The Internet of the Future

Convergence Nirvana?

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Convergence as Mantra

- is IP the ATM of today?
  - ATM was the answer, what was your question?
  - note that ATM is no longer ***the*** answer
- is convergence a mantra or a direction?
- do people building networks want it?
- is MPLS IETF's ATM?
- how useful is circuit switching in an IP world?
  - not very for applications
  - VPNs & long lived flows (video on demand) OK

Convergence as Myth

- phone traffic is special
  - only in that you pay for it by the minute
- need to change IP to support phones
  - never needed to change IP for an application before
  - voice will be a "niche market" (but not for $$)
- need to use phone #s as IP addresses
  - physics says this is *very* hard
- video on demand will be a big money maker
  - couch potato heaven
  - has not been true to date

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Convergence as Reality

- mixed world
  - hard to justify tearing out existing circuit-switched nets
    - known operations, significant amortization xx
  - no reason to recreate it if starting new
- very mixed view on economics of convergence
  - yes equipment is cheaper but equipment is not a big part
- phone companies are very worried
  - why would I call you through them? (just so they can charge?)
- too much focus on QoS

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Convergence and Architecture

- one big issue in telco/Internet convergence are the architectural assumptions in each camp
- Internet:
  - stupid network
  - smart edges
  - applications on 3rd party servers or in end nodes
- teleco network
  - smart network (Intelligent Network - IN)
  - dumb edges
  - applications in service provider network

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Architecture Example

- within IETF - megaco vs. SIP
- megaco/H.248:
  - explode phone switch
  - into server & gateways (MGC & MGs)
  - but still "looks" and manages like a a phone switch
  - applications in server
- SIP / H.323 (original concept)
  - end-to-end to smart phones
  - can work on their own or with local light-weight servers
  - applications in phone not network

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Phone Net vs. Internet

- phone net
  - applications & services in network
  - applications built & installed by phone switch company
  - services provided by phone company
  - hard to do 3rd-party applications & services
- Internet
  - applications & services in computers at edges
  - applications & services can be built by users
  - applications & services can be installed by users
  - no permission required from network operator

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Quote

- from Sun, 16 Apr 2000 11:10:57 +0200

```
Hi Roy,
 I still don't understand why it is a
 "users" choice where the "services"
 are executed - I would have thought
 that this would be networks choice -
 and the means for doing that is what
 we are now discussing.  Can you
 please clarify why a user "MAY" which
 to decieded this.
```

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Convergence Prospects

- campus IP-tel - yes!
- WAN IP-tel - some
- VoDSL/VoCable - what problem is being solved?
- Internet-radio - done
- video chat - sure
- mini-video (CNN in a window) - sure
  but needs useful multicast
- TV-quality video - what is the problem?
- HDTV - good capacity tester

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Quality of Service (QoS)

- is the Internet a one trick pony?
  only 'best-effort' service
  currently QoS to ISP means ' I will accept your packets"
- the Internet needs multiple "products"
  better reliability for better money
- IETF working on QoS technology
  coming to your network soon
  RSVP & diffserv
- but real problems are business

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QoS, contd.

- the ability to define or predict the performance of systems on a network
  - note: predictable may not mean "best"
- unfair allocation of resources under congestion conditions
  - Bill pays to get Fred's traffic dropped
- long-time SNA feature
- pundits want QoS, some purists are not sure
  - do you want to block an emergency phone call?

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QoS, contd.

- different views about the need for QoS
- many big IP-ISPs do not see a need
- telco-based ISPs can not imagine live without it
- 'just throw bandwidth at the problem'
  - few points of congestion
  - fixing these would not cost much compared to adding QoS
  - complex (i.e. expensive) to manage QoS
- fact: the Internet traffic pattern is not conducive to circuit-based networking
- remember: this is the Internet!

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QoS Types

- predictive
  - architect network based on observed loads
  - can also police input loads
- flow based
  - reserve bandwidth through network for an execution of an application
  - keep track of reservation in each network device in path
- non flow based
  - mark packets to indicate class
  - process differently in network based on marking

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Flow Lengths in the Internet

```
IP Flow Switching Cache, 16384 active flows, 0 inactive
  132159644 added, 124468367 replaced, 4892577 timed out, 2782316 invalidated
  statistics cleared 270640 seconds ago

Protocol         Total  Flows   Packets Bytes  Packets Active(Sec) Idle(Sec)
--------         Flows   /Sec     /Flow  /Pkt     /Sec     /Flow     /Flow

TCP-Telnet     5222464   19.2        40    89    785.3      32.9      17.3
TCP-FTP        2087345    7.7         6    87     47.9       7.3      22.7
TCP-FTPD       1275958    4.7        95   390    449.5      21.9      23.6
TCP-WWW       83916123  310.0         9   304   2944.5       5.4      20.9
TCP-SMTP      14106833   52.1         8   173    448.9       6.4      21.6
TCP-X            94849    0.3        81   176     28.6      24.1      17.8
TCP-other     16095661   59.4        38   274   2290.8      20.9      21.5
UDP-TFTP           339    0.0         1   207      0.0       2.3      21.0
UDP-other     5059444   18.6        11   217    208.4       9.4      26.0
ICMP          4201689   15.5         2    83     46.0       5.2      26.8
IGMP            39809    0.1        30   398      4.4      48.2      29.4
IPINIP           9431    0.0      1808   254     63.0     147.1      18.6
GRE             32811    0.1       594   204     72.0      62.1      18.8
IP-other          909    0.0         3   223      0.0       1.2      31.8
Total:      132143665  488.2        15   260   7389.7       0.0       0.0
```

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A Different View

- is adding bandwidth all that's needed?
- Andrew Odlyzko of AT&T Labs

  may be cheaper to just throw bandwidth at QoS problem

  1 - only a few points of congestion

  2 - 80% of data com costs non-transmission

  3 - adding QoS complexity will add to other costs

  labor, management & billing systems etc

  4 - local part of data com dominate overall cost

  5 - cost of transmission coming down

  Fortune reports - 99.8 Tbps capacity by 2001 = glut

  upgrade congested points - cheaper than QoS complexity

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