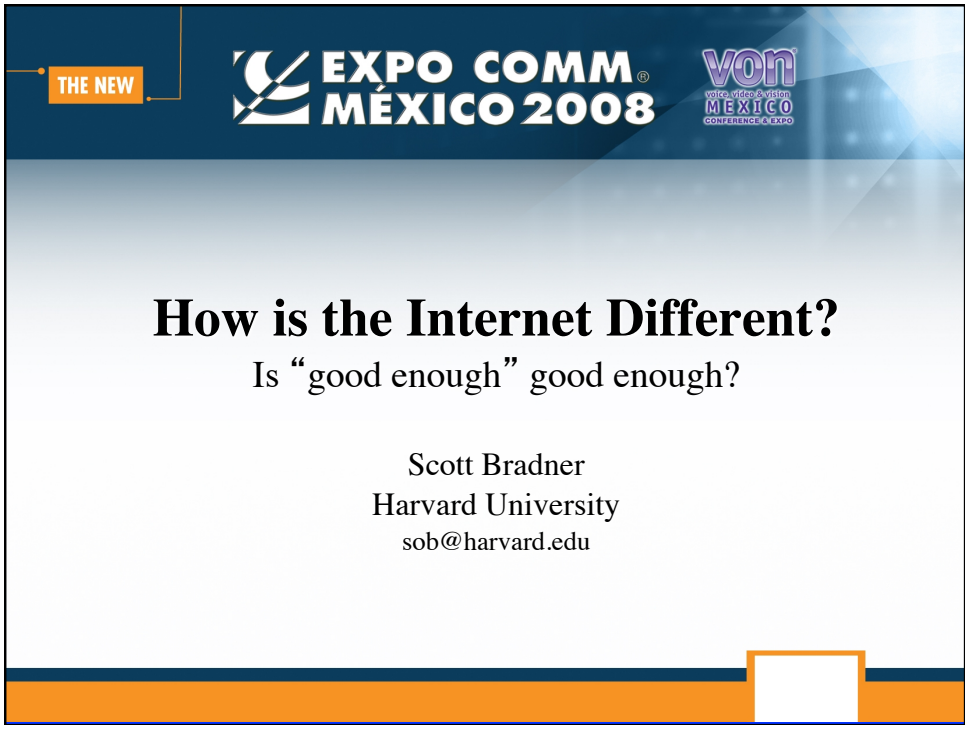
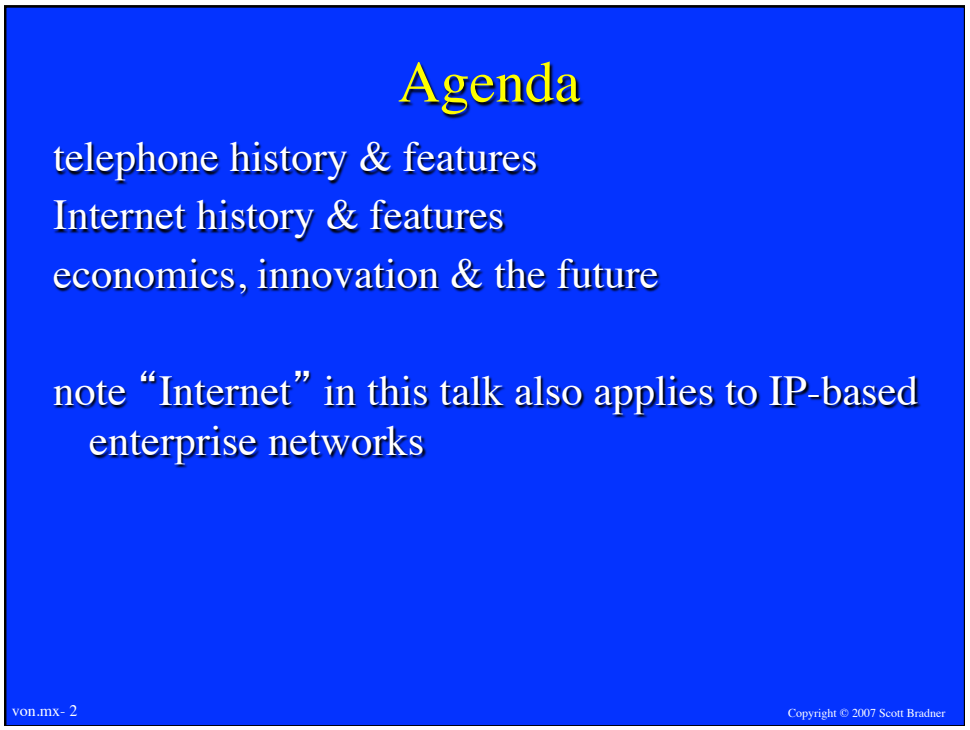




Telco Start

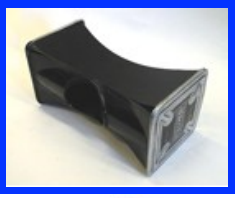
Bell founded 1877, patent upheld 1879

rent not sell
- long term return
- slow change

dumb instrument

closed system
- until Hush-A-Phone & Carterphone

regulated as common carrier
- not responsible for customer actions
- sell same service to everyone



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Telco Features

circuit switched
- defined quality & call state

end system to switch signaling
- operator
- dial (1st 1904, deployed 1919)
- touch tone (1st 1941, deployed 1968)
  - accidental end-to-end signaling

switch to switch signaling
- in-band tones (end in 2006)
- out-of-band SS7 (1980)

one application: voice

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Telco Business

- stared with per call billing
  - flat rate expanding
- long distance
  - intra country, inter country
  - different fees
- settlements
  - calling party compensates receiving telco
- regulators
  - dictate quality, features, tariffs, coverage ...

Telco Security

- dumb end stations secure
  - changing with cell phones
- hackable signaling
  - tones - "phone phreaks"
  - SS7 - no built-in security & gateways
- hackable switches (i.e., computers)
  - e.g., Mitnick & Greek telco
- caller ID spoofing

Internet Start

ARPANET 1969, www 1993

overlay network

- enabled by Carterphone

government funded at start

smart ends, dumb network

open system **RFC 791: Internet Protocol**

- standards, hardware & applications

generally not regulated (some country exceptions)

- generally not responsible for customer actions
- sell same service to everyone

Internet Features

packet switched

- no defined quality or call state

end system to switch signaling

- destination internetwork address in packet

end station to application signaling

- end-to-end - “just IP” packets

switch to switch signaling

- in-band routing protocol

thousands of applications

- not designed for any particular application

End-to-End Argument (e2e)

- 1981 paper by Saltzer, Reed & Clark
- end stations know best
- application aware networks get in the way
  - keep per-session state out of network
- network aware applications inhibit network innovation
  - e.g. ATM
- enables user innovation -- "generative"
  - far faster deployment of new technology
  - not dependent on carrier permission

E2E Got Us Here

- not convinced that e2e is important?
  - the www exists because of e2e
    - as do Google, iTunes, Skype, Vonage, YouTube, Facebook, ...
- e2e is hard to get at a corporate desktop or residential net
  - except port 80 (web)
  - NATs abound & block some types of applications as a byproduct
  - firewalls are designed to block some types of applications
- but e2e still exists between enterprise boundaries

Internet Business

- small users: flat rate, big users: tiered
- no concept of long distance
  - distance insensitive
  - technically too hard to know destination location
- no settlements
  - origin ISP keeps all
    - but may have to buy transit service if small
    - large ISPs do cost-shared peering
- governments & regulators are puzzled
  - try to make telco regulations fit
- few ISPs make money
  - even with Internet bust

Internet Security

- mostly end-to-end
  - i.e, security is the end system's responsibility
- the net, itself, transports versus and hacker attacks as reliably as it transports any traffic
- firewalls help but often ignores the inside attacker
- mixed security in Internet infrastructure
  - secure routing updates
  - do not secure accuracy in routing updates
    - e.g., Pakistan induced You Tube outage

Mental Images

traditional teleco: the Internet does not work

- can not define what "work" means
  - no defined QoS
  - no service guarantees
  - no reachability guarantees
  - not good enough for voice

Internet geek: the Internet works "good enough"

- as-is, the Internet can (and does) support all sorts of applications - but not everything
  - voice, video, etc (this conference itself)
  - Skipe, Vonage, Apple movie downloads etc.

Good Enough

first basic Internet tussle

use the Internet (or enterprise net) that's there

or change the net to support an application

- e.g., voice or emergency service

problem is that the Internet is "good enough" (most of the time)

"the Internet is not reliably crappy enough"

Scott Bradner

"It fails to fail often enough so it looks like it works."

Mike O'Dell

Routing Money

second basic Internet tussle

no ISP lock in for services

> *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* - an IETF mailing list mid 1990s

telco carriers would rather have use-specific fees

- like railroads
- some bits are worth more than others

service provider can not reward distant ISP

- no telco-like settlements

"We do not know how to route money"

Dave Clark

International Settlements

significant strain over International Internet costs

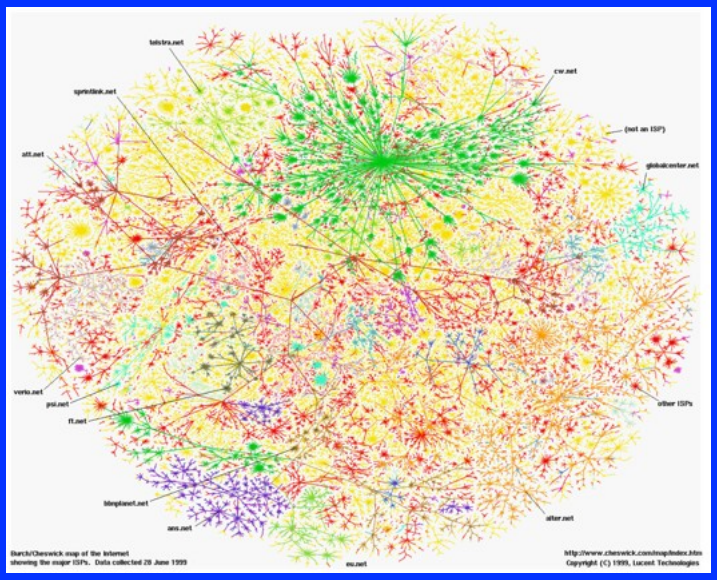
non-US ISPs generally buy a connection to the US to be part of the Internet

- or buy transit service from an international ISP
- seen as unfair buy non-US ISPs
- seen as realistic by US ISPs
  - non-US content seen (by ISPs) as not worth paying for

sender-pays works in the phone world

- but not in the Internet
  - e.g., asymmetric traffic in the web

Internet "Architecture"



Role of Regulators

Internet benefited from little effective regulation

some attempts

- content (USA CDA, China "great firewall")
- applications (VoIP is just a type of traditional teleco)
  - quality, 911, wiretapping, tariffs

future?

- quality, services, openness, security
- but regulators do not understand the technical differences between the Internet and traditional telco

biggest issue: business model

regulator's #1 job: protect incumbents

The View From the ITU

after WSIS - Secretary-General Yoshio Utsumi

- *"the Internet need not be one net controlled by one centre"*
- domestic networks are "*more efficient and economical*" (because much traffic is local)
- *"telephone networks are made up of regional, domestic networks united together in agreement with ITU framework. A similar situation may start with the Internet"* - if so the ITU will be called upon to fix things (within 5 years)

Network Neutrality

ISPs used to be ISPs

- now telcos are ISPs

different mindset

- public claim: need more money to deploy infrastructure
- one way to get the money is to shake down service providers using the teclo's wires ("my wires")
- options (as they see it):
  - carrier gets revenue from service providers
  - carrier is in the commodity business

forgotten factor: little real competition

Neutral Networks

- treat all traffic the same
  - or all traffic of a type (e.g., all traffic identified as VoIP)
- network does not bias traffic to or from users based on its content, source, or destination
  - e.g., not give its own VoIP better quality
- networks do not get in the way of innovation
- a problem if the network becomes overloaded
  - could accept user markings to enable different handling (maybe for more money)
    - e.g., diffserve- requires admission control (does not exist)

Non Neutral Networks

- innovation pace driven by carrier
  - unless innovator can pay
- require much more management than neutral nets
  - cheaper to add bandwidth is many cases
    - assuming aim is good service
- may provide more revenue
  - but may not compensate for more management
    - Internet 2 experience
- e2e must be blocked
  - at least for some things

Driving Innovation

- innovation happens when the user does not know what they want
  - little innovation in mature applications - e.g. old voice
- low "market uncertainty" mans little innovation and little product differentiation other than cost
- high "market uncertainty" means he who guesses right can win big -- e.g., iPod
- we are (or should be) in a time of high market uncertainty when it comes to Internet applications - e.g., voice
  - but too much imitation, too little innovation

Enterprise Networks

- enterprise nets are different
  - generally a single control/management/business/ security regime
  - QoS is a business decision
  - applications are a business decision
    - but remember the tyranny of the data center
    - innovation in enterprises can also be hard
- security is generally misunderstood
  - some bad guys are inside and they know where things are

VoIP in Enterprises

- phone-think still gets in the way
  - best effort (and good enough) are not good enough
- security is misunderstood
  - today VoIP security is about the same as non-IP voice
    - i.e., not very good
  - standards exist but not enough implementation
  - end-to-end security is seen as a threat
    - by regulators, by enterprise security people
  - a perimeter firewall may be necessary but not sufficient

VON

- voice (and video) over the net has been brought to you by the letter e, the digit 2 and the letter e
  - and not by X.25, ATM or SNA
- do not forget that unless you think that innovation (over the Internet) has stopped
  - like Charles H. Duell did in 1899
- or should be controlled (e.g., slowed, guided or stopped)
  - like too much of the traditional telco world, some countries, and some regulators think

Dance With the Lady That Brung Us

e2e-enabled innovation got us here

but we are not yet where we will be, if we are permitted to go there