

# Witness to the Evolution

Cisco Networkers  
July 15, 2004



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networkers 04: 1

## Agenda

### history:

mine, concepts, federal nets, hosts, users, public  
impression

### current

architecture, regulations, business

### future

business, regulations, alternates

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# Observation Posts

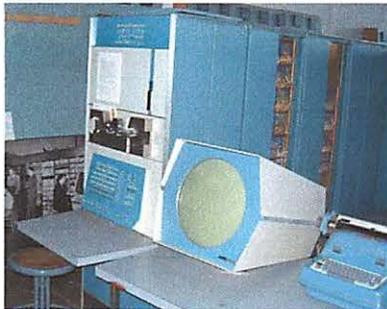
@ Harvard University: since 1967  
Harvard connected to ARPANET in 1970  
(sob@: since ~1972)  
Harvard networks: since ~1973  
JvNCNet: 1986 to 1989  
router / switch testing: 1988 to 1999  
NEARnet / CoREN: 1989 to 1995  
IETF: since 1989  
ISOC: since 1993  
ITU-T watcher: since 1995  
Internet 2: 1996-1998  
ICANN: since 1998

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## @ Harvard

Center for  
Cognitive Studies

DEC PDP 4  
8K 18-bit words  
of memory  
DECtape  
0.04 mips max  
great display



1967

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# @ Harvard

Computer-  
Based Lab

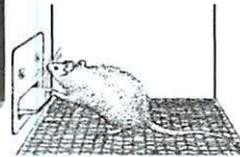
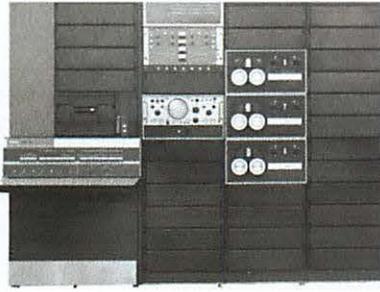
DEC PDP 9T

32K 18-bit words  
of memory

DECtape

2 MB disk

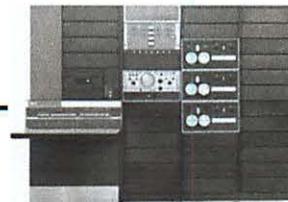
0.3 mips max



1969

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# @ Harvard



18-bit  
parallel  
~100Kbps

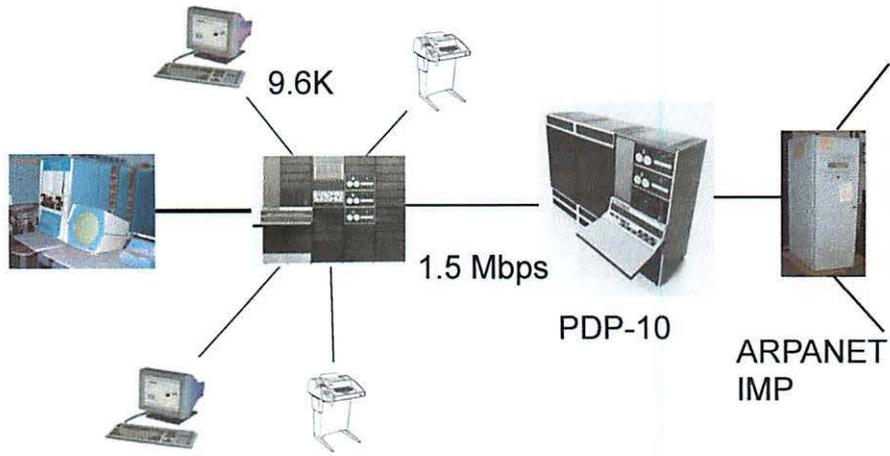
**My First Network**

(or my computer interconnection anyway)

~1972

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# @ Harvard

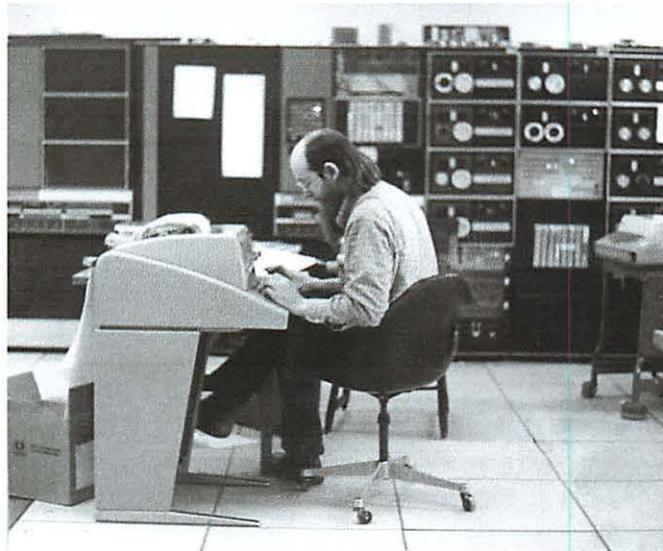


**Selling Time and  
Connecting to the ARPANET**

mid 1970s

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# @ Harvard



~1977

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# @ Harvard

PDP 11/44  
512 KB memory  
500 MB disk



research support  
for behavioral sciences

{genrad|bbncca|  
panda|ihnp4|  
allegra|  
harvard}|!  
wjh12!sob

multi-lingual word  
processing for much of  
Harvard (CAT 8)

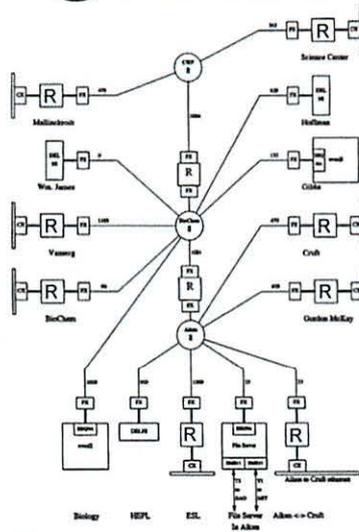
sob at harvunxw      usenet & bitnet gateway to Harvard  
usenet/bitnet/arpnet gateway

**Interconnecting the world**

early 1980s

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# @ Harvard

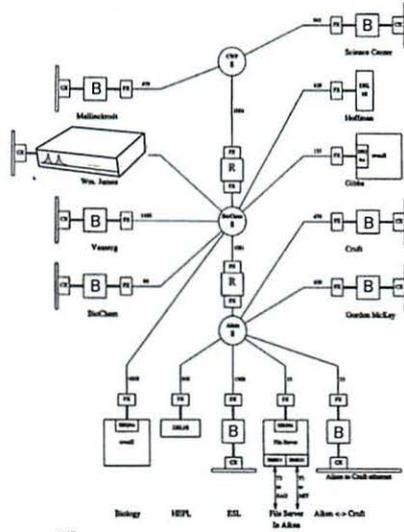


**My First Fiber Network**

1986

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# @ Harvard



**Routers are your friends**

1988

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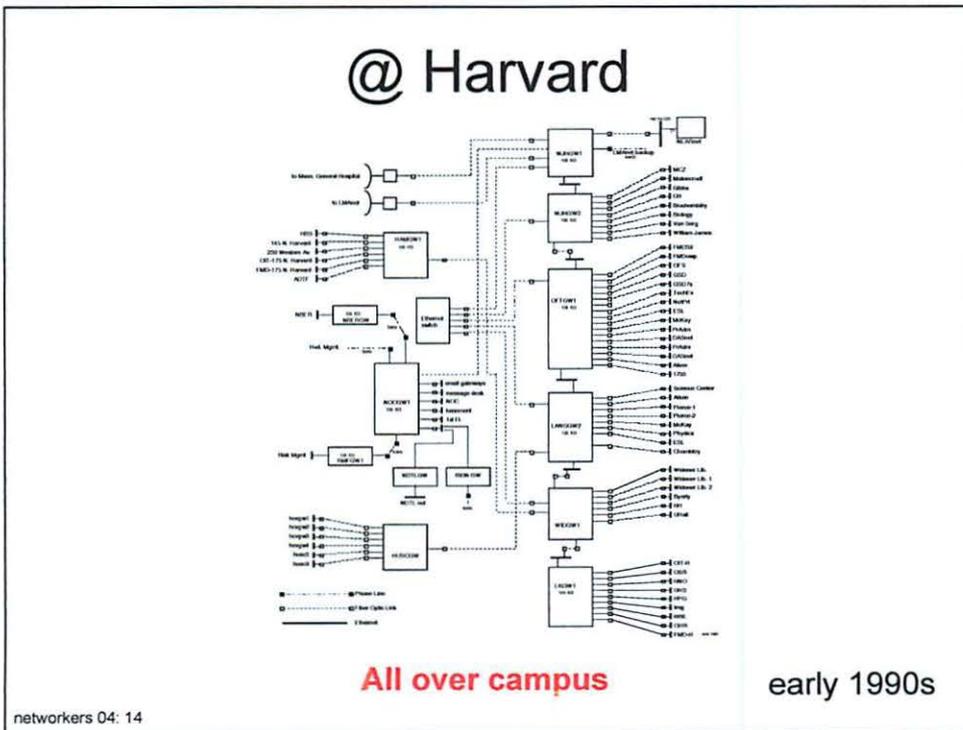
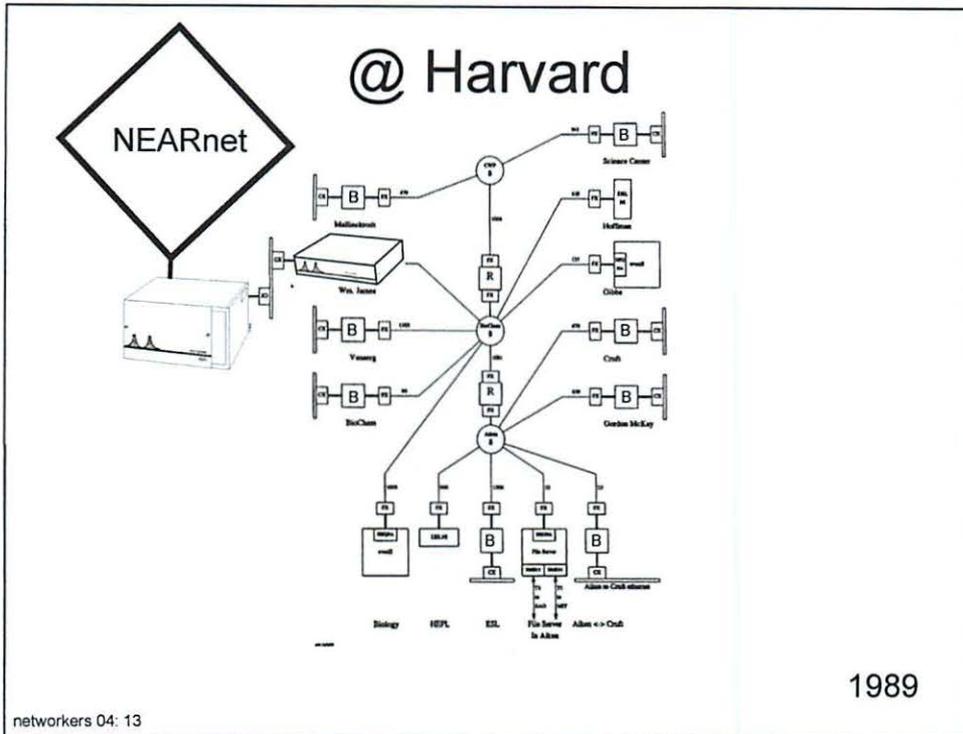
# @ Harvard

an aside

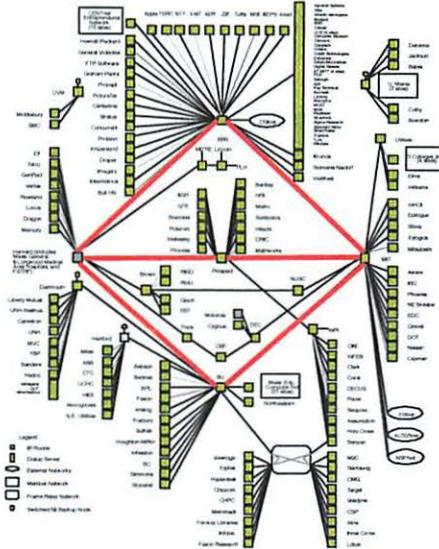
Harvard Network Device Text Lab

**just how fast is it?**

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# NEARnet



**We can do it better**

early 1990s

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# This Internet Thing

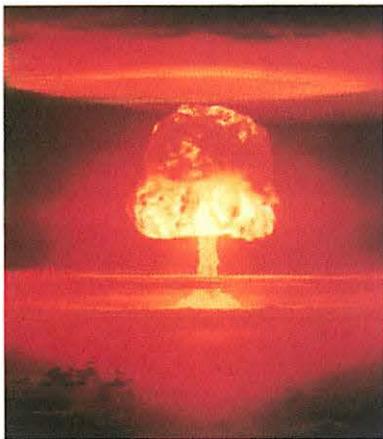
(U.S. centric view)

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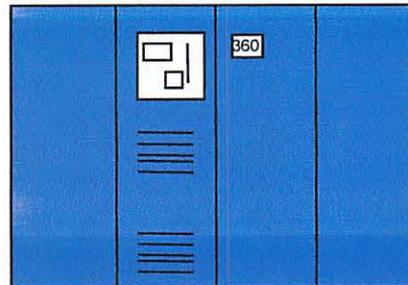
# Why?

## (In the Beginning)

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or



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# What existed?

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## **The** Phone Network from **The P**hone **C**ompany

**circuit**-based

**predictable** interconnections between ends

**assumed** absolute requirement for QoS

assumption of being **carrier**-provided

the service was **voice**

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## What Was Wrong With That?

nothing, if you just wanted to talk

nothing, if you just wanted to talk to Joe

nothing, if you just wanted one service

trick question: what does a **fast busy** signal mean?

nothing, if you thought that TPC innovated

note: this was pre breakup just post Carterphone

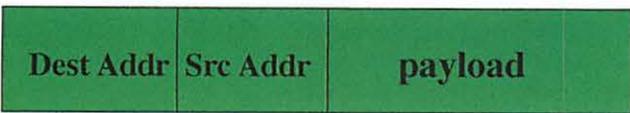
nothing, if you wanted your data service

provided to the wall by a carrier

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if not **TPC**, lets create our own layer  
(note: layer not network)

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### Vint' s Goals

- 0/ multiplexed utilization of **existing** networks
- 1/ **survivability** in the face of failure
- 2/ support **multiple types** of communications service
- 3/ accommodate a **variety** of network types
- 4/ permit **distributed management** of resources
- 5/ **cost effective**
- 6/ **low effort** to attach a host
- 7/ **account** for use of resources

**!security**  
**!QoS**  
**!efficiency**

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**e2e!**

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What did **they** think the Internet was?

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- by definition  
some **theys** still think this  
(but some of them are now **us**)

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## Architecture Feature

ISP does not profit from services running  
over network

some telcos do not grok concept

some carriers building “content aware” next  
generation networks

*“We do not know how to route money”*

Dave Clark

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## Some views over time

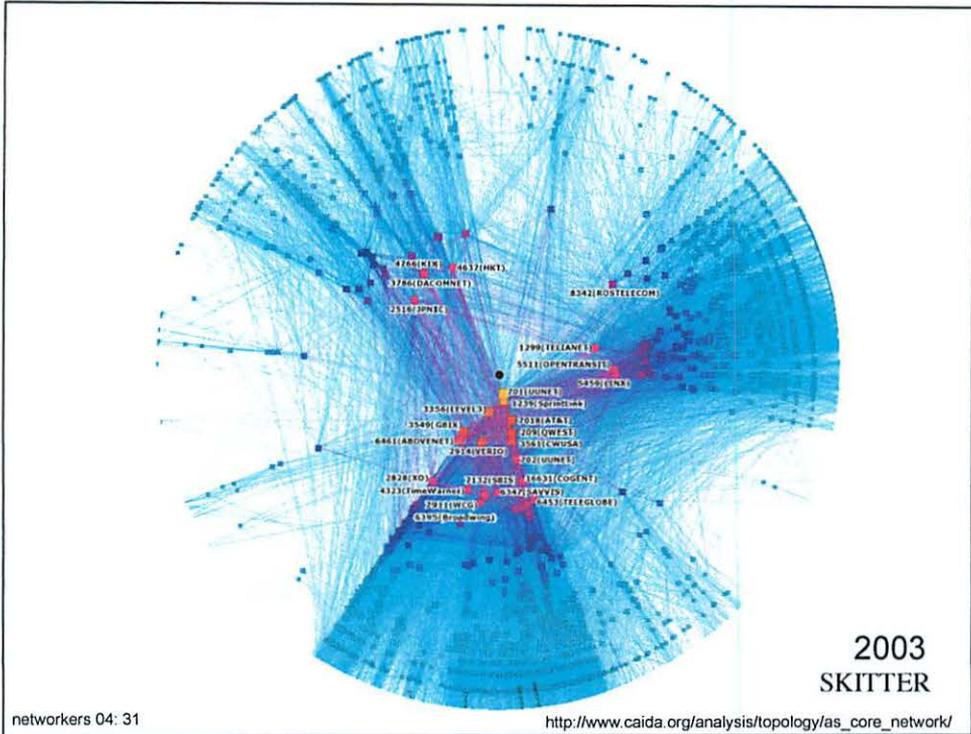
US federal funded network topology

psychological time line

Internet stats

networkers 04: 28

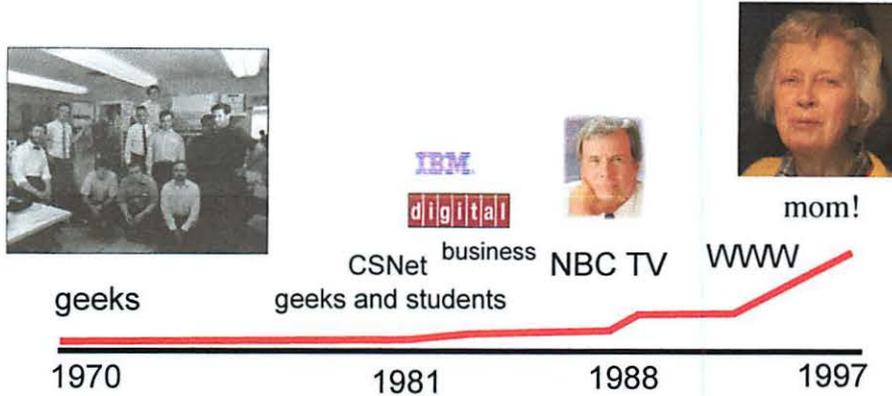




# Internet Psychological Time Line

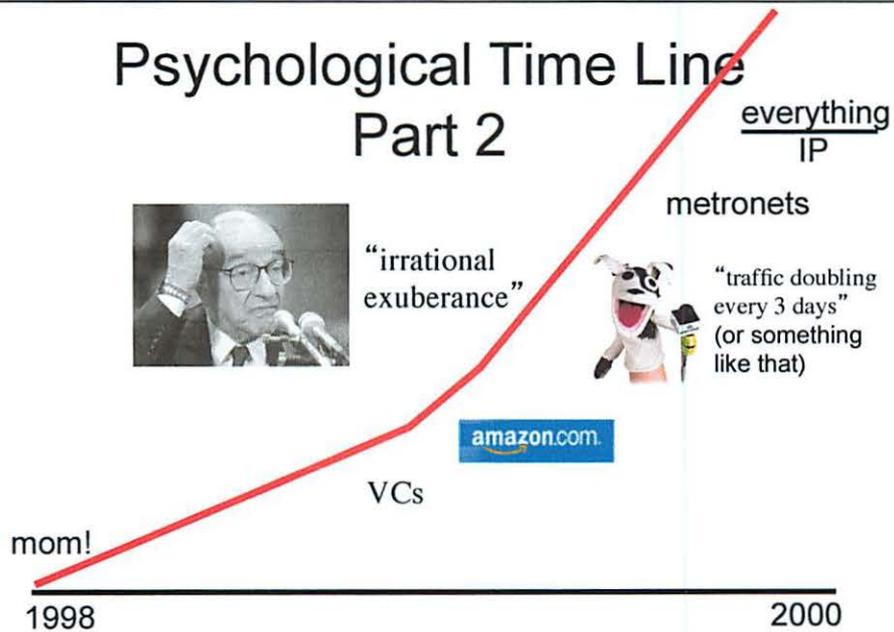
networkers 04: 32

# Psychological Time Line Part 1



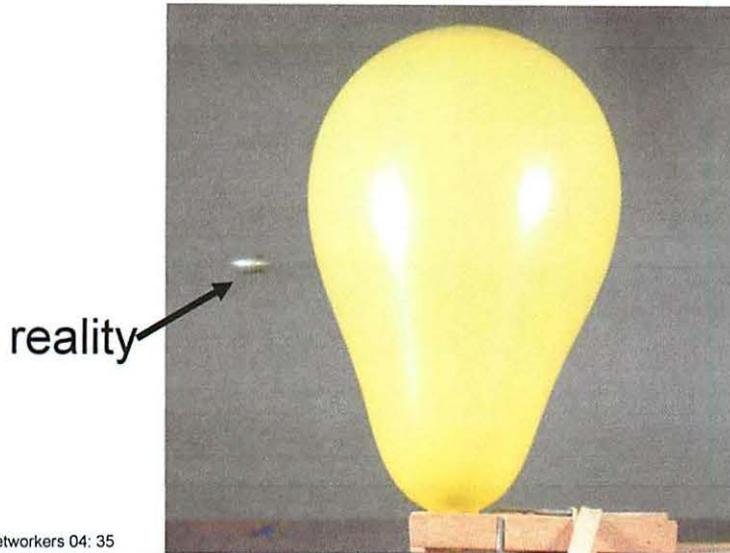
networkers 04: 33

# Psychological Time Line Part 2



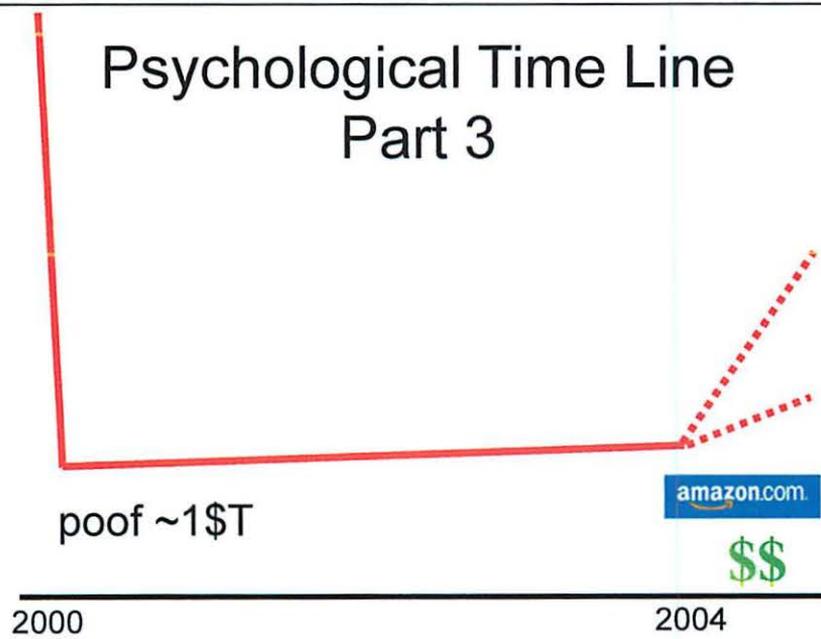
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## Psychological Time Line Part 2 - in retrospect



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## Psychological Time Line Part 3

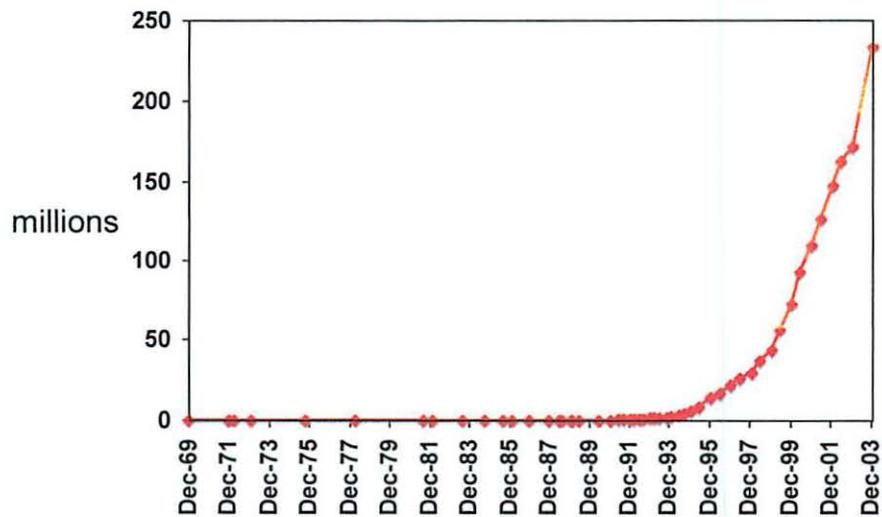


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Psychology and reality  
may not be the same thing  
(some other trends)

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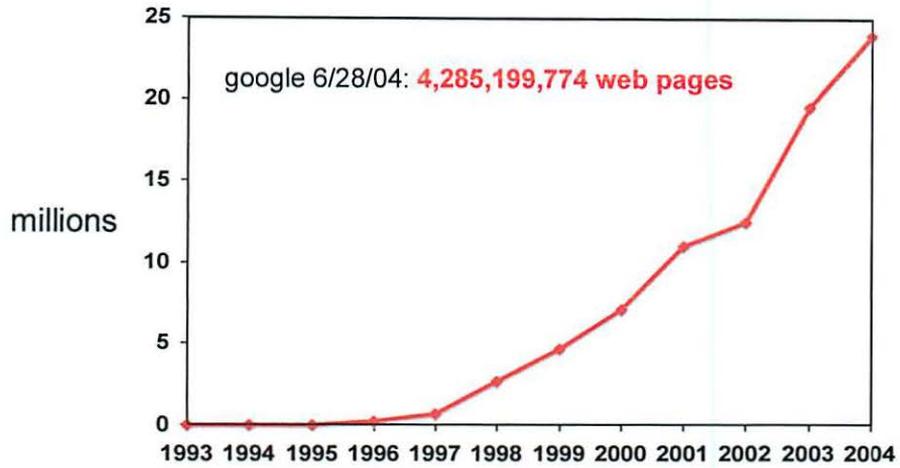
## Internet Hosts



networkers 04: 38

data from [www.isc.org](http://www.isc.org)

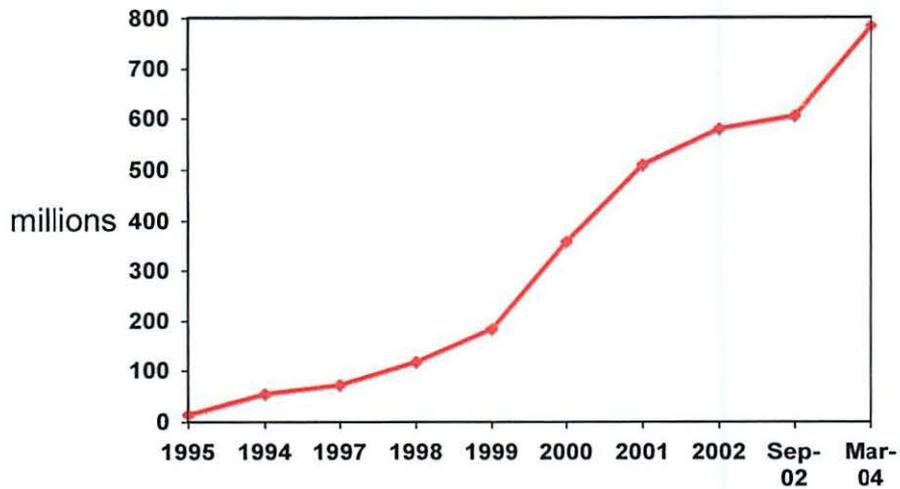
# Web Sites



<http://www.mit.edu/people/mkgray/net/>  
<http://www.oclc.org/research/projects/archive/wcp/stats/size.htm>  
<http://news.netcraft.com>

networkers 04: 39

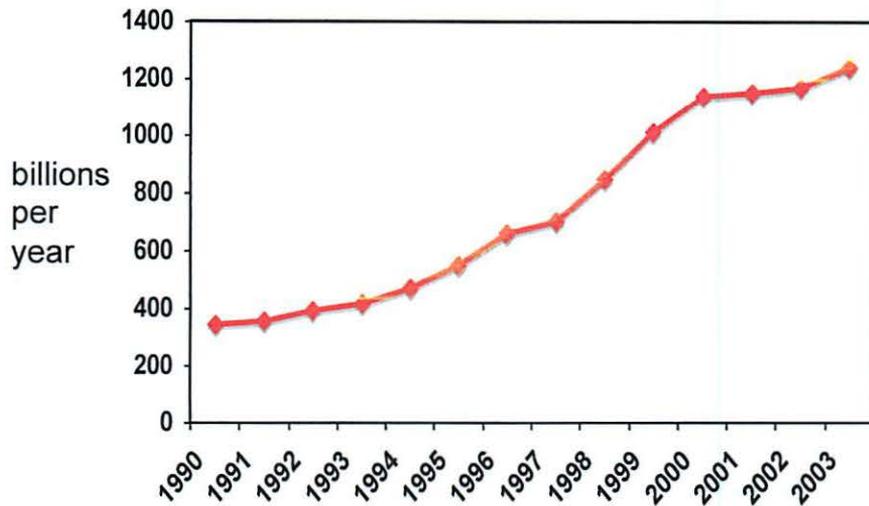
# Internet Users



data from [www.nua.com](http://www.nua.com)  
<http://www.internetworldstats.com/stats.htm>

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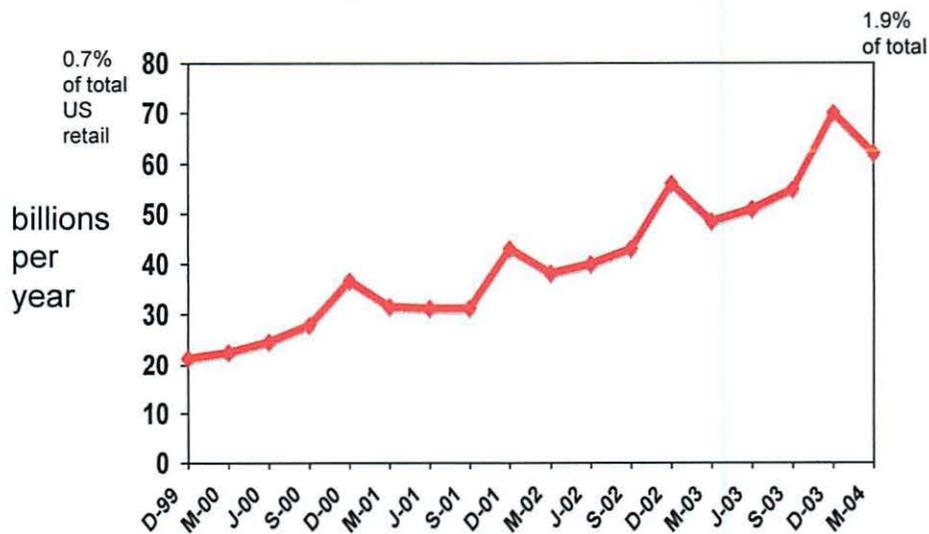
## U.S. Information Technology



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<http://www.esa.doc.gov/TheEmergingDigitalEconomy.cfm>  
<http://www.esa.doc.gov/DigitalEconomy2003.cfm> (2002 & 2003 are estimates)

## U.S. Retail E-Commerce



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<http://www.census.gov/estats>

## So, the real IT/Internet world did not end

(but the ride did cost a \$T or so)

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## Disintermediate more than Bits

no requirement for customer to get services  
(other than transport) from their ISP

e.g., email, DNS, VoIP, content  
some ISPs would like to “fix” this

no requirement for suppliers to distribute  
products (just) through stores

e.g.,



low barrier to establish web-based store bypass  
web site, PayPal/Amazon - UPS/FedEx delivery

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# Standards: (growing the pond)

e.g. twisted pair Ethernet

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## IETF: Meta View

Internet standards R us  
does not exist, **no** members, **no** voting  
1,200 to 2K at 3/year meetings, **NK** on mail lists  
1,233 & 1,390 last 2 meetings  
130ish **working groups**  
8 **areas** (for convenience) with **ADs**  
APS, GEN, INT, O&M, RTG, SEC, SUB, TSV  
management: **IESG** (ADs chosen by community)  
architectural guidance & liaisons: **IAB**  
produces **standards**  
supported by **Internet Society**

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## IETF “Standards”

standards only when people use them  
no formal recognition  
no submitting to “traditional” standards  
organizations  
but do work with other SDOs

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## IETF Impact

maintain base Internet Protocols  
IP(4,6), TCP, UDP, ICMP , etc  
Internet Routing - OSPF, BGP, PIM, SSM, IP IS-IS  
IP infrastructure protocols  
DNS, DHCP, PPP, I2tp, HTTP, SNMP, IP storage  
IP security  
IPSec, TLS, Kerberos, PGP, S/MIME, geopriv, etc  
quality of service/measurement  
InteServ, diffserv, RSVP, nsis, bmwg. ippm  
subIP  
MPLS, GMPLS, GSMP, traffic engineering  
IP- telephony  
RTP, SIP, ROHC, megaco/H.428, ENUM

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## Some Examples

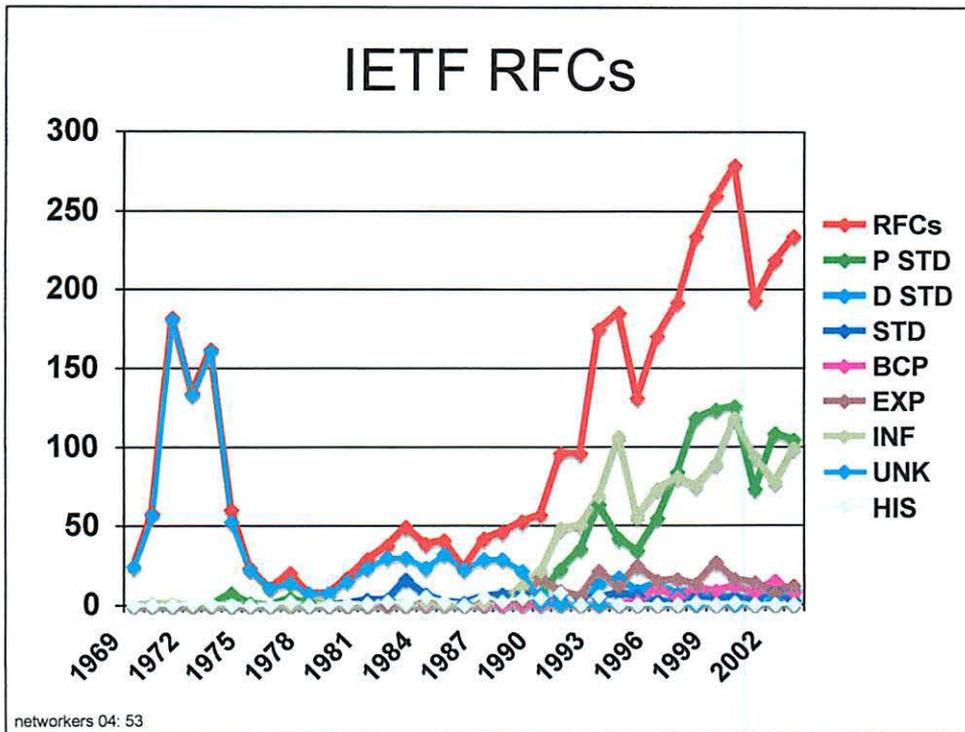
BGP - inter-AS Internet routing protocol  
BGP/MPLS VPNs  
CIDR - Classless Internet Domain Routing  
DIFFSERV - Differentiated Services  
GRE - Generic Routing Encapsulation  
IKE - Internet Key Exchange  
IPv6 - Internet Protocol Version 6  
L2TP - Layer 2 Tunneling Protocol  
MGCP - Media Gateway Control Protocol  
MPLS - Multiprotocol Label Switching  
PIM - Protocol Independent Multicast

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## Some More Examples

ppp - point to point protocol  
RPSL - Routing Policy Specifications Language  
RSVP - Resource Reservation Protocol  
SCTP - Stream Control Transmission Protocol  
SNMP - network management protocol  
SSM - Source-Specific Multicast

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## IETF Importance

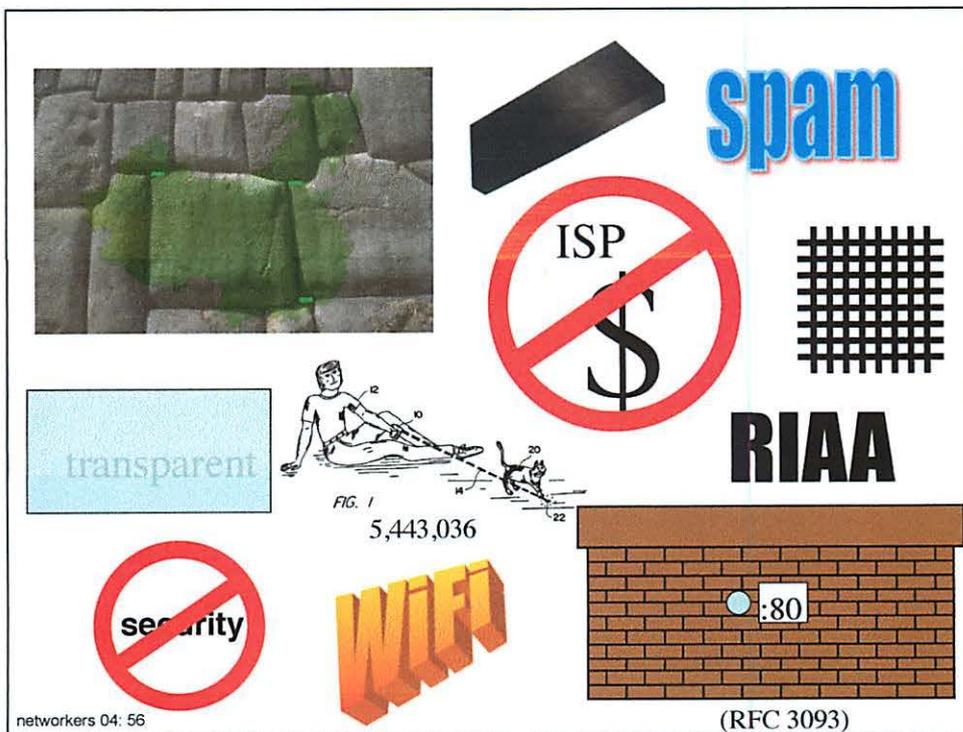
Internet would not run without IETF standards  
 VoIP == SIP (mostly)  
     not so for video  
 traffic engineering and VPNs use MPLS  
 mixed bag on applications  
 IETF v. ITU-T  
     governments are us  
 IETF v. forums  
     'faster and what we want' (some vendors)

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# Today's Internet

some perception, some reality

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(RFC 3093)

## Using or Providing?

major Internet issue:

making money **providing** Internet service is hard  
lots of money to be made (or saved) **using** the  
Internet

e.g., Cisco, eBay, Amazon ....

but lack of ability to route money to ISPs means

little money in providing Internet service

i.e., commodity product - cheapest bit

tools are in routers to do more: learning how to use

future strain: possibilities

regulations

use restrictions

government owned infrastructure

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## An Opaque Network

Internet is no longer e2e

firewalls, NATs, L9 filtering, content aware networks

“good” reasons

but inhibits innovation

depends on ability to bring up a new applications

w/o permission (or knowledge) of network operator

core (provider-enabled) services slow to change

edge (user-provided) services fast to change

if market uncertainty high:

big win for “right” answer

if market uncertainty low:

commodity - low return

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## Managed Networks

QoS technology has been defined and works

RSVP, diffserve, etc (also MPLS)

smart devices can protect network

mixed current real-world application

enterprise nets

part of basic design of modern enterprise nets

support for VoIP, SAP etc

ISPs

not much multi-tier service

some SLA-based offerings (including VPNs)

future/now?

VoIP / special service support

VoD contracts

so maybe money can be routed

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## Beyond Standards

Internet was ignored for a long time

by most governments, regulators & telcom SDOs

no longer ignored

ITU-T is in the telcom standards business

telcom is moving to the Internet ...

governments worry about confused citizens

regulators worry about disrupting incumbents

(and cash flow)



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# Regulators

lots of regulators & regulations  
economic

tariff rules, fair competition, disruption  
service

define required quality of service  
safety

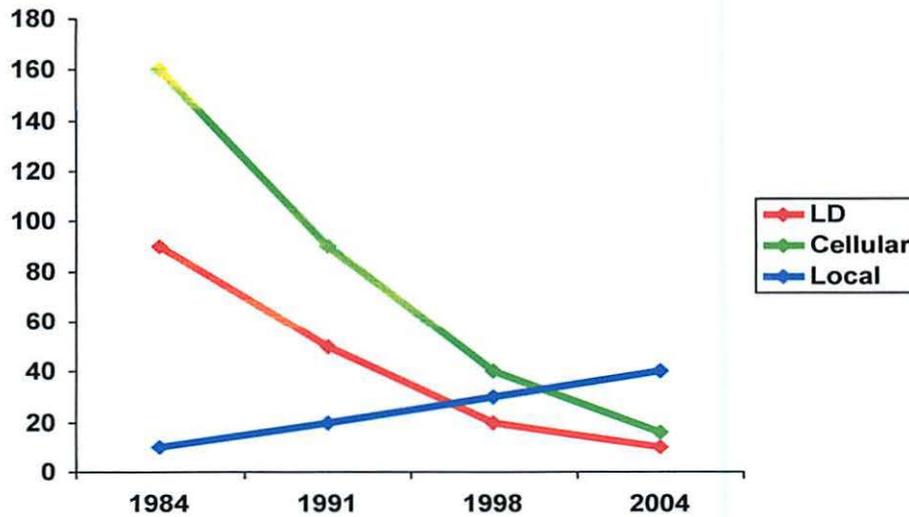
E911, emergency use of network  
law enforcement

wiretapping, encryption  
society

content control

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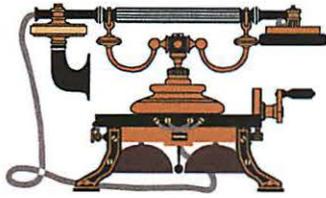
# Competition is your friend



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from Daniel Berninger

# IP Telephony or Internet Telephony?



innovation or replication?

voice

IP

or

IP

“make sure it stays good”

“it is good enough”

some regulators want to “define” voice over IP  
but no way to know what it *will* be

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# Alternate Future Histories?

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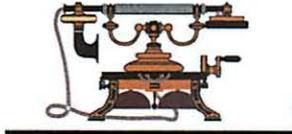


**we built it so we own it!**



**Internal Revenue Service**

DEPARTMENT OF THE TREASURY



**IP**

*far too important for the geeks*



world summit  
on the information society  
Geneva 2003 - Tunis 2005



*"make sure it stays good"*



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**content**



**Qwest.**  
Spirit of Service™

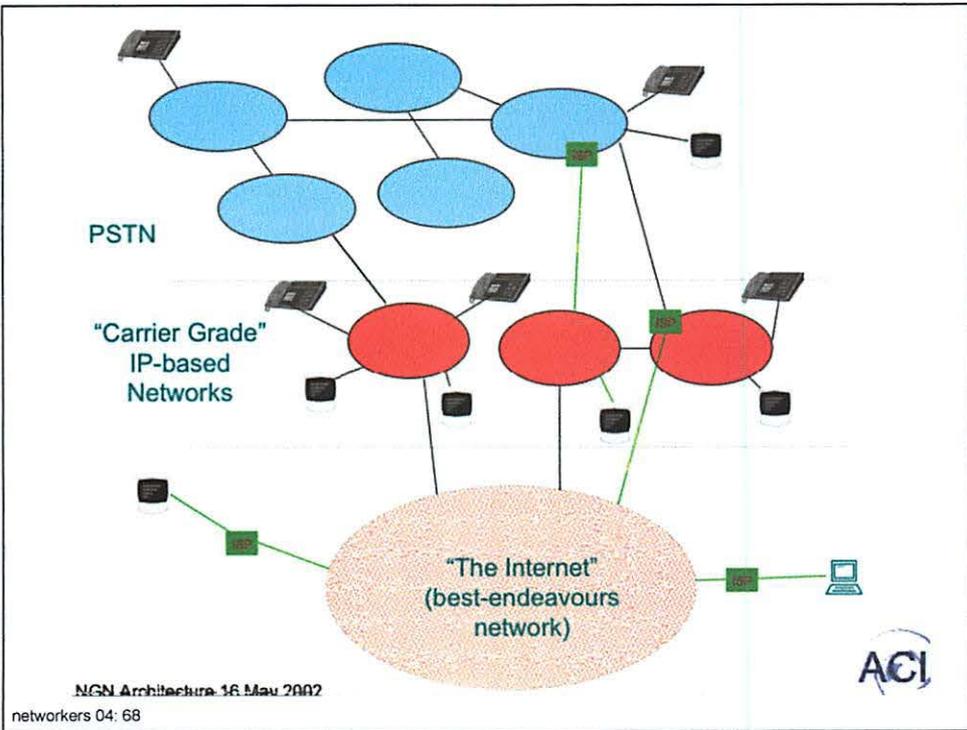
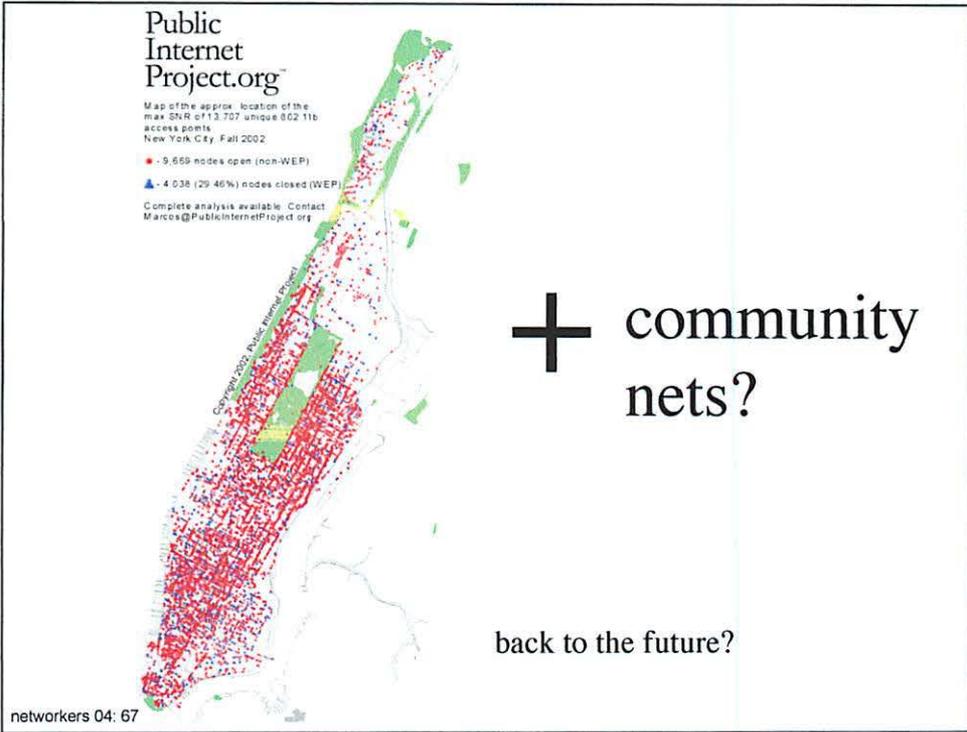


**VoD**

**BELLSOUTH**

**games**

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## next time? (or is it now?)

support **existing** networks  
**datagram**-based

creating the **router** function

split TCP **and** IP

DARPA fund Berkeley to add TCP/IP to **UNIX**

CSNET and **CSNET/ARPANET** deal

NSF **require TCP/IP** on NSFnet

ISO **turn down** TCP/IP

NSF Acceptable Use Policy (**AUP**)

**minimal** regulation

decisions that  
made  
a difference

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## Some Current Decisions

path openness

standards

security

privacy

ISP business model

regulations



or



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## Key Open Questions

**Who says who makes the rules?**

**Who says who pays for what?**

watch out for WSIS  
answering these questions



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it is **NOW**  
(and it is us)

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I' m pessimistically optimistic

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