

Interconnection as Networks Evolve to Internet Protocol (IP)

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27 February 2009

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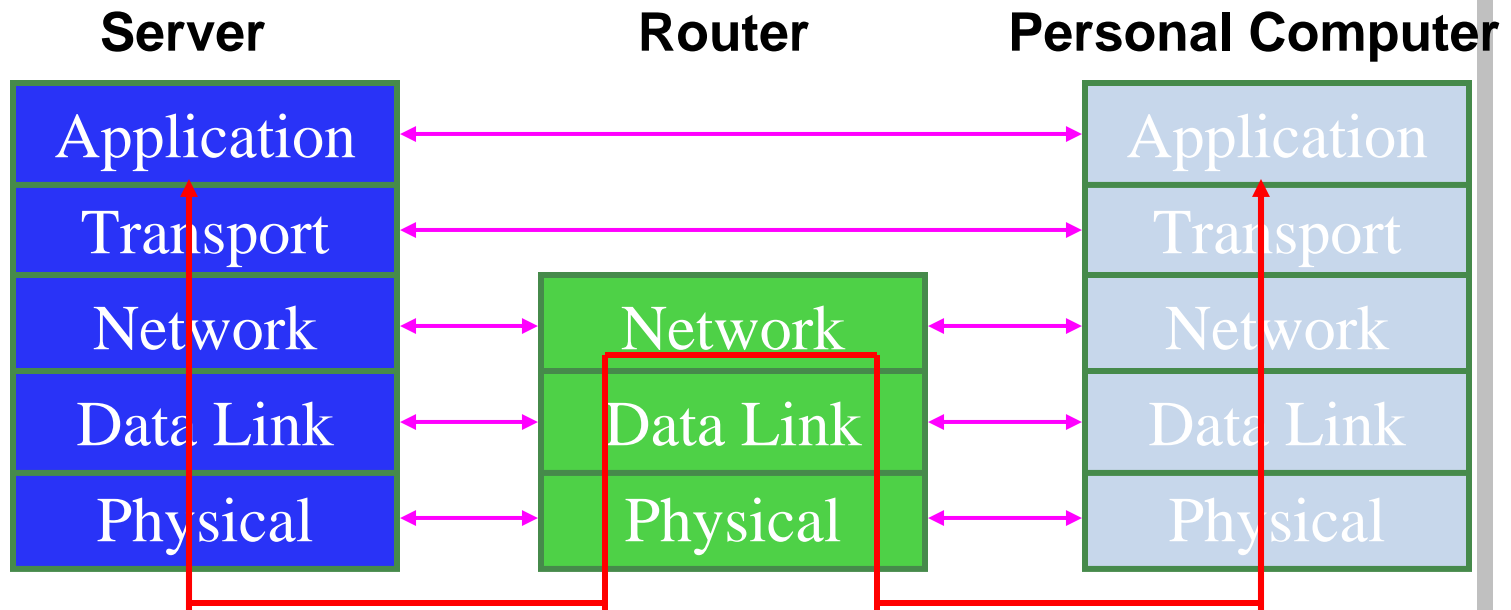
- What is different in an IP network?
- IP Interconnection
- Switched network interconnection
- Quality of Service (QoS)
- Transition issues
- Concluding remarks

“Everything should be made as simple as possible, but not simpler.”

- Albert Einstein

What is different in an IP Network?

Layers interact with peer layers



Layers derive services from successively lower layers

What is different in an IP Network?

- Any device could simultaneously process any combination of voice, video or data.
- Any network link can simultaneously process any combination of voice, video or data.

What is different in an IP Network?

- Implies profound changes in the value chain.
- Implies profound changes in the nature of competition.
 - Different *kinds* of networks compete.
 - Multiple-play services.
 - Services providers without a network.

What is different in an IP Network?

- Regulation addresses market failures:
 - Competitive bottlenecks.
 - “Public goods” problems
 - Allocation (spectrum, numbers)
- Changes in the character of competition have big implications for regulators.

What is different in an IP Network?

- IP interconnection has worked reasonably well without regulation.
- Traditional network interconnection has always required regulation.
- Are they different? How? Why?

IP Interconnection

- IP Interconnection is primarily implemented by peering and transit.
- With rare exceptions (notably including Australia some years ago), regulators have been satisfied with negotiated arrangements.

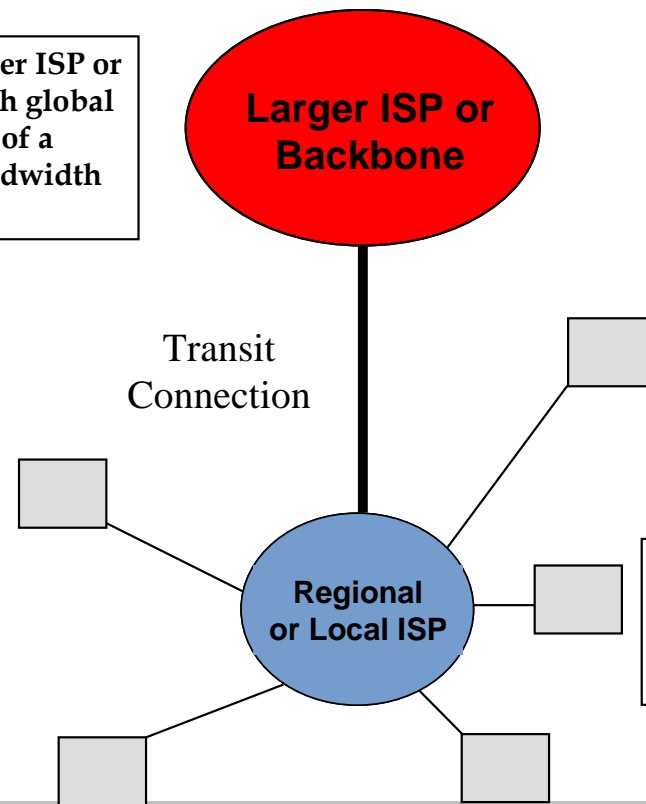
IP Interconnection

- “*Peering* is an agreement between ISPs to carry traffic for each other and for their respective customers. Peering does not include the obligation to carry traffic to third parties. Peering is usually a bilateral business and technical arrangement, where two providers agree to accept traffic from one another, and from one another’s customers (and thus from their customers’ customers). ...
- *Transit* is an agreement where an ISP agrees to carry traffic on behalf of another ISP or end user. ...
- Peering thus offers a provider access only to a single provider’s customers. Transit, by contrast, usually provides access at a predictable price to the entire Internet.
- Historically, peering has often been done on a bill-and-keep basis, without cash payments...”

- NRIC V (US FCC), Interoperability Focus Group

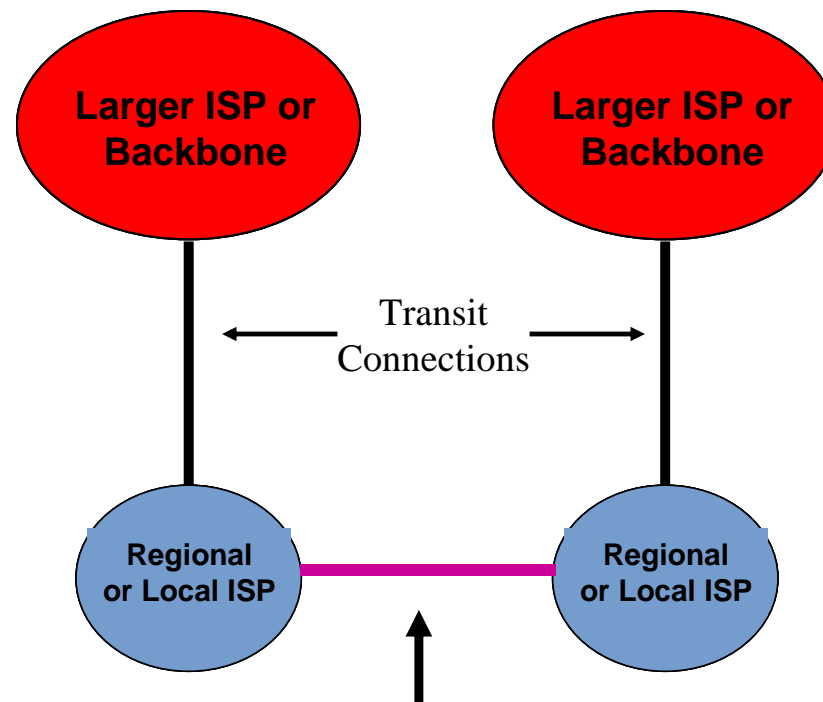
IP Interconnection

Concentration to a larger ISP or backbone provider with global connectivity by means of a concentrated, high bandwidth connection



Many remote locations connect to a regional or local ISP with individual, low bandwidth connections

IP Interconnection



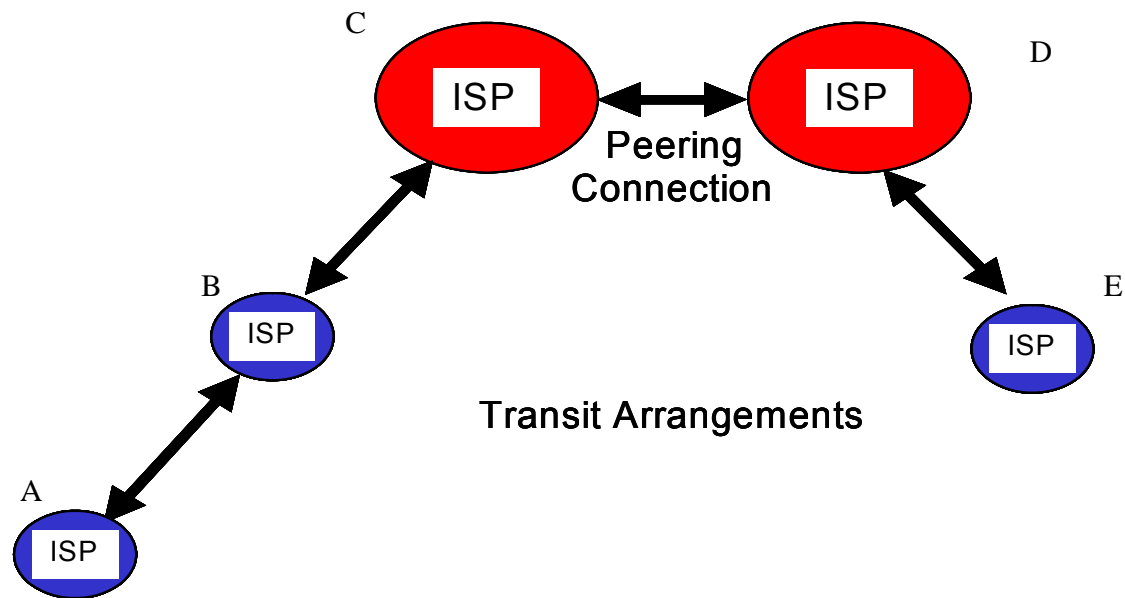
This peering connection will tend to exist if the cost of the connection to each ISP is less than the money each saves due to reduced transit traffic.

IP Interconnection

Upstream



Downstream



Switched Network Interconnection

- Extensive literature developed over the past ten years.
- Linkages to IP interconnection are progressively better understood.
- Important to distinguish between retail and wholesale arrangements.

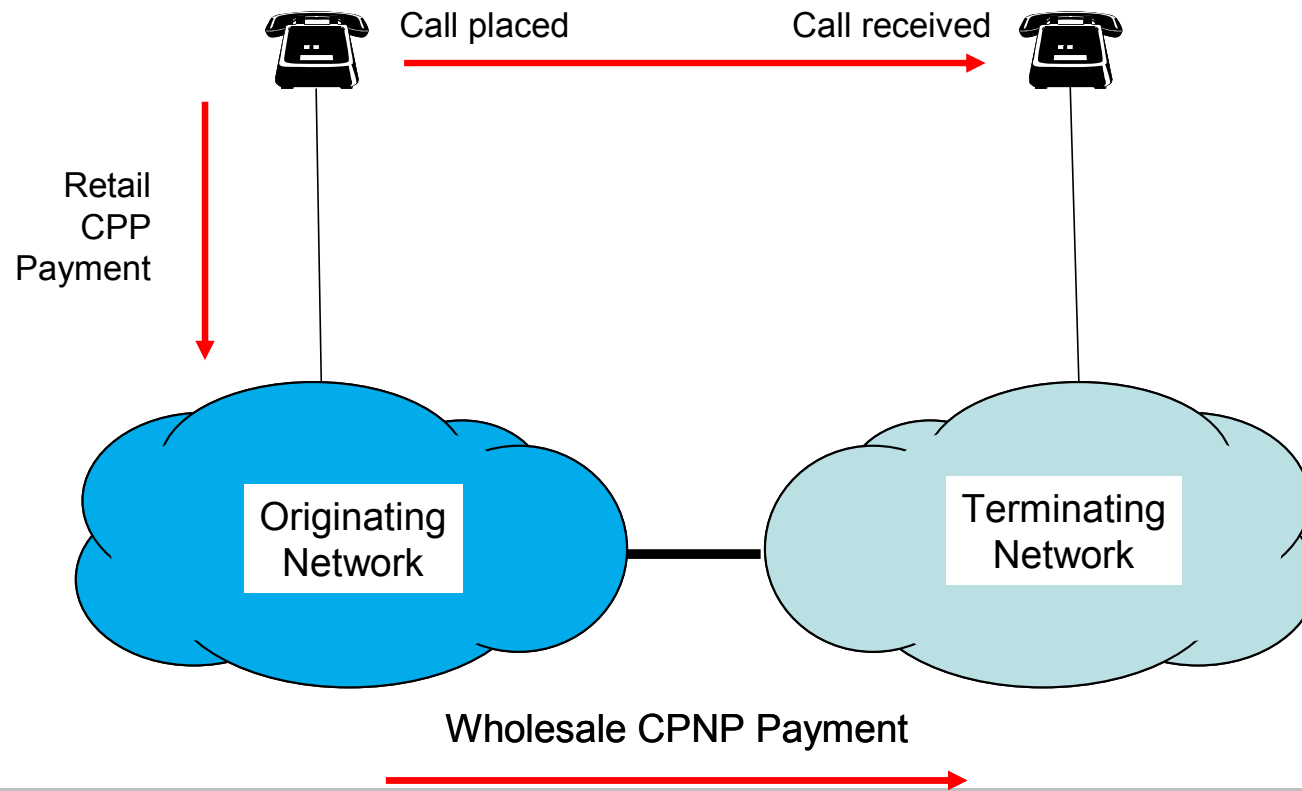
Switched Network Interconnection

- Retail arrangements:
 - Calling Party Pays (CPP) – common
 - Receiving Party Pays (RPP) – nearly extinct. An academic curiosity.
 - Flat rate plans – what most consumers want
 - “Buckets” plans – banded flat rate

Switched Network Interconnection

- Wholesale arrangements:
 - Calling Party's Network Pays (CPNP) – the prevailing system worldwide
 - Bill and Keep – an alternative set of arrangements used selectively in the U.S., Canada, Hong Kong, Singapore. Usually leads to termination rates of zero.

Switched Network Interconnection



Switched Network Interconnection

- CPNP has a known defect:
 - No way to bypass the terminating network: the *termination monopoly*.
 - Operators often set prices at high levels (the highest levels permitted).
 - Creates economic distortions, e.g. between the fixed and mobile networks.

Switched Network Interconnection

- US reciprocal compensation is by no means a lack of regulation.
- Complex, hard to understand.
- Results have clearly been positive.

Switched Network Interconnection

US Reciprocal Compensation

A – voluntary negotiations, often Bill and Keep.

B – Reciprocal compensation to ILEC cannot exceed ILEC's LRIC cost.

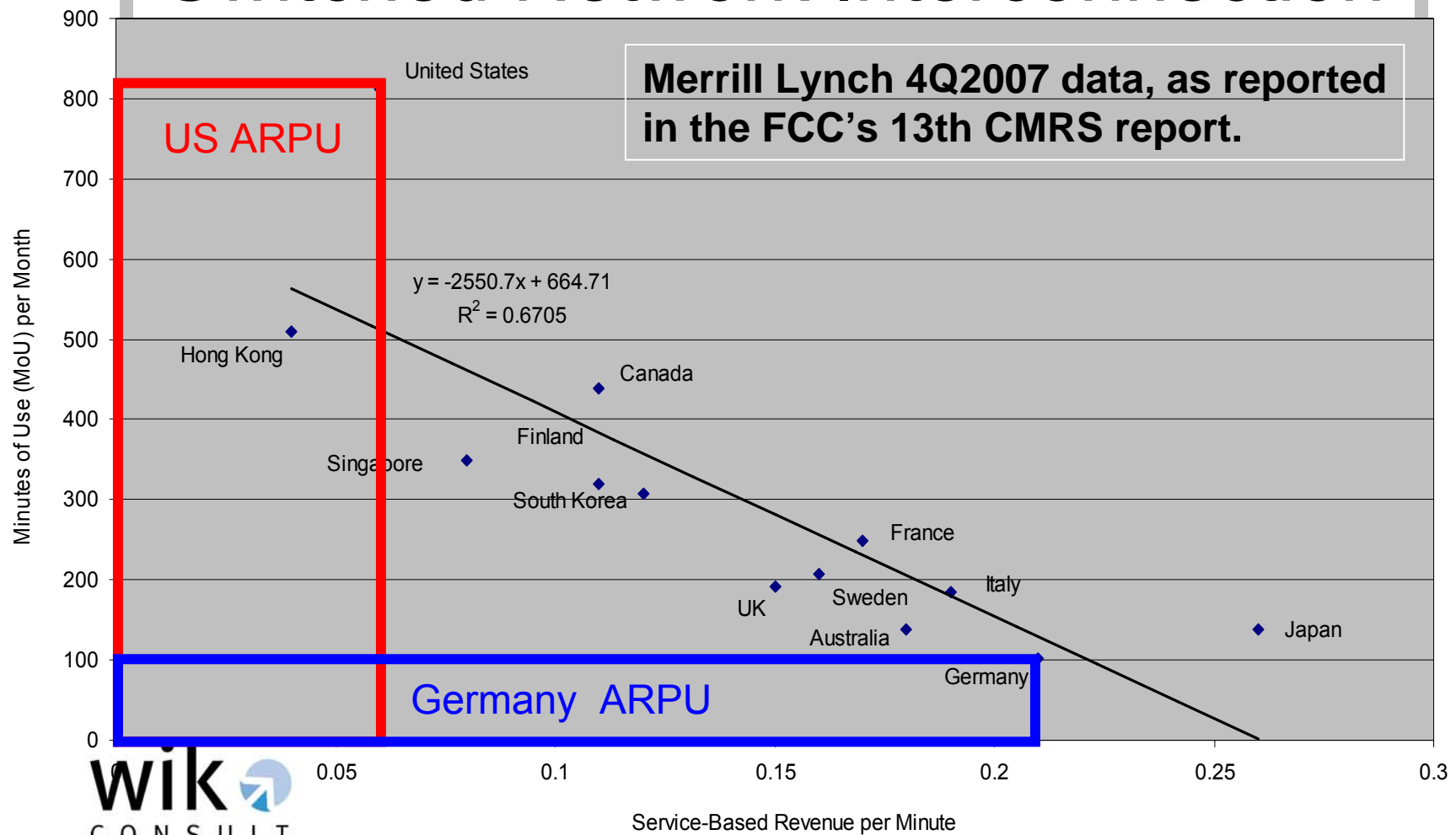
C – Reciprocal compensation to CLEC or mobile operator cannot exceed ILEC's LRIC cost unless the CLEC or mobile operator can demonstrate a higher cost.

| Origination | Termination | | |
|-------------|-------------|------|--------|
| | ILEC | CLEC | Mobile |
| ILEC | A | C | C |
| CLEC | B | A | A |
| Mobile | B | A | A |

Switched Network Interconnection

- Systems with low or zero termination rates tend to:
 - Set no limitations on retail arrangements.
 - Enable flat rate plans without exclusions.
- High termination rates tend to set a floor on retail marginal price.

Switched Network Interconnection





So what's Scott's problem with termination, anyway?



Switched Network Interconnection

- CPNP → high termination rates.
- High termination rates →
 - High usage-based retail prices
 - Exclusions from flat rate plans
 - Low willingness to place calls
 - Reduced ARPU (but possibly increased profits) for mobile operators.

Switched Network Interconnection

- Termination rates above true incremental cost also encourage on-net off-net price discrimination.
- Undermines the ability of competitors to price aggressively.
- Tends to soften competition.
- Distorts fixed-mobile development.

Switched Network Interconnection

- High mobile termination rates also →
 - Greater willingness to subsidize handsets.
 - Lower initial and monthly prices.
 - Faster adoption of mobile services.
 - Possibly slower adoption of fixed.

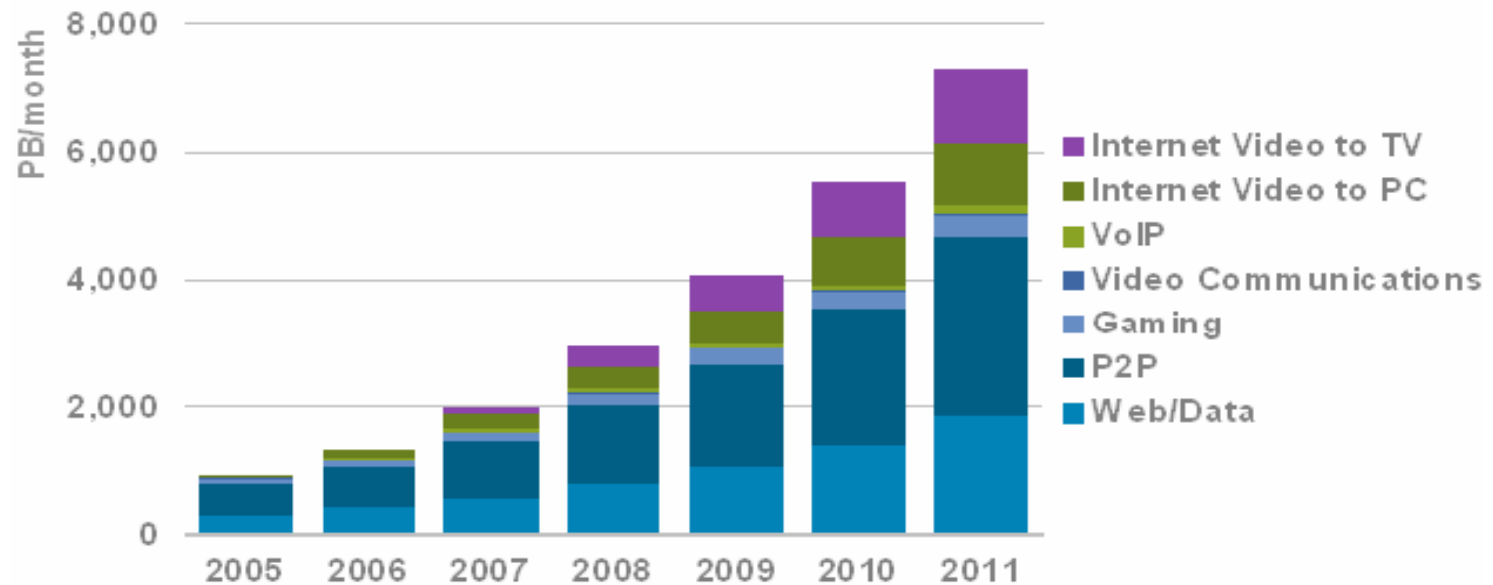
Switched Network Interconnection

- Rationality of CPNP rests on many assumptions:
 - That the network exists primarily to carry voice.
 - That the retail service party is the same as the wholesale network operator.
 - That there is a fundamental and easily discerned difference between placing and receiving a call.
- A wholesale payment to “correct” for an asymmetry in retail payments.

Switched Network Interconnection

- The migration to IP does not eliminate termination market power.
- The migration to IP calls the underlying assumptions into question.
 - Voice is only a small fraction of network cost.
 - The service provider need not be the network operator.
 - The origination or termination of a call is largely arbitrary.

Switched Network Interconnection



Source: Cisco (2007)

Quality of Service

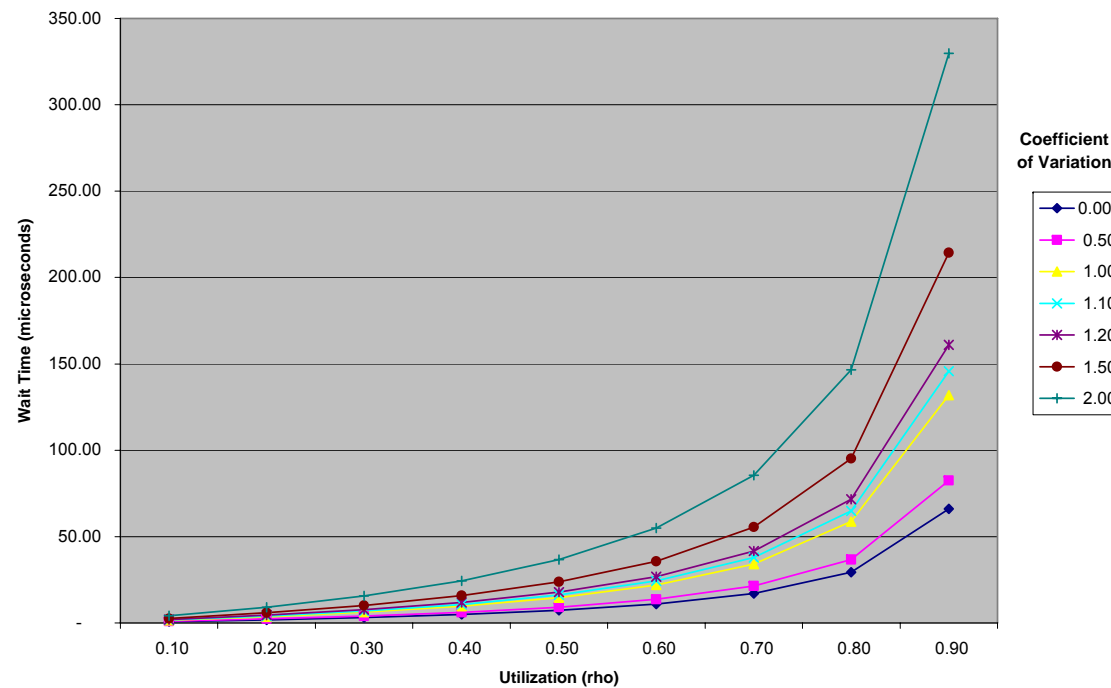
- Not every application needs special arrangements for QoS (delay, loss).
 - Bi-directional real time voice: 150 msec
 - Email: no special handling
 - Streamed voice or video: a “jitter buffer” of a second or two should suffice.

Quality of Service

- Technology to implement differentiated QoS has been sufficiently mature for ten years.
- Widely implemented within networks.
- Why no implementation *between* networks?

Quality of Service

M/G/1 Queuing Delay (155 Mbps Link)



Quality of Service

- Customers perceive little benefit
- Network externalities
 - Difficult to cross initial adoption hump
 - Cf. Rohlfs, “Bandwagon Effects”
- Transaction costs
- Vertically related market segments

Quality of Service (QoS)

- In competitive markets, quality discrimination usually enhances societal welfare.
- In markets that are subject to market power, quality discrimination can harm consumer welfare.

Quality of Service (QoS)

“The chief executive of AT&T, Edward Whitacre, told *Business Week* last year that his company (then called SBC Communications) wanted some way to charge major Internet concerns like Google and Vonage for the bandwidth they use. “What they would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it,” he said.”

NY Times, March 8, 2006

Quality of Service (QoS)

- The Network Neutrality debate in the US is largely about how to deal with a concentrated broadband market.
- Much less of an issue in Europe:
 - More robustly competitive broadband markets.
 - Extensive palette of regulatory tools.

Transition issues

- Countries that have transitioned to NGN have experienced numerous transition issues:
 - Last mile competition issues
 - Changes in Points of Interconnection
 - Challenges to cost structure and cost modelling

Transition in New Zealand

- TCF IPWP is working to define standards for IP interconnection suitable for voice services.
- I judge the work to be promising, and to rank with the best I have seen.
- Substantial challenges remain, and a great deal of work lies ahead.

Concluding thoughts

- Regulation of IP data interconnection will probably continue to work adequately with little or no regulation.
- Regulation of voice services will probably continue to be needed.

Concluding thoughts

- Current voice arrangements face severe challenges going forward.
 - Not clear that non-zero rates are sustainable in the medium term.
 - Rates in most countries are too high for economic efficiency today.
 - Consider lowering the *level* of rates before addressing the *structure*.

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