The Future of the Net

CINA

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Scott Bradner
sob@harvard.edu

Note

- some of this talk is taken from a presentation to be given at Next Generation Networks conference in Boston in November 2001

History

- history is a good place to start
- because some of us had to live through it
  - and are living through it now
- because some {people | ideas | crashes } seem to be doomed to repeat (and repeat ....)
- warning - the story is not:
  - 1/ a fairy tail
  - 2/ all nice
  - 3/ concluded

Background and History

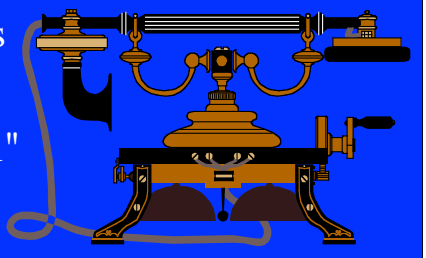
- historical competition between circuit- and packet-based network designs
  - circuit: phone net, SNA, ATM, frame relay, MPLS, switched optical . . .
  - packet: XNS, IPX, AppleTalk, CLNP, IP
- historical competition between smart and stupid networks
  - smart: phone net
  - stupid: Internet
- layers get confusing
  - layers 1, 2, 3 & 8 interact

End-To-End Argument

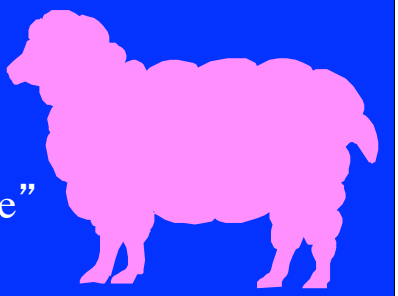
- the End-to-End Argument
  Saltzer, Clark & Reed
- network does not know what the application needs
  so should stay out of the way
- extension:
  no per application functions in network
  no per session information/state in network
- effect: an application-agnostic network

Traditional Phone Network

- circuits
- connection-oriented
- hard state in network devices
- central resource control
- socialist? "for the good of all"
- applications in network
  e.g., phone switch
  end-to-end touch-tone signaling was a mistake
- predictable development path
  extended development cycle



Internet



- datagrams
- soft state in network devices
- competitive resource control
- capitalist? "individual initiative"
  - but too much selfishness hurts all
  - must play by the same rules - but no enforcement
    - **the tragedy of the commons**
- applications in hosts at edges (end-to-end)
- hard to predict developments
  - chaos at "Internet time"

Implications of Packet-Based Networks

- "shortest", rather than "best" path used
- paths through network are not stable
  - they change based on
    - link failure, traffic engineering, routing instability
- impacts QoS
  - can not reserve resources
  - unpredictable QoS
- access control harder
  - e.g. tracking down DoS attacks
- little central control

!QoS

The Power of Experimentation

- what is the effect of the difference between the core-based and edge-based application architectures in providing what the user wants
  - nothing - if you know exactly what the market wants
  - otherwise - core-based makes it hard to experiment with new applications
- innovation
  - not the word that comes to mind for telephone services
- note: VCs should pay attention to this observation

Internet Architecture, contd.

- service provided by 3rd parties - not only by ISPs
- different from phone world
- a quote from an IETF mailing list

```
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
```

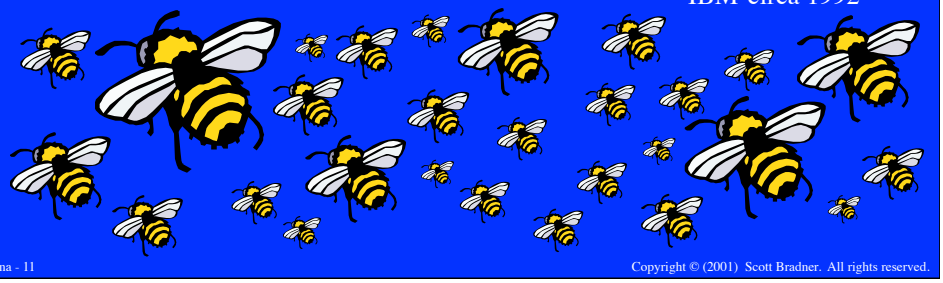
Conceptualization Problem

- fundamental disconnect between "Internet" and "phone" people "bell-heads vs. net-heads"
- by their definition the Internet can not work

  and must be fixed - they will rescue us

"You can not build corporate network out of TCP/IP."

IBM circa 1992



MPLS as an Example

- multi protocol label swapping
- not really routing (was in IETF routing area)
- circuit-based path setup
- **direct data in a way that routing would not have**
- original purposes:

  traffic engineering & forwarding speed
- moving into QoS

  circuit per QoS class -> circuit per flow
- some treating MPLS like IP-based ATM

  circuits are better than packets?

MPLS

- original purpose: ISP traffic engineering
  - placing city-pair trunks along a particular path
  - make up for unequal distribution of bandwidth vs. load
  - MPLS for TE in use at a few ISPs
- other uses:
  - Virtual Private Networks (VPNs)
  - per-application path selection
  - generalized tunneling protocol
- whatever ATM was **thought** to be good for
  - but what did ATM turn out to be good for?

MPLS Lesson

- Bell-head vs. net-head still with us
- VC $ attracted to Bell-think
  - Bell-think sounds good - but it refers to a different world
- MPLS lesson same as ATM lesson
  - why do we need to do it again?
- learning? - What's that?

IP as a Common Bearer Service

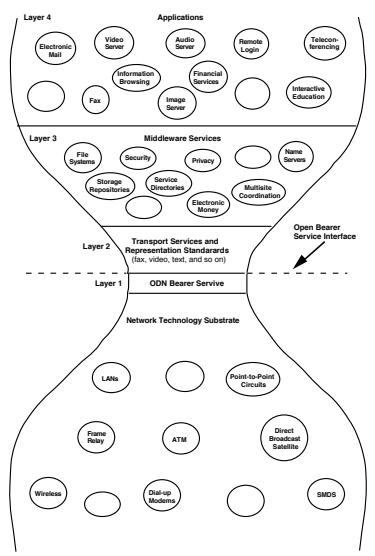


FIGURE 2.1 A four-layer model for the Open Data Network

From: Realizing the Information Future

IP As Common Bearer Service, contd.

- but what should it bear?
- just because you **can** get everything to run over IP, **should** you?
- a LAN is a reasonable concept
- a level 2 access network can make sense
- broadcast HDTV over IP may not
- phone calls?
- videoconferences?
- ATM- & MPLS-like analysis process?

everything over IP ?

Language

- an aside to confuse the issue
- current Internet is based on English
  - can put up a non-English web site but use English URLs
- IETF working on internationalizing the DNS
  - has required extended language support in applications for years
- political as well as technical issue
  - who decides on mapping for Chinese?
    - international researchers, PRC government, Taiwan NIC, Singapore, ... ?

Technology, Regulation & VCs

- potentially deadly embrace:
  - technology, regulation & VCs
- technology can not be developed without investment
- VCs often do not understand technology
- regulators feel technology is second to policy
- regulations scare VCs and inhibit market forces
- scared VCs do not invest in technology

The Importance of Phones

- big issue in IETF development of telephony technology for IP networks
- phone people assumed that phone traffic would have precedence over all other use

  IETF did not agree — I'm more important!
- particular issue in responding to congestion

  everyone thinks the other guy should back off

I'm more important! I'm more important!

I'm more important!

Applications

- too many applications are replicating function from some other medium

  "keep it the same" so users are not confused and VCs will fund it
- not enough thinking

  Internet-ness is lost

  replicate smart-net

  where is e2e?
- often not really Internet

  IP-telephony or Internet-telephony?

Future of the Net

- you see what got us here
  - where do you see that in VC image of future Net?
- why is there no e2e?
  - dumb net == commodity service
  - real hard to make money from a commodity service
- can be done
  - see Coca-Cola
  - but how do you make bits tasty?

Basic Problem: $

- in traditional phone net: applications run by carrier
  - value of application flows to carrier
- in pure Internet: application not run by carrier
  - no transfer of value from application to carrier

"**We do not know how to route money.**"

Dave Clark

Is Differential Service the Answer?

- pay more to get a better service?
  - a way for ISP to get application-based revenue
- Internet is not consistently bad enough
  - **"It fails to fail often enough so it looks like it works."**
    Mike O'Dell
- assumption:
  - you will pay more every time to make the service better some of the time
  - e.g., IAD- vs. Ethernet-attached phones
  - IT managers: yes, real world: ???
    - e.g. VoIP at Harvard

Can't Get There From Here

- current work in Congress would leave it to telco world (Broadband Freedom Act)
- telcos want to do per-application billing
  - call detail records for Internet
- what about innovation?
- the telco world can not provide **Internet** service
  - it's a conceptualization problem
    - (and a business problem)

Future of the Internet

- the Internet has a bright future if there is an Internet in the future
- iMode lesson
  - do not think carrier can do it all
  - enable 3rd party service providers
  - support them (e.g., billing) **if they want it**
    - do not require that all service providers participate
  - a way to transfer value from service provider to carrier
  - carrier also gets "minutes"

I'm optimistically pessimistic