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# The Open Internet

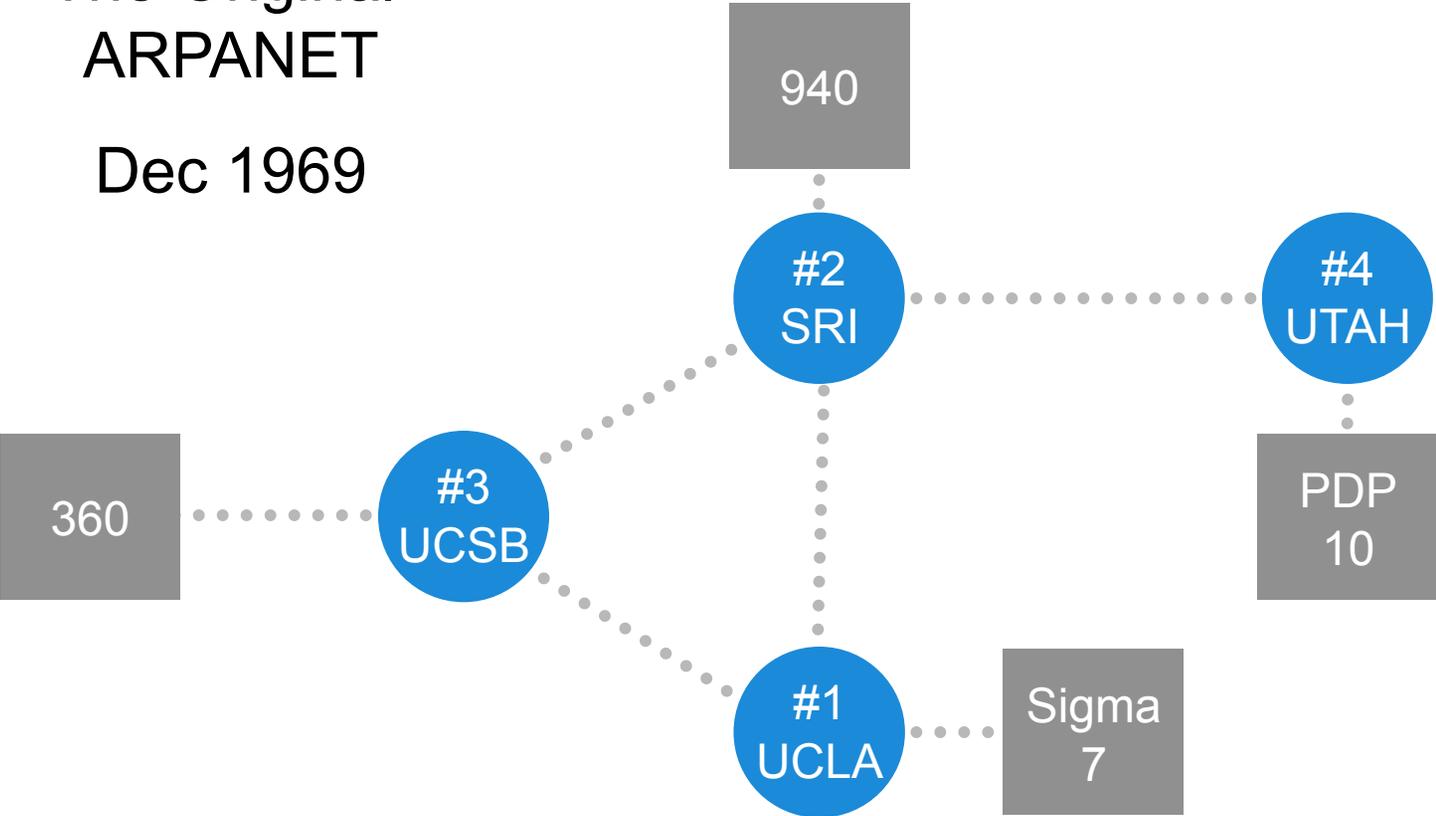
Vint Cerf

March 2010

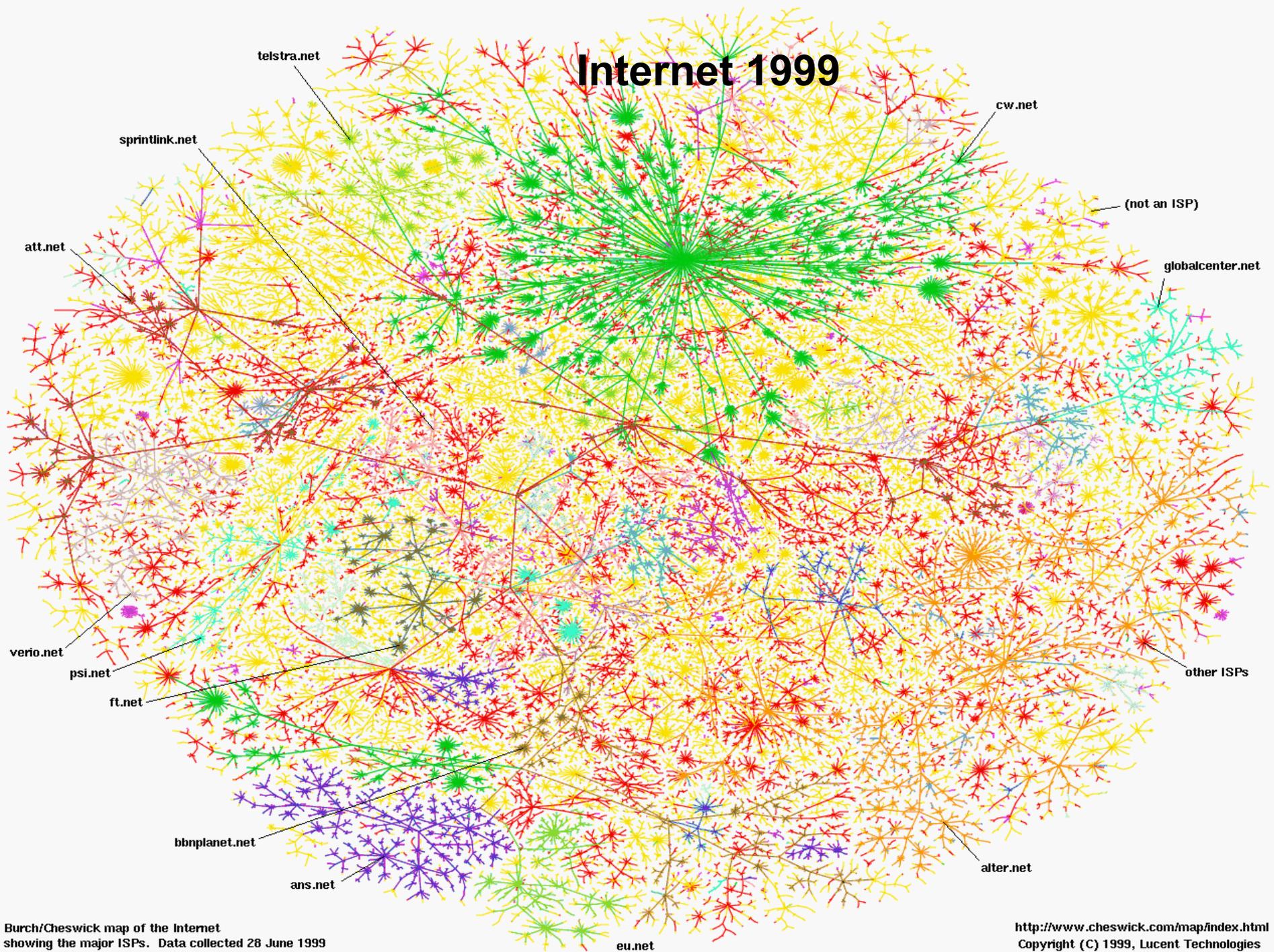


# The Original ARPANET

Dec 1969



# Internet 1999



Burch/Cheswick map of the Internet  
showing the major ISPs. Data collected 28 June 1999

<http://www.cheswick.com/map/index.html>  
Copyright (C) 1999, Lucent Technologies

**681,064,561**

(<ftp.isc.org/www/survey/reports/current/>  
Jul 2009)

**1,733 Million Users**

(InternetWorldStats.com, Sept. 30, 2009)

(approx. 4 B mobiles and 1 Billion PCs)

## Regional Internet Statistics 9/30/2009



Region	Internet Population	% penetration
Asia	738.3 Mil.	19.4 %
Europe	418.0 Mil.	52.0 %
North Am.	252.9 Mil.	74.2 %
LATAM/C	179.0 Mil.	30.5 %
Mid-East	57.4 Mil.	26.3 %
Oceania	21.0 Mil.	60.4 %
Africa	67.4 Mil.	6.8 %
TOTAL	1,734.0 Mil.	25.6 %

# Bob Kahn's Open Architecture Idea



Each distinct network would have to stand on its own and no internal changes could be required to any such network to connect it to the Internet.

Communications would be on a best effort basis. If a packet didn't make it to the final destination, it would shortly be retransmitted from the source.

Black boxes would be used to connect the networks; these would later be called gateways and routers. There would be no information retained by the gateways about the individual flows of packets passing through them, thereby keeping them simple and avoiding complicated adaptation and recovery from various failure modes.

There would be no global control at the operations level.

Global addressing

Gateway functions to allow it to forward packets including routing using, handling interfaces, breaking packets into smaller pieces if necessary, etc.

Algorithms to recover from lost packets.

Providing "pipelining" so that multiple packets could be en route

End-end checksums, reassembly of packets from fragments and detection of duplicates, if any.

Techniques for host to host flow control.

Interfacing with the various operating systems

There were also other secondary concerns, such as implementation efficiency, internetwork performance

# Important Design Concepts



No particular application drives Internet design!

Layering (design factorization)

ARPANET layering (circa 1970)

Open Systems Interconnection (circa 1978)

Internet Protocol specification does not mention routing

IP Packets don't know what they carry or how they are carried

Non-national IP address structure

Best-efforts performance target

RFCs - Request for Comment

IETF - no membership, just participants

ISOC - free “membership” and open chapters

Dial-up Internet of the 1990s - thousands of competitors

no switching costs (dial a different number)

Any host can communicate with any host (changed with enterprise deployments)

Permissionless innovation

Fewer service providers (compared to dial up)

Much less competition

No intra-modal wireline competition (but see wireless)

New definition of Universal Service? BB access to Internet?

Badly distorted term

Does NOT mean all packets treated identically

Does NOT mean cannot charge based on volume (but note bandwidth vs byte count metrics)

Does NOT mean cannot prioritize by traffic class (e.g. low latency for games, high capacity but lower priority file transfers)

Does mean cannot use control of basic highspeed transport for anti-competitive purposes (e.g. shutting out application competition)

System security at all levels

Privacy (technical, policy, transparency, user control)

Censorship

Intellectual property treatment

Bi-lateral and Multi-lateral law enforcement

Authentication, Identify, Authority

Spam, Fraud, DOS, Abuse, Misinformation, ...



# Major Changes to Internet



- IPv6 - in parallel with IPv4
- Internationalized Domain Names
- Domain Name System Security (DNSSEC)
- Digitally-Signed Address Registration (RPKI)
- Sensor Networks
- Smart Grid
- Mobile Devices
- Cloud Computing

# Internet-enabled Devices





## Woodhurst sensor net

2008-09-21 4:16:38 pm EDT

[Help on this Page](#)  
[How to Build this Page](#)

Home

Setup

Server  
Routers  
Nodes  
Software Update

System and Network

Connectivity  
Energy  
Traffic  
Reliability

Sensing and Control

Sensor/Actuator Devices  
Sensor Data Analysis  
Actuator Control  
Data Export

Support

User Guide  
Network Admin Guide  
Developer Guide

I wish this page would...

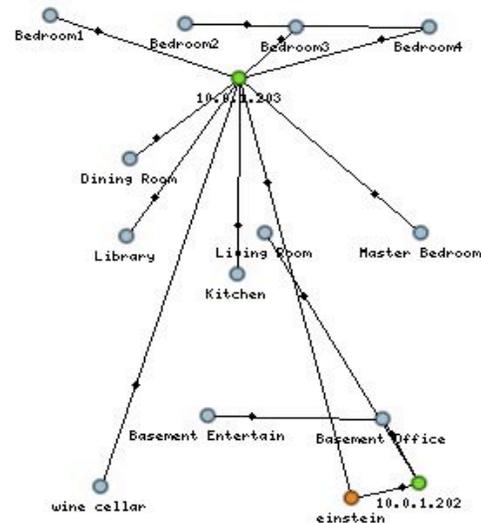

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## Home

● Server  
 ● Router  
 ● Node  
 ● Missing Router or Node

Deployment started on 2008-07-11 12:35:48 pm EDT, running for 72d 3h 40m 51s.

### Deployment Map



### Network Devices

15 Devices

● einstein

● 10.0.1.202

4:15:01 pm

● 10.0.1.203

4:15:00 pm

1st Floor

● Dining Room

4:15:05 pm

71 °F 55.3 % 10 lux 1 lux

● Kitchen

4:12:03 pm

72.9 °F 51 % 21 lux 1 lux

● Library

4:12:35 pm

73.3 °F 50.1 % 10 lux 0 lux

● Living Room

4:14:57 pm

70.4 °F 51.5 % 7 lux 0 lux

● Master Bedroom

4:15:13 pm

70.1 °F 56 % 14 lux 2 lux

2nd Floor

● Bedroom1

4:12:14 pm

74 °F 48 % 14 lux 1 lux

● Bedroom2

4:15:10 pm

74.4 °F 49 % 80 lux 17 lux

● Bedroom3

4:15:12 pm

73.5 °F 47.9 % 14 lux 1 lux

● Bedroom4

4:15:06 pm

70.7 °F 56.7 % 3 lux 0 lux

# The Data Will Come to Us!



- Sensor networks everywhere!
  - Seismic, oceanographic, atmospheric, satellite
  - Smart buildings, instrumented highways
  - Video sensors (traffic, security...)
- The Smart Grid
  - (Google) PowerMeter application
  - Hybrid and Plug-In vehicles
  - Injecting power into the Grid
  - Tracking usage for better lifestyle decisions
  - Office and building efficiencies

- Spam
- Viruses/Worms/Trojan Horses
  - Infected websites
  - Infected thumb drives
  - Infected CD-ROMs, DVDs, etc.
- DOS and DDOS attacks
- Social Engineering
- Poor passwords (re-usable especially)
- Phishing, Pharming(DNS compromise)
- IP address poaching
- Spectacular human error (configuration esp.)

- Lax user behaviors (social networking, unsafe configuration)
- Weak protection of personal data by business, government
  - Lost laptops, thumb drives
  - Weak security configuration of servers
  - Poor access controls
  - Bad business practices (sharing personal information)
- Invasive devices
  - Mobiles with cameras and sound recording capacity
  - GPS tracking
  - RFID tracking
  - Closed Circuit TV surveillance (traffic, stores, public places)

# Policy Considerations



- Broadband and wireless infrastructure
- Non-discriminatory access (“net neutrality”)
- Common Carriage style safe harbors regarding content
- Permissionless innovation, Freedom of Speech
- Support for ecommerce (e.g. digital signature frameworks)
- Intellectual property in the digital age
- Cloud computing efficiencies (note US CIO position)
- Multi-lateral ICANN Affirmations
- Continuation of IGF