

Hello everyone,

Here's the PowerPoint slides from my talk at the May, 2003, general meeting. I've printed the speaker's notes as they contain much of the "audio" that's missing from the slides.

Enjoy,

Jim Scheef

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The Rules

This is interactive

- *If I use an acronym and don't define it, you call out 'acronym break'.*
- *I'm not really an expert, but I'll tell you what I know – or think I know.*
- *Questions are OK but really good questions will be deferred.*
- *My PowerPoint skills are abysmal*


If you call out 'acronym break' on something I already defined, it means you weren't paying attention so you must do two laps of the auditorium.

There is no prize if I cannot remember the definition of an acronym.



Agenda

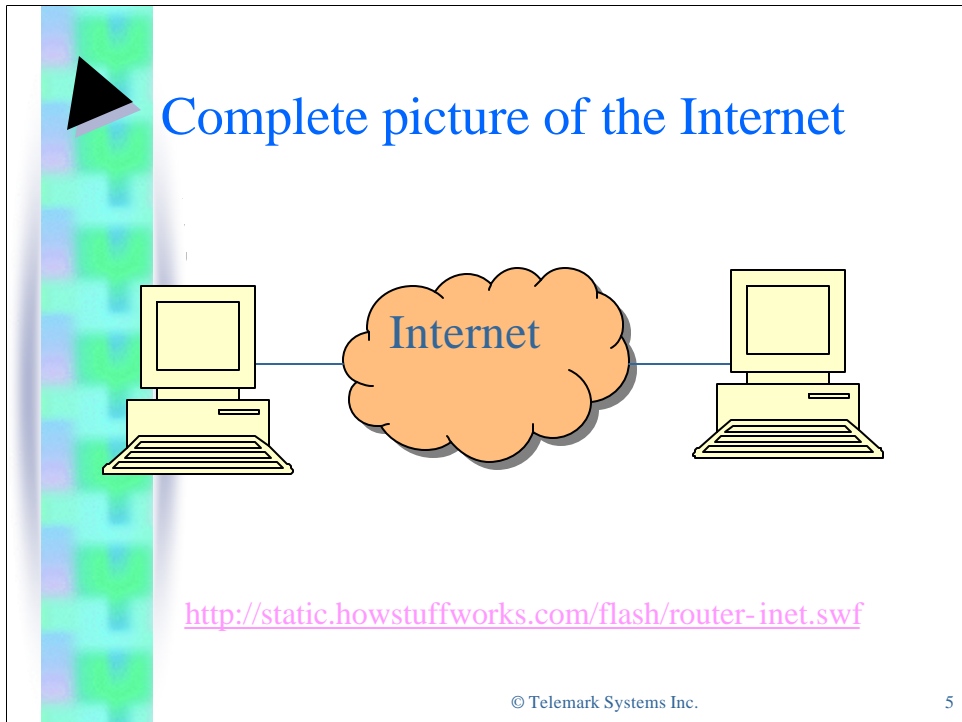
- **Where did it come from?**
- **Underlying principles**
- **Packets**
- **Protocols**
- **You**



Some acronyms we will NOT
cover tonite

AA AAA AMA DC AC AC/DC TBD
CLEC RBOC TV RADAR USA NA
WWF WWE CPU HD NBC NBA
NFL MLB

and I will miss many others...



The Internet takes different shapes depending on where, when and how you look at it.

The Internet is NOT the WWW. We will not discuss HTTP specifically.



Part 1 - A little history

Where did the Internet come from?



A little history

- **Who invented the internet?**
 - No, not Al Gore, but he did have a part in the funding to expand the ARPANet in the mid-80's.
 - The goal was to create a means to use a single terminal on computers across the country.
 - Surviving a nuclear war was not a design objective but reliability was.

Al Gore had “the vision” but the Arpanet was already in use. Gore’s contribution was more in making the Internet more widely available as it is today. The Internet first tickled a terminal in 1969. I think Al Gore was still a newspaper reporter.

The internet project was an outgrowth of the technology panic that came from the “missile gap thinking” after Sputnik.

If there is a father of the Internet, look to J.C.R. Licklider published a series of memos describing a “Galactic Network”.

Disagreement on whether it was a military project or simply an aid to research.



A little history

What made it possible?

- *The theory of packet switching*
- *Bolt Beranek & Newman*

Leonard Kleinrock at MIT published the [first paper on packet switching theory](#) in July 1961 and the [first book on the subject](#) in 1964 (*Communication Nets: Stochastic Message Flow and Delay*). Other people had the same idea.

Robert Kahn of BB&N and Vinton Cerf of Stanford advanced the concepts thru the 70's. Cerf is often credited with TCP/IP, although he did not do it alone. Arpanet switched to TCP/IP on Jan. 1st, 1983. Prior to this it use NCP (network control program).

Tim Berners-Lee, inventor of HTTP, came much later.



A little history

The technology

- *Why not use the phone system?
AT&T did not want to build what
ARPA wanted*
- *The 'switched' versus 'packet'
debate*



Part 2 - Plumbing

The underlying principles



Technically...

- The Internet is a network of networks
- It works using a stack of protocols
- The ISO model has seven layers - in theory




Theory

The ISO Reference Model

- Seven nice neat layers
- Businesses waited years to implement LANs based on this model

The Internet is NOT seven nice neat layers. Some protocols use multiple layers other times layers are skipped.



The ISO Model

- 7 - Application
- 6 - Presentation
- 5 - Session
- 4 - Transport
- 3 - Network
- 2 - Data-link
- 1 - Physical

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Start at the bottom

Physical – electrical and signal properties of the physical media – coax, UTP, air, phone lines, whatever

Data-link – transports data across the physical media – examples: Ethernet (802.3), Token Ring (802.5), Wi-Fi (802.11 a,b,g), cable modem – is concerned with physical addresses (ethernet MAC address)

Network – provides connections and routing between nodes on the network – logical addresses

Transport – varies, often provides for quality of service, reliable connections (UDP, TCP)

Session – provides for management of logical connections between nodes (establish, manage, disconnect) – similar to a telephone call where you dial an address, the phone system does some work to find that address, rings that address and establishes a session when the other phone answers, the session is disconnected when you hang up.

Presentation – provides a means for negotiation between protocol stacks (enough said on that!)

Application – uses the services of lower layers to execute or talk to an application like email (SMTP), file transfer (FTP), etc.



Some network terminology

- **Repeaters**
- **Bridges**
- **Routers**
- **Switches**
- **Gateway**
- **Hosts**
- **Nodes**

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14

Repeaters – originally used to extend the length of a network segment, now most commonly seen as a hub

Bridges – works at the data-link layer – no longer popular – slower - a store and forward device used to break a network into smaller pieces to reduce traffic congestion, more useful when LANs were slower

Routers – operate at the network layer – connect multiple networks - use the address (IP, IPX) to forward a packet from one network to another – very complicated devices with languages all their own like RIP (routing information protocol)

Switches – two definitions – older definition was a device similar to a bridge that works at the data-link (MAC address) layer but begins to forward the packet immediately – newer switches include some router-like functionality to decide which port should receive a packet, one port can be the WAN

Gateway – connects networks using different protocols such as ATM to IP – can also mean an application gateway, for example to translate email from SMTP to PROFS (professional office system??)

Host – a computing device running a network protocol – usually a host has applications that make it useful – examples: PC, server, router, gateway, etc. Called hosts because in the beginning, almost all devices were multi-user (timesharing) computers to which were connected many terminals

Node – geekier way to refer to any device on the network



Reality

**Physical depends on where you are
at the moment – dial-up phone
connection, ethernet, and wireless
are all “physical”**



Request For Comments

**Each Internet standard is defined
and detailed in an RFC**



Part 3 - Packets

How stuff gets around



Data in packets

*Data is broken into common sized
chunks, a header is added and the
packet is handed off...*



Packing

Each protocol in use at the moment gets to add it's own header.

One protocol might handle addressing, another reliability, and yet another the “meaning” of what's inside

For example, email sent by SMTP requires a connection between hosts, the packets must be addressed and something has to ensure that all the packets arrive (TCP) and request missing packets be resent



Unpacking

- Reverse the process and send an acknowledgement
- Packets may not arrive in the order they were sent
- Lost packets are resent – how do we know they were lost? TTL



It all starts with the MAC address

- **Media Access Control**
- **Every network connection has a unique MAC address**
- **MAC address for a dial-up connection is generated dynamically – Microsoft uses a GUID**

MAC – remember the data-link layer? Layer 2



The magic IP address

- A 32-bit number - 4 trillion of them
- *192.168.125.222 – dotted decimal notation*
- *Or we could use 3,232,267,742 – which is easier?*

For convenience we use dotted decimal notation. Remember number bases? Normal numbers are base-10. Binary is base-2. Programmers use hex which is base-16. Dotted decimal IP addresses are base-256. An IP address is a 4-digit base-256 number.

How many people remember number bases from math classes? How many people have kids in middle school learning about number bases?



Parts of the IP address

- The network part – in our example:
 - 192.168.125.xxx
- The host address part
 - xxx.xxx.xxx.222
- The network mask
 - 255.255.255.0 (typically)



Parts of the IP address

The Internet had classes

Class A – 128 with 16,777,214 possible hosts

Class B – 16,384 with 16,382 hosts

Class C – 2.1 million with 253 hosts

Class D – multicast

The class structure led to wasted addresses. Not even IBM had 16 million hosts!



Parts of the IP address

The Internet had classes

- 001 to 127 – Class A
- 128 to 191 – Class B
- 192 to 223 – Class C
- 224 to 247 – Class D
- 248 to 255 – reserved

The last addresses are reserved for experimentation.



Private networks

There are special network addresses reserved for private networks

10.x.x.x class A

172.16.x.x class B

192.168.x.x class C



Is this important anymore?

- *CIDR – Classless Inter-Domain Routing saved the Internet from oblivion*
- *IPv6 – the next generation*
 - Addresses 128 bits long! This is not four times as many addresses...
- *Most everyone gets a dynamic address - DHCP*

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27

For example Mags Net issues IP addresses that start with 66 yet they do not own an entire Class A address space.

CIDR – also called subnetting. Subnetting allows a network to be split into smaller pieces. The computer uses the netmask to determine the size of the network rather than the first few bits of the address.

At home I use a network address of 10.0.42.x

IPv6 has 2^{96} more addresses! Someone said this would be enough to individually address every atom on Earth.



Part 4 - Protocols

Acronym soup



Domain Name Service

- *Without it there could be no Internet*
 - DNS translates a user-friendly name like dacs.org into the IP address 66.181.192.63
- *What's a domain?*
 - *A registered name on the Internet like telemarksys.com, or scheef-family.com*

DNS translates a user-friendly name like dacs.org into a IP address

Within a DNS server, a domain takes on a different meaning.



Domain Name Service

- Domain names have a structure
- Top level domains:
com, net, org, edu, gov, mil
us and other countries
- New top level domains:
info, name, biz, others



Domain Name Service

- the InterNIC - once upon a time there was this nice group of people who guarded the Internet
- Now Network Solutions, Inc.
- RIPE - Réseaux IP Européens



Domain Name Service

- Your own domain name?
- Many registrars are now available

Once you register a domain name, the Internet routers must be told



Some Network Protocols

- **DHCP**
- **RIP**
- **OSPF**
- **UDP**
- **SMB**
- **PPP**
- **RADIUS**

Dynamic Host Configuration Protocol

Routing Information Protocol

Open Shortest Path First

User Datagram Protocol

Server Message Block

Point to Point Protocol

Remote Authentication Dial-In User Service



Some Application Protocols

- HTTP
- SMTP
- SSH



Port Numbers

Port numbers identify the application for which a packet is intended.

Some common port numbers:

- 21 – FTP
- 22 – SSH
- 25 – SMTP
- 53 – DNS
- 80 – HTTP
- 137 – NetBIOS name service
- 139 – NetBIOS session service
- 6000-63 – X Window System

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35

Port numbers are analogous to a telephone extension at a large office. The phone number gets you to the company but you need the extension number to get to Accounts Payable.

The port number is a 16-bit number so there are 65K possibilities.




Routing

- Routing is not a protocol – it uses protocols
- The Internet was not really a military application but survivability and redundancy are good things
- The self-repairing characteristic of the Internet is the best legacy of using packets



Routing

- **Remember that network number?**
once upon a time there was the IANA



Routing

- Today the backbone carriers...
- Packets take different routes

<http://static.howstuffworks.com/flash/router-inet.swf>

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The backbone carriers are the Internet as we know it. We don't know or care whether they use fiber or copper, Cisco routers or somebody else, they all connect together. The local ISP connects to (hopefully) more than one service provider. Those companies, in turn, connect to others. WorldCom (what's left) connects to AT&T connects to MCI connects to...

[Click on link to get flash.]

Successive packets can take different routes at the whim of the program running inside a router.

If the Arpanet was the original Internet, then the new ultra high-speed backbone is the reincarnation of the Arpanet in that it connects a few universities and research organizations – right where the Internet started.



Routing

- Packets may take different routes



Part 5 - You

Using the Internet and staying safe



DSL vs. cable

Remember when you bought your
first 28.8 modem?

It was so.... Fast!

How many people no longer use a modem to connect to the Internet?



Home Network Security

- Basic principle – be a *little* paranoid
- *Basic goals*
 - Keep the bad guys (and girls) out
 - Keep out advertisers and others who would spy on you
 - Let yourself in when appropriate

Some guidelines:

1. Use a hardware firewall
2. Keep ports closed unless you have a reason to open something
3. If anything is open to the Internet, keep patches up to date

If you're running Windows XP Pro, you can log into your machine remotely using the Remote Desktop – this is cool!



Some resources

- **Web sites:**
 - The Living Internet: livinginternet.com
 - The Linux Docs: tldp.org
 - Internet Encyclopedia: freesoft.org/CIE/index.htm
 - Internet Society: www.isoc.org
- **Book: *Internet Standards and Protocols*, Naik, 1998, Microsoft Press**

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Living internet is a great example of “pure” hypertext.

Tldp.org is The Linux Documentation Project web site

Freesoft.org is an Internet encyclopedia

There are others that are more official such as the ietf.org – Internet Engineering Task Force)



Questions?



Questions?

**Adjourn to the post meeting
meeting at Chilies near Exit 8**