Interconnection, Peering and Financial Settlements in the Internet

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Internet Society
... Interconnection

- an overview of how ISPs interact to form today’s Internet
The Sum of Many Parts

• The Internet is the sum of more than 30,000 component service providers (ISPs)
• Each ISP has its own network with services, tariffs, customers, policies.

• many policies
• many services
• one Internet?
The Well-Ordered Internet

• This view is based on a conventional distribution infrastructure

• Every relationship is bilateral
  – a provider sells services to a consumer

• Tiering of the ISP sector
  – Tier 1 - global backbone transit networks
  – Tier 2 - national wholesale transit networks
  – Tier 3 - local retail access ISPs

• Assumption that every relationship is part of a provider / client hierarchy
The resultant structure is a hierarchy of relationships
The Internet - as we know it

- The competitive ISP industry tends to equilibrate on the lowest local cost structures
- There are no objective criteria to identify who is the provider and who is the customer
- Debt is better than profit as a means of leverage of ISP value
  - there are fewer ways of establishing true value
- underlying carriage tariffs shape Internet-based ‘locality’
- Within each local tier cell ISPs tend to SKA peer - or not
  - bluff is a critical component of the peering game
- Strict tiering blurs because of the confusion over value identification
  - is content of equal value to transit?
The Internet - as we know it
The Problem - as we see it

• how to interconnect many thousands of component networks while:
  • minimizing local cost everywhere by:
    • localizing transit traffic
    • matching diverse import, export and transit policies
    • avoiding super dense traffic black holes
    • maintaining stability and quality
      – both technical and financial
  • staying within the bounds of available technologies
  • and also adding thousands more component networks
The Role of the Exchange

- An examination of the rationale for public Internet exchanges
The N-squared problem

- $N^2$ circuits, $N^2$ peerings
- questionable scaling properties
The Exchange Router

- Too simple
- Router-based exchanges impose transit policy
The Exchange Switch
The Exchange L2 Switch

- An L2 switch does not implement routing policy
- Routing policy is then the outcome of bilateral agreements
The Distributed Exchange

- Use of L2 virtual circuits to support bilateral peering eliminates the need for co-location
Adding Value to the Exchange

- exchanges represent a very efficient centralized service launch point
The Role of Private Peering

- Not all interconnection happens at public exchanges
- Exchanges can represent very dense traffic aggregation points
- Exchanges do not readily permit continuity of QoS mechanisms
- Exchanges are vulnerable to third party forcing
- Private peering allows private financial arrangements
What is being exchanged?

- **IP Routes**
  - A sends B routing advertisements

- **IP Packets**
  - B sends A IP packets destined to A’s advertised network’s
Routing Policy

• At an exchange you may exchange routes with any other network that is also present at the exchange

• Whom you choose to exchange routing information with is a matter of local policy determination
  - local purchase of transit
  - honoring remote transit obligations
  - local peering
Routing Policy

• Which routes you choose to advertise is a matter of policy.

• Network A PEERS with Network B:
  - A advertises A’s CUSTOMERS to B
  - A does NOT advertise its value-added customer SERVICES to B
  - A does NOT advertise its peer-learned routes to B
  - A does NOT advertise its upstream provider’s routes to B
Peering and Financial Settlements

- An overview of the financial basis of interconnection within the Internet
Follow the Money

In a uniformly structured retail market the money flow is easy to identify:

- John initiates the transaction
- John pays his local provider A for the entire end-to-end transaction charge for the end-to-end service
- A pays B to terminate the transaction
- B terminates the transaction at Mary without charging Mary
Interprovider - Who pays who?

- The inter-provider financial relationship will vary for each individual transaction.
- The net outcome is balanced through financial settlement.

Financial Settlement

A pays B

B pays A

$0 settlement point
Interprovider - Who pays who?

• BUT, this assumes:
  - each transaction has a measurable value
  - each transaction is individually accountable
  - each transaction is funded by the end clients in a consistent fashion
    • initiator direction pays or
    • responder direction pays
Enter the Internet . . .

• In the Internet there is no readily identifiable uniform bi-directional transaction
  - The currency of interaction must shift to the lowest common denominator
  - Each individual IP packet is an individual ‘transaction’

• In a chaotic retail market each part of a multi-provider supported transaction has an individual monetary flow
  - The ‘value’ can be in either direction at each interconnection

• Per-Service charging is difficult - to say the least
  - The service is within the IP payload
  - Per-packet transmission is the currency of IP money
Cost Apportionment

• Financial Settlements are intended to undertake a role of fair cost apportionment
  - How are costs incurred by Internet Providers?
  - How does each provider apportion local costs?
Distributed packet costs

Per-packet transit costs

$1

$3

$2

$1

$1

$1
... BUT

• IP packets
  - have a vanishingly small value
  - have no readily identifiable transaction context
  - may not be delivered
  - have no tracking field in the header to accumulate ‘value’
  - are usually not individually accounted within a retail tariff structure
The Internet model

- There is no known objective financial settlement model which is financially robust and technically feasible in the Internet.
- The most stable outcome is a bilateral agreement creating a provider / customer relationship, or SKA peer relationship.

A is a customer of B, SKA, B is a customer of A.
How are costs apportioned?

- At the consumer level, IP transmission costs are administratively apportioned bilaterally between sender and receiver.

  John funds partial path

  Mary funds partial path

  SKA handover
Fixed Relationships

• There are no known IP financial settlements models that are technically and financially fair and robust

• Every peering tends to a statically determined relationship of provider/customer or SKA peer

• The resultant business strategy
  – only SKA peer with ‘larger’ ISPs
The Aggregation of ISPs

- Every customer wants to be a peer
- Every peer wants to be a provider

- Bigger is better
  - ISPs that aggregate through mergers and takeovers can obtain access to a more advantaged position with respect to their peer ISPs
Today’s Environment

• Natural tendency to aggregate within the ISP industry
  – Economies of scale of operation
  – Access to more advantageous SKA peering agreements

• Risk factors
  – Reduction of competitive pressure
  – Collective action on industry peering arrangements
  – Collective action on retail pricing
Imminent Death of the Net
Predicted - MP3 at 11:00

- Aggregation of the IP global transit market to a very small number of operators
- Ability to execute global price setting through control of the underlying transmission resource
- Recovery of operating margins through elimination of competitive pressure for commodity pricing

- Is the communications industry attempting to rebuild the colonial structures of global provider and local franchise operator?
The Bottom Line

- A stable open competitive market for ISP services is based on the public availability of pricing at all levels.

- Continued operation of a strongly competitive IP supply market may require an active role for regulatory intervention at the level of inter-provider interaction.

- Intense aggregation is always an alternative to industry regulation.
Further Reading


- Varian, H., "The Information Economy - The Economics of the Internet, Information Goods, Intellectual Property and Related Issues". [http://www.sims.berkeley.edu/resources/infoecon/](http://www.sims.berkeley.edu/resources/infoecon/) This is a collection of references to other online resources, and is a useful starting point for further reading on this topic.
Further Reading

• INET’99 Conference Paper: Interconnection, Peering and Financial Settlements - Geoff Huston
• ISP Survival Guide - Geoff Huston - John Wiley & Sons