunications traffic flows.

4.1.2 What the Module 2 ICAIS Data Base Can Tell Us

A public, macro-economic analysis of Internet traffic trends can nevertheless be highly useful to

ISPs, operators, policy-makers and analysts. Given the unprecedented levels of investment in international network capacity building, such an analysis can provide important guidance to the future development of the Asia-Pacific Information Infrastructure. The authors believe this data gathering process will provide an on-going framework to assist APEC economies develop the APII in an equitable, sustainable manner that will yield the greatest benefits to the greatest number.

As noted, at present we are unaware that any organization gathers Internet traffic information for these macro-economic and policy planning purposes. Such information that is gathered is either of a highly technical, narrow nature (such as router NetFlow information, etc) or broad extrapolations of Internet economic trends based upon ill-fitting telecommunications models.

We believe an ICAIS data base will be highly useful in several aspects:

- It will be a step towards a new understanding of traffic flow and capacity cost implications

  The APEC ICAIS effort is commencing at the same as complementary programs within the OECD and ITU. These various multilateral efforts reflect the need to develop a greater understanding of the economics of Internet capacity development, which remain – compared to the venerable world of circuit-switched telecommunications - immature and fast-evolving.

- It will place into context the role of traffic flows and capacity cost as a total proportion of the economic value of the Internet

  The development of an ICAIS data base will be a vital step in any analysis of APEC economies' policy options in this area. This data base will identify and quantify the various elements that comprise ICAIS. By doing so, it will reveal levels of access to and development of the APII.

- Brings into focus the challenges faced by smaller APEC economies and by ISPs in rural and remote regions

  While it is true that capacity costs on major trans-oceanic routes are declining quickly, there is concern that some smaller, developing APEC economies may find themselves at a seemingly permanent disadvantage. What are some of these challenges?:
  - Remoteness from the major undersea cable routes
  - High domestic cost structures resulting from limited economies of scale
  - Monopoly or newly-liberalizing regulatory environments where levels of competition are at a nascent or fragile stage
  - Concerns that small economies will not have economies of scale to compete against or negotiate with global "brand" ISPs/backbones

- Concerns that small economies lack skills to develop adequate levels and quality of Internet content, thus placing them at an e-commerce and cultural disadvantage.

The ICAIS database will assist in isolating cost elements and outlining options (eg, declining satellite capacity costs) that may help address and obviate the concerns of developing economies.

- It will address concerns about inequitability in traffic flows and economic benefits

This is a subset of some of the concerns outlined above. The assymetrical nature of Internet traffic flows – that "the few key-strokes needed to enter the name of a far-off website may then generate a torrent of bits in the opposite direction"[6]- has led to some of the specific issues discussed in chapter 3. How serious a concern is this? There is a sharp division of opinion between those who believe that traffic assymetries are hindering the growth of the APII and those who believe they are irrelevant. This debate will only be resolved through the collective efforts of APEC economies to better understand the economic components of the Internet and what can be addressed at the collective level. This ICAIS data gathering stage will be vital in this regard.

4.2 Module 2: Building an Empirical Data Base

The second module of the ICAIS study will provide APEC economies with an easily-updated empirical database of the key cost elements and macroeconomic indicators that chart the growth of the Internet and the development of the APII.

With the cooperation of APEC governments and Asia-Pacific ISPs, consultants managing this module should establish a baseline inventory of indicators within three broad categories, explained in detail within the sections below:

(1) Bandwidth Availability, Deployment, Charging Arrangements (International Private Lines)
- Trans-oceanic capacity trends, bandwidth cost trends – major routes and thin routes
- Developments in cable and satellite technologies, systems
- Pricing and tariffing arrangements
- Wholly-owned circuits and development of private networks
- Peering arrangements (PoPs, peering points)

(2) Domestic Charging Arrangements as Element of ICAIS(Arrangements within APEC Economies)
- ISP basic indicators: competition, market shares, subscribers

- ISP retail pricing and cost elements
- Domestic private line, tail/local loop elements
- External gateways and peering arrangements

(3) Internet Traffic Trends as Determinant of ICAIS
- Subjectivity considerations based upon survey techniques (see 4.3.3. below)
- Economic significance of different types of traffic
- Basic Indicators: NAPs, access nodes, hosts, sites, mirror/caching arrangements
- Traffic by type (WWW, E-mail, FTP, DNS look-ups, etc)
- Breakdown of domestic versus international traffic: percentages, trends, regional breakdown
- Traffic growth by type, domestic/international

All matrices developed within these three broad categories must be constructed in order to be updated easily. This set of baseline measurements will provide a macro-level view of where and how Internet traffic travels in Asia-Pacific, and track the economic elements that comprise the growth of the APII.

Of particular importance in follow-on modules will be an assessment of the potential for future revised peering arrangements and policies. One key variable affecting the potential for change appears to be the extent whether and how Asia-Pacific ISPs handle intra-region traffic routings. The OECD study and prevailing view assumes that absent a few exceptions, a preponderance of regional Internet traffic transits the United States or Canada. This outcome results from:

- a conscious strategy by ISPs in the Asia-Pacific region to exploit comparatively cheaper private lines to these economies;
- the location of servers able to provide Domain Numbering System answers to look-up queries;
- evidence that intra-regional routings are slower than using high-capacity routes transiting North America (eg, Australia-US-Japan may be faster than a direct bilateral route)
- the disproportionately larger number of content servers and Web sites outside the region relative to the general population and the number of computer users; and
- the location of predominately used peering points in the U.S. and Canada.

Increasing ability to handle intra-region traffic using regional facilities exclusively may significantly reduce the flow of traffic to outlying points, such as Canada and the U.S.

4.3 Module 2: Compilation of ICAIS Cost Element Data – Categories and

Methodology

As noted above, Module 2 will build an empirical foundation behind the major ICAIS issues reviewed in the above chapters. Given the dearth of existing information on ICAIS, this data gathering stage is a necessary prerequisite to any further analysis on this topic. Within this stage it will be critical to "ask the right questions". Those conducting the follow-on study must remain mindful of the overall goals of the ICAIS project: to adopt a holistic approach (looking at all components that comprise ICAIS) in reviewing the issues affecting ICAIS to ensure the sustainable development of the APII.

While international bandwidth pricing trends may comprise the main determinant of international Internet charging arrangements, it is vital within Module 2 that the study also review domestic infrastructural cost data and overall traffic and technological trends in order to construct an accurate view of the role of ICAIS within the overall development of the APII.

4.3.1 International Private Lines (IPLs): Availability, Deployment, Charging Arrangements

For most APEC economies a high proportion of Internet traffic travels internationally. Current charging arrangements for international private line capacity is thus a key economic consideration. ISPs must lease capacity outright, as opposed to the traditional telecommunications model of correspondent agreements and half-circuits. Irrespective of arrangements, actual prices are declining rapidly on some routes but not others. For the purposes of the study, the following indicators must be tracked:

- IPL Capacity Trends: Historical, Current, Projected
    - Trans-Pacific
        - Bandwidth (Cable and satellite)
        - Routes
    - Intra-APII Region
        - Bandwidth (Cable and satellite)
        - Routes

- IPL Charging Arrangements: Historical, Current, Projected
    - General: Undersea Cable Systems
        - Survey of Arrangements for Traditional and New Cable Systems
    - General: Satellite Systems
        - Survey of Arrangements for ICAIS on Regional Satellite Systems
    - City Pairs
        - Matrix of selected city pairs and routings
            - This will include major routes and selected "thin routes"

4.3.2. Domestic Elements

As indicated in the original ICAIS Study Terms of Reference, domestic considerations play a sizeable role in access to and development of the APII. Any study of ICAIS must take domestic considerations into account, as they comprise a significant portion of how the end-user derives access to the Internet. The vast majority of APEC Internet users, even quite large ones, rely upon incumbent telecommunications operators for "last kilometre" access, whether via dial-up modems, ISDN, or new DSL technologies.

Module 2 should encompass the following measures:

- Local Access Charges
    - User costs
        - Average dial-up access rates: 28.8k/56k/ISDN/other
        - Pricing plans, incentives for use
    - ISP costs
        - ISP interconnection costs
        - ISP infrastructural costs (IXPs etc)
        - Domestic Private Line Charges: Per km averages
            - Average tail/local lop charges
            - Presence of competition in domestic PL/local loop (eg, CLEC)

- Domestic ISP Competition
    - Number of ISPs
    - Market Share of ISPs

- Policies and Regulatory Structures Promoting Competition
    - Basic overview – analysis should be left to Module 3

4.3.3. Internet Traffic Analysis

As noted, measuring Internet traffic per se, whether by Gigabits or other criteria, cannot be undertaken using the same methodology as traditional telecommunications flows. Moreover, such information would not reveal the same macroeconomic information – as explained in chapter 2, Internet traffic between two points may have nothing to do with either "point" but may indeed constitute stages in packet flows between two completely different points in other parts of the world.

Nevertheless, traffic flows matter, as is detailed in chapter 3. They reveal the presence of content and infrastructure within the region, and trends in traffic flows reflect the changing economics and expanding network development of the Internet.

Detailed traffic information is, as noted, largely unobtainable for commercial and privacy reasons. However, the authors propose surveying network and business managers at leading ISPs and operators within the region in order to compile a sustainable database of the following:

- Internet Basic Indicators – By Economy: Historical, Current, Projected
  - Internet Penetration
  - Facilities Base: growth, access nodes, RSPs/IXPs
  - Hosts
  - WWW Sites
  - Mirror sites, caching

- Identification of Trends: Historical, Current, Projected
  - Survey and Interviewing of In-Region ISPs
    - Breakdown of Internet Traffic by Type
      - Eg, e-mail, FTP, WWW, DNS Look-Ups, etc
    - Percentage of Traffic sent Internationally, Ranked by Economy
      - Determination of intra-regional/in-economy versus trans-oceanic traffic trends
    - Growth Figures of domestic and international Internet traffic

4.4 Assessing what has been done in module 1

In terms of carrying out module 1,the consultants offer this assessment of what we have done in this module, and what is properly the domain of those who will execute the second module.

For the ICAIS Information Seminar in March 1999, the following tasks were assigned:

Internet development and architecture:

This has been extensively discussed in Chapter Two.

Internet economics, traffic exchange and peering and transit arrangements

This has been treated in Chapter Three.

Development and presentation of Issues Paper by consultant focusing on paragraph 2(a) and 2(b) of the Terms of Reference with proposals on

- Analysis of the terms of reference and prioritizing of terms

> 2(a) an analysis of the existing international charging arrangements for Internet services between and among all APEC economies, including connection charges, transit charges, bandwidth and infrastructure costs and a study of local Internet access policies in each economy.
>
> 2(b) a study of the underlying factors contributing to the current economic model, an analysis of whether these factors have changed, of emerging market trends and of whether the current model is economically viable in the medium and long term.

The consultants consider that the issues raised in paragraph 2(b) of the terms of reference have been substantially answered in Chapter 3 and this Chapter. As regards paragraph 2(a), the consultants consider that they have provided an analysis of existing international charging arrangements in general. They are not in a position to carry out a study of the charges and costs mentioned in the latter part of paragraph 2(a), which must necessarily await the gathering of data from the relevant economies, which is the essence of Module 2 of the study.

The consultants acknowledge that the charging arrangements for Internet services include several variables as identified in 2(a) of the Terms of Reference, namely, connection charges, transit charges, bandwidth and infrastructure costs. In Module 1 we have addressed the dynamic between these variables, with an eye toward showing how they inter-relate. For example, an ISP typically can secure low transit charges from another ISP where the telecommunication costs to reach the transiting ISP are low coupled with low transit costs for the ISP routing traffic onward toward the final destination. We identified a correlation between the location of peering points and the cost of access to these points. For many APEC ISPs comparatively cheaper international private lines to the United States and Canada has affected transiting, peering and routing decisions for the entire region.

The consultants also recognize the importance of local Internet access policies, particularly since total end user charges combine local and long haul expenses. For Module 1 we identified these two component parts, but did not specify whether any particular APEC member nation has metered or usage insensitive pricing for either price element. As noted, we believe that the consultant performing follow-on work will need significant cooperation from ISPs and telecommunication

carriers in APEC member nations to compile end user and carrier cost data.

Section 2(b) of the Terms of Reference calls for an analysis of the current and future economic models that describe international charging arrangements for Internet service. In Module 1 we identified many of the economic models that describe how ISPs exchange and transit Internet traffic. We also identified the changing circumstances that will trigger changes in these models, including a more hierarchical, settlement-based system. Insofar as the first and last kilometer of access, we mentioned that end user local access can be metered, or usage insensitive, flat-rated ("All You Can Eat") model used in some APEC nations. We did not elaborate on the economic consequences of either system, but did note that usage insensitive pricing stimulates a level of consumption that would not occur under a usage sensitive scheme. Pricing a circuit-switched telephone network on a flat-rated basis has a greater potential for triggering congestion when end users have both telephony and Internet access requirements.

The consultants have been careful to state that the Internet does not work on principles derived from circuit-switched voice telephony. Accordingly traffic measurement in a packet-switched environment will require new methods as well as a new understanding of what can and cannot usefully be measured. Moreover traffic measurement in a world-wide packet switched network, where each message is broken up into innumerable packets which can route themselves to an IP address, cannot have the same significance as traffic measurement in a circuit-switched world. In some cases, measurements of Internet traffic at a given point in time or for a given route will not necessarily produce results useful for future policy. The reasons for this have been extensively set forth in Chapters Two and Three.

- Timeline and workflow for data gathering

The following timeline for Module 2 is proposed:

01 Apr 1999	APECTEL issues Module 2 RFP
12 Apr 1999	Deadline for Submissions
20 Apr 1999	Awarding of Module 2 Contract
30 Apr 1999	Initial Survey Questionnaire and List of Contacts to be circulated by consultants
07 May 1999	Survey Sent
May-Jun	Replies Received, Matrices Developed and Populated

28 Jun 1999 Initial First Draft of Results circulated, follow-up queries sent
05 Jul 1999 Interviewing in-economy, if necessary

30 Jul 1999 Circulation of first draft of Module 2
16 Aug 1999 Deadline for comments and replies

03 Sep 1999 Final Report of Module 2 Circulated
20 Sep 1999 Presentation of Results at APECTEL 20 ICAIS Seminar, Lima

- Methodology of study, definition of the problem set and framing of working definitions

The consultants consider that the timelines established in module 2 are feasible. An approach to the problem has been described above within this chapter. However a more complete exposition of the issues involved in module 2 should be presented in the bid for that portion of the work.

- Any relevant findings from initially available data gathered and identification of information gaps

- Ongoing work in other fora, important sources of information to tap

The consultants consider that in the course of putting together this draft of the document, these duties have been attended to. We are aware of documents and findings from the OECD, ISOC, AT&T, Telegeography and the ITU. Within Module 2, the consultants will need to build upon existing relationships with those organizations in order to make full use of complementary studies and other programs currently under way in those entities. Members of the Steering Committee will also bring to our attention information that they think should receive attention.

Endnotes

1. Organisation for Economic Co-Operation and Development, Directorate for Science, Technology and Industry, Committee for Information, Computer and Communications Policy, Working Party on Telecommunications and Information Services Policies, Internet Traffic Exchange: Developments and Policy, p. 6 DSTI/ICCP/TISP(98)1 (1998).
2. Id.

3. See Id. at p. 42, Table 9 reporting that Canada and the United States represent 71.6 percent of Singapore=s total Internet transmission capacity while representing only 5.6 percent of Singapore=s outgoing minutes of telecommunication traffic.

4. AThere is little information available for understanding the balance of these [transiting] costs, or even the patterns of international traffic . . . although such information is necessary to inform discussion of the financing of international infrastructure . . ..@ Id. at 7.

[5] Two papers were submitted for consideration at the APECTEL 19 ICAIS Seminar, Miyazaki (Japan), 8 March 1999: J. Nevil Brownlee, Internet Traffic Measurement: An Overview; and K. Claffy, T. Monk, and D. McRobb, Internet Tomography.

[6] Gregory C. Staple, ed., TeleGeography 1999 (Washington DC, Telegeography Inc., 1998), p. 14.