

Network Basics

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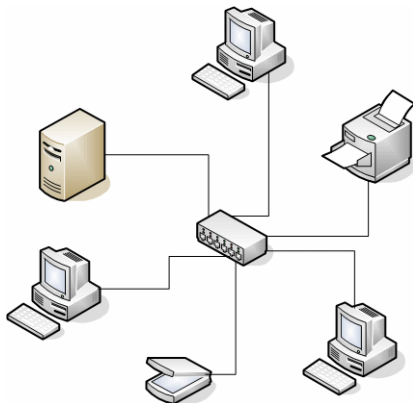
June 27, 2011

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What's A Computer Network?

- ▶ http://en.wikipedia.org/wiki/Computer_network



The History of Internet

- 1836: Telegraph
- 1858-1866: Transatlantic cable
- 1876: Telephone
- 1957: USSR launches Sputnik
- 1962-1968: Packet-switching networks developed
- 1969: Birth of Internet
- 1971: People communicate over a network
- 1977: E-mail takes off, Internet becomes a reality
- 1982: TCP/IP defines future communication
- 1987: Commercialisation of Internet Born
- 1993: The WWW Revolution truly begins
- 1996: Microsoft enters

- ▶ [RFC2235 — Hobbes' Internet Timeline\(v8.2\)](#)
- ▶ [Internet History Timeline](#)

Network Classification

- ▶ connection method: wired, wireless...
- ▶ topology
- ▶ scale
- ▶ network architecture: c/s, p2p...

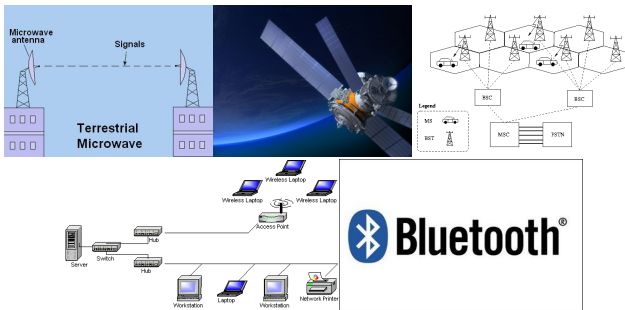
Network Classification

Connection method

Wired Technologies:



Wireless Technologies:



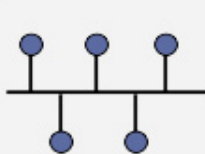
Network Classification

Scale

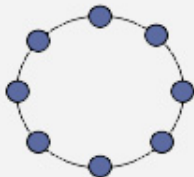
PAN, LAN, CAN, WAN, **MAN** ...

Network Classification

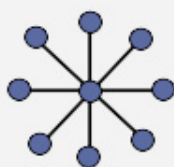
Topology



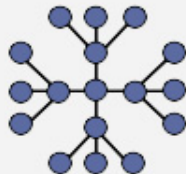
Bus



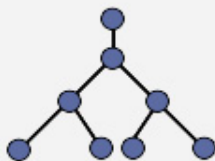
Ring



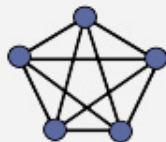
Star



Extended Star



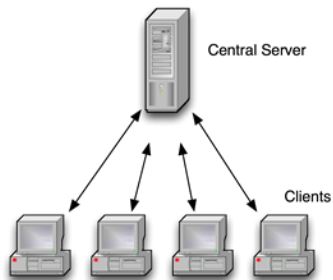
Hierarchical



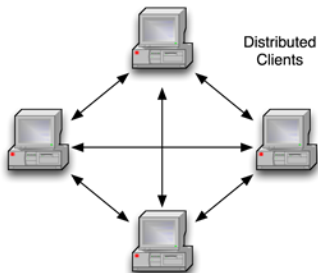
Mesh

Network Classification

Network Architecture



Client / Server



Peer to Peer

Basic Hardware Components

NIC:



Hub:



Switch:



Repeater:



Bridge:



Router:



What Computer Networks For?

- ▶ Resources sharing
- ▶ communicating
- ▶ more ...

What's The Internet?

- ▶ The network of networks.
- ▶ Tech view: TCP/IP
- ▶ App view: Google

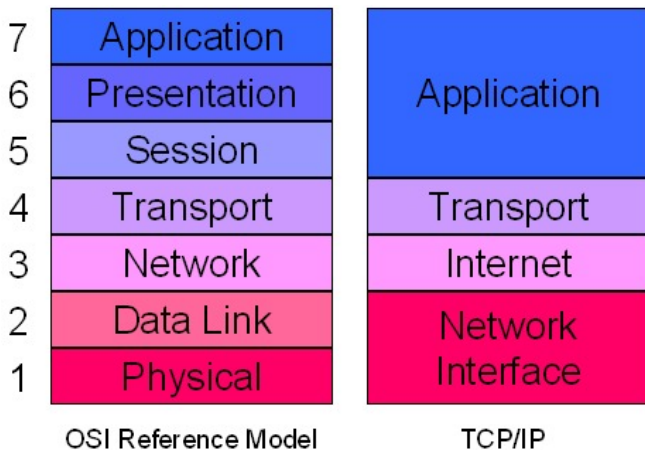
What's TCP/IP?

A set of communication protocols designed for the Internet.

what's a protocol? a rule, a treaty, an agreement ...

TCP/IP Protocol Stack

Every networked computer has it inside.



TCP/IP Overview

Basic Structure

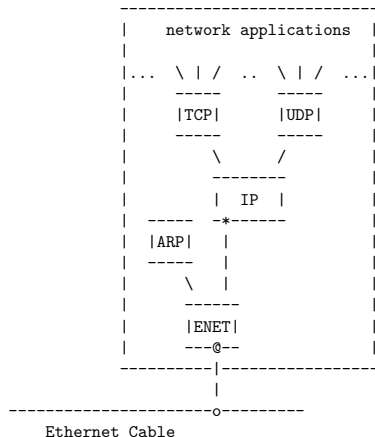


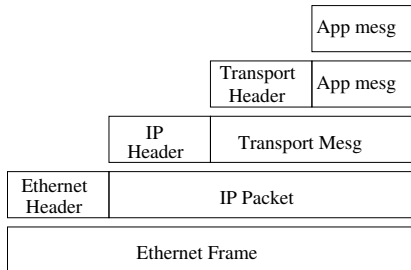
Figure: Basic TCP/IP Network Node

Questions we're going to answer:

1. Where will an incoming Ethernet frame go? ARP module or IP module?
2. Where will an incoming IP packet go? UDP module or TCP module?
3. Where will an incoming transport message (UDP datagram, TCP segment) go? TELNET or FTP or ...?

The Name Of A Unit Of Data

- ▶ Application Message
- ▶ TCP Segment , UDP Datagram
- ▶ IP packet (Fig. 5)
- ▶ Ethernet frame (Fig. 2)



Ethernet

1. Frame format?
2. Address format?
3. Broadcast address?
4. CSMA/CD? (Please explain)

Ethernet

Ethernet Version II Frame

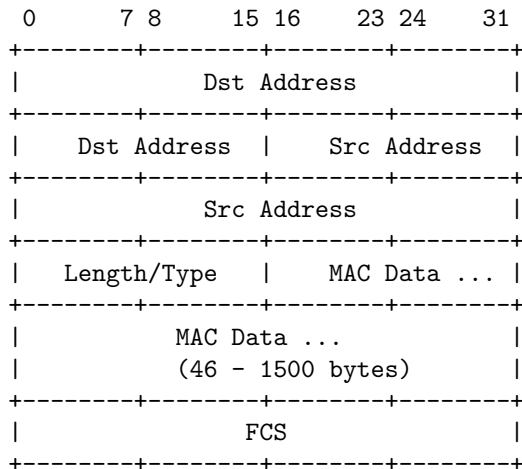


Figure: Ethernet Version II Frame Format

ARP

ARP Looking up the ARP table to find the destination MAC address.

Example ARP table

IP address	Ethernet address
223.1.2.1	08-00-39-00-2F-C3
223.1.2.3	08-00-5A-21-A7-22
223.1.2.4	08-00-10-99-AC-54

ARP

Where does the ARP table come from?

Example ARP Request

Sender IP Address	223.1.2.1
Sender Enet Address	08-00-39-00-2F-C3
Target IP Address	223.1.2.2
Target Enet Address	FF-FF-FF-FF-FF-FF

Example ARP Response

Sender IP Address	223.1.2.2
Sender Enet Address	08-00-28-00-38-A9
Target IP Address	223.1.2.1
Target Enet Address	08-00-39-00-2F-C3

ARP

Where does the ARP table come from?

The updated table

IP address	Ethernet address
223.1.2.1	08-00-39-00-2F-C3
223.1.2.2	08-00-28-00-38-A9
223.1.2.3	08-00-5A-21-A7-22
223.1.2.4	08-00-10-99-AC-54

IP

Router

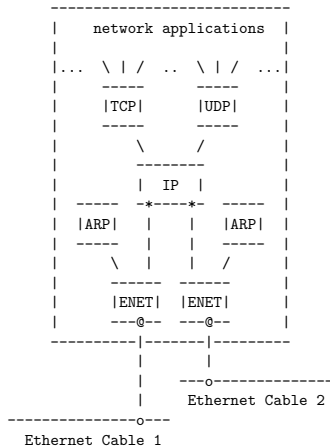


Figure: Router

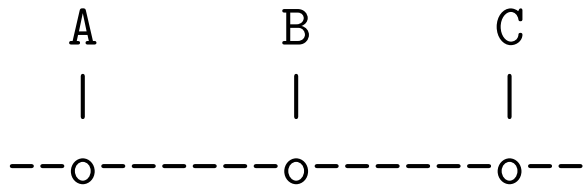
IP

Routing

Routing Find a route in the route table.

IP

Direct Routing—IP is overhead



Ethernet 1

IP network "development"

Addresses in an Ethernet frame for an IP packet from A to B

address	source	destination
IP header	A	B
Ethernet header	A	B

IP

Indirect Routing

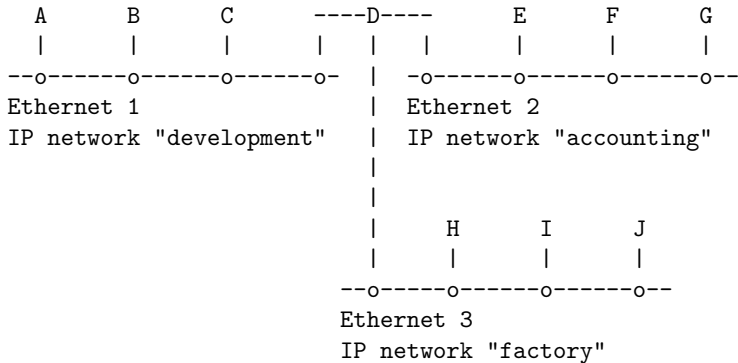


Figure: Three IP Networks; One Internet

Computer D has a TCP/IP protocol stack similar to Figure 3.

IP

Indirect Routing

Addresses in an Ethernet frame for an IP packet from A to E (before D)

address	source	destination
IP header	A	E
Ethernet header	A	D

Addresses in an Ethernet frame for an IP packet from A to E (after D)

address	source	destination
IP header	A	E
Ethernet header	D	E

IP

IP Module Routing Rules

1. For an outgoing IP packet, entering IP from an upper layer, IP must decide whether to send the IP packet directly or indirectly, and IP must choose a lower network interface. These choices are made by consulting the route table.
2. For an incoming IP packet, entering IP from a lower interface, IP must decide whether to forward the IP packet or pass it to an upper layer. If the IP packet is being forwarded, it is treated as an outgoing IP packet.
3. When an incoming IP packet arrives it is never forwarded back out through the same network interface.

Address Formats

High Order Bits	Format	Class	Decimal Address Range
0	7 bits of net, 24 bits of host	a	1 - 126
10	14 bits of net, 16 bits of host	b	128 - 191
110	21 bits of net, 8 bits of host	c	192 - 223
111	escape to extended addressing mode		

IP

Special IP Addresses

- ▶ A value of zero in the network field means this network. (source only)
- ▶ A value of zero in the host field means network address.
- ▶ 127.x.x.x are loopback address.
- ▶ 255.255.255.255 is boardcast address.
- ▶ Private address:
 - ▶ 10.x.x.x
 - ▶ 172.16.x.x~172.31.x.x
 - ▶ 192.168.x.x
- ▶ CIDR—Classless Inter-Domain Routing—An IP addressing scheme that replaces the older system based on classes A, B and C.

IP

Names

People refer to computers by names, not numbers.

/etc/hosts

127.0.0.1	localhost
202.203.132.242	cs2.swfc.edu.cn
	cs2

/etc/networks

localnet	202.203.132.192
----------	-----------------

IP

IP Route Table

Example IP Route Table

```
wx672@cisd-ftp:~$ route
```

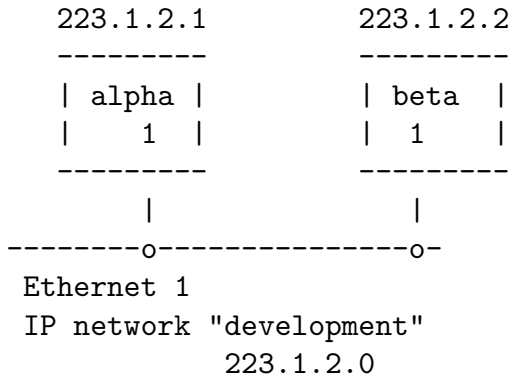
```
Kernel IP routing table
```

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
localnet	*	255.255.255.192	U	0	0	0	eth0
192.168.128.0	*	255.255.252.0	U	0	0	0	eth0
default	202.203.132.254	0.0.0.0	UG	0	0	0	eth0

'man route' for detailed meaning of each field.

IP

Direct Routing Details



The route table inside alpha (simplified)

network	flag	router	interface
development	direct		1

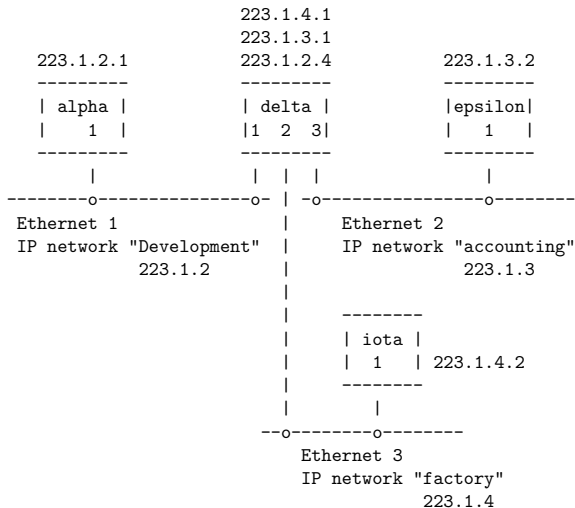
IP

Direct Scenario

Alpha is sending an IP packet to beta...Please describe.

IP

Indirect Routing Details



(For protocol stack inside delta, see Figure 3)

The route table inside alpha

network	flag	router	interface
223.1.2	direct		1
223.1.3	indirect	223.1.2.4	1
223.1.4	indirect	223.1.2.4	1

The route table inside delta

network	flag	router	interface
223.1.2	direct		1
223.1.3	direct		3
223.1.4	direct		2

IP

Indirect Scenario

Alpha is sending an IP packet to epsilon...Please describe.

IP

Managing The Routes

- ▶ Manually maintained by administrator
- ▶ ICMP can report some routing problems
- ▶ For larger networks, routing protocols are used.

IP Packet

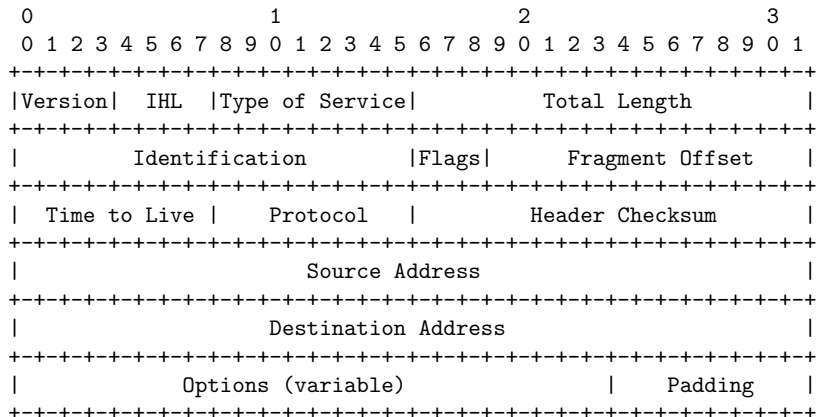


Figure: IP Packet Format

Networking Devices

Application
Presentation
Session
Transport
Network
Data Link
Physical

Routers

Bridges/Switches

Repeters/Hubs

Application
Transport
Network
Network Interface

Physical Layer Networking Devices

Repeater connects network segments at the physical layer.

Physical Layer Networking Devices

Repeater connects network segments at the physical layer.

Hub a multi-port repeater

Physical Layer Networking Devices

Repeater connects network segments at the physical layer.

Hub a multi-port repeater

- ▶ simple, cheap
- ▶ Repeaters/Hubs do NOT isolate collision domains.
- ▶ 100m maximum

Link Layer Networking Devices

Bridge connects multiple network segments at the data link layer (layer 2)

Switch a multi-port bridge

Transparent bridging

Uses a forwarding database to send frames across network segments

- ▶ Learning
- ▶ Flooding
- ▶ Forwarding
- ▶ Filtering
- ▶ Aging

Network Layer Networking Devices

Router connects two or more logical subnets at the network layer (layer 3)

Routing is to find a route in the route table.(page 22)

Bridging vs. Routing

L2	L3
MAC addr.(local)	IP addr.(global)
intranet	internet
Forwarding DB	Routing table
relearn, flooding	more efficient

- ▶ to put multiple segments into one bridged network, or
- ▶ to divide it into different networks interconnected by routers

The Logo of The Internet

What pops up in your mind if I say “Internet”?

Google Philosophy

Ten things Google has found to be true

1. Focus on the user and all else will follow.
2. It's best to do one thing really, really well.
3. Fast is better than slow.
4. Democracy on the web works.
5. You don't need to be at your desk to need an answer.
6. You can make money without doing evil.
7. There's always more information out there.
8. The need for information crosses all borders.
9. You can be serious without a suit.
10. Great just isn't good enough.

Software Principles

1. **INSTALLATION** — We believe software should not trick you into installing it.
2. **UPFRONT DISCLOSURE** — When an application is installed or enabled, it should inform you of its principal and significant functions.
3. **SIMPLE REMOVAL** — It should be easy for you to figure out how to disable or delete an application.
4. **CLEAR BEHAVIOR** — Applications that affect or change your user experience should make clear they are the reason for those changes.
5. **SNOOPING** — If an application collects or transmits your personal information such as your address, you should know.
6. **KEEPING GOOD COMPANY** — Application providers should not allow their products to be bundled with applications that do not meet these guidelines.

1. Focus on people – their lives, their work, their dreams.
2. Every millisecond counts.
3. Simplicity is powerful.
4. Engage beginners and attract experts.
5. Dare to innovate.
6. Design for the world.
7. Plan for today's and tomorrow's business.
8. Delight the eye without distracting the mind.
9. Be worthy of people's trust.
10. Add a human touch.

We do not allow pop-up ads of any kind on our site.

Google Philosophy

Security

- ▶ Google Security
- ▶ Product Safety

Google Products



a lot more...

Viruses, Worms, and Trojan Horses

A **computer virus** is a computer program that can copy itself and infect a computer without the permission or knowledge of the owner.

A **computer worm** is a self-replicating computer program. It uses a network to send copies of itself to other nodes (computers on the network) and it may do so without any user intervention. Unlike a virus, it does not need to attach itself to an existing program.

A **Trojan horse**, or *trojan* for short, is a term used to describe malware that appears, to the user, to perform a desirable function but, in fact, facilitates unauthorized access to the user's computer system. Trojan horses are not self-replicating which distinguishes them from viruses and worms.

Malware, Adware, and Spyware

Malware, short for malicious software, is software designed to infiltrate or damage a computer system without the owner's informed consent. Malware includes computer viruses, worms, trojan horses, most rootkits, spyware, dishonest adware, crimeware ...

Adware or advertising-supported software is any software package which automatically plays, displays, or downloads advertisements to a computer after the software is installed on it or while the application is being used. Some types of adware are also spyware and can be classified as privacy-invasive software.

Spyware is a type of malware that is installed on computers and that collects information about users without their knowledge.

Choose The Right Tool To Do The Right Thing



Google

vs. Bai du 百度

Safe Surfing Advice

Take care of your identity and privacy

- ▶ Avoid identity theft by using an up to date web browser and blocking bogus emails with a spam filter
- ▶ Always use strong passwords
- ▶ Don't give away too much personal information on blogs and social networking sites

Safe Surfing Advice

Protect Your PC

- ▶ Get anti-virus software, anti-spyware software and a firewall
- ▶ Keep your computer up to date
- ▶ Block spam emails
- ▶ Use an up to date web browser
- ▶ Make regular backups
- ▶ Encrypt your wireless network

Safe Surfing Advice









Avoid online rip-offs

- ▶ When you're shopping online, look for clear signs that you're buying from a reputable company
- ▶ On an online auction site, learn how it works and learn to pick good sellers
- ▶ Use safe ways to pay, such as PayPal or credit and debit cards
- ▶ Use your common sense to avoid scams – if it sounds too good to be true, it probably is

Recommended Websites

- ▶ Google
- ▶ Wikipedia
- ▶ Delicious
- ▶ MIT Open Courseware
- ▶ Librivox

References

-  RFC1180 - TCP/IP tutorial
-  RFC1122 - Requirements for Internet Hosts - Communication Layers
-  RFC 1123 - Requirements for Internet Hosts - Application and Support
-  RFC791 - Internet Protocol
-  RFC2235 - Hobbes' Internet Timeline
-  Wikipedia - Computer Network
-  Wikipedia - Computer Virus
-  Google Corporate Information