

Computer Networking

DM2112

Digital Entertainment Systems



Lecture 13

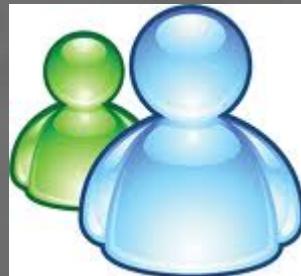
Computer Networking

THE INTERNET



The Internet

- You use it everyday



The Internet

- Can you live without it?
- Let's take a look at what makes it work
 - But first, a bit of history



Dial-up Modems

- Before the Internet, BBS (Bulletin Board Services) were commonplace
- Dial-up Modems were ‘high tech’



Dial-Up Modems

- How “Slow” are they?
 - 56kps (bits per second)
 - 1 start bit
 - 1 parity bit
 - 8 data bits
 - 5.6kBytes per second
 - ~1MB per 3 min
 - Takes ages to download anything huge



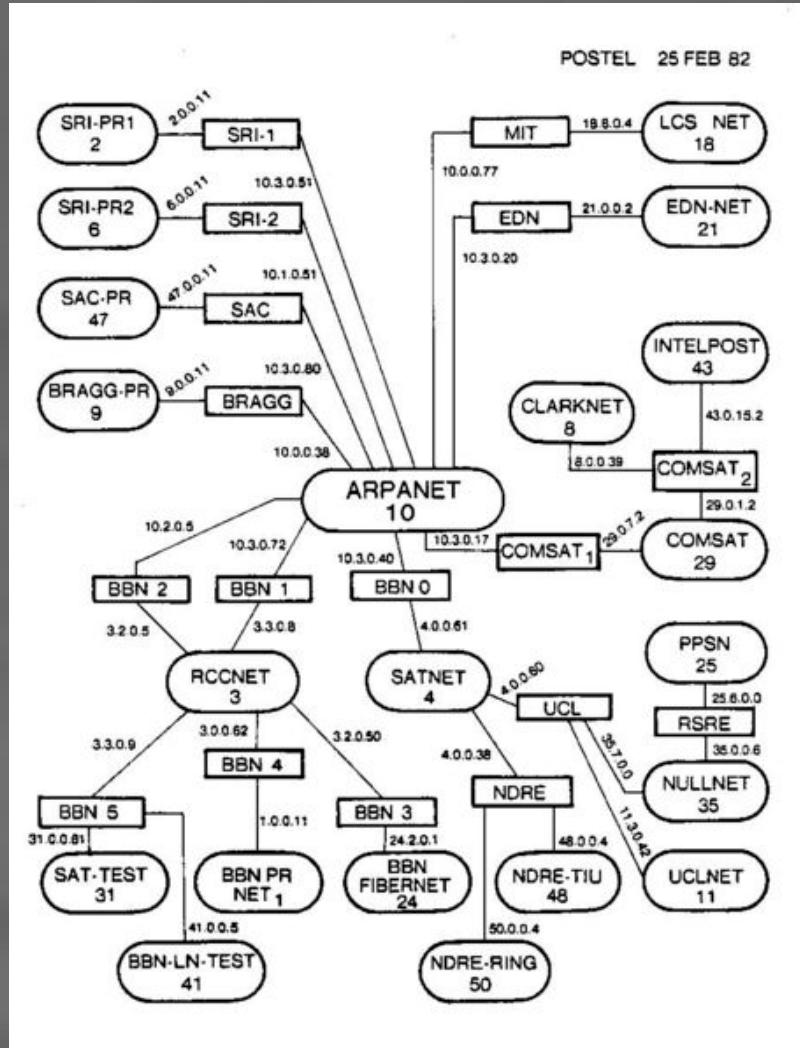
Start of the Internet

- Once Upon a Time
 - Not very long ago.
 - Mid 1968 (You are not born yet 😊)
 - Funded by Defense Advanced Research Projects Agency (DARPA) of the United States Department of Defense
 - Research project across a number of university in USA
 - Called ARPANET



ARPANET

- Utilize existing technology
 - i.e. IPX/SPX Lan infrastructure, MAC addressing
- Key advantage
 - No fixed hierarchy
- Unified under common protocol
 - TCP/IP



Early Day Internet

- The Internet evolved from linking up these pre-existing network technologies
- Examples:
 - LAN (Local Area Network)
 - Within a building / organisation
 - WAN (Wide Area Network)
 - Telephone Network (ISDN)
 - ATM Relay Network – Asynchronous Transfer Mode
 - Leased Lines (e.g. T1)



The Hardware

- The Internet is made up of a series of very different hardware that connects equipment.

- The ‘links’:

- Telephone copper wires (CAT-3)



- RJ45 Cables (CAT-5)



- Coaxial cable network



- Power-line networking



- Fibre optics



The Hardware

- ADSL vs Cable vs Fibre



More Hardware



Wireless 802.11n gateway



Wireless 802.11n gateway
(back)



Access Point (AP)



Wireless 802.11n Network
Interface Card (NIC)



Switch



Router



Wireless 802.11n USB adapter



Wireless print
server



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OSI MODEL



Open Systems Interconnection (OSI)

- Conceptual model that characterizes and standardizes communication systems into 7 layers

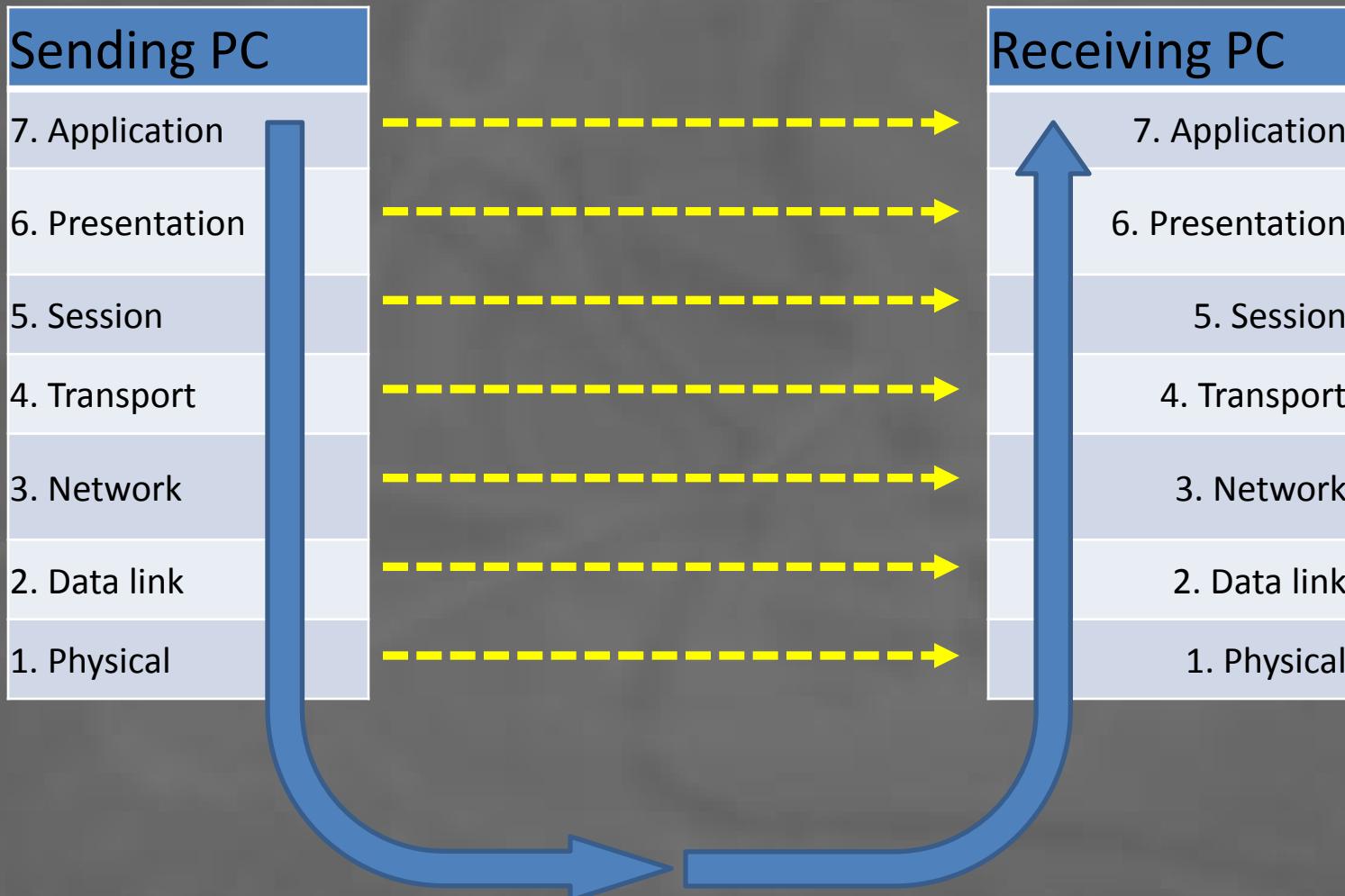


OSI 7 Layers

Layer	Function
7. Application	Network process to application. (E.g. HTTP, FTP)
6. Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data. (E.g. SSL)
5. Session	Interhost communication, managing sessions between applications. (E.g. Winsock)
4. Transport	Reliable delivery of packets between points on a network. (E.g. TCP, UDP)
3. Network	Addressing, routing and (not necessarily reliable) delivery of datagrams between points on a network. (E.g. IP, ICMP)
2. Data link	A reliable direct point-to-point data connection. (E.g. Ethernet MAC, ATM)
1. Physical	A (not necessarily reliable) direct point-to-point data connection. (E.g. RS-232, DSL, Token Ring)



OSI 7 Layers



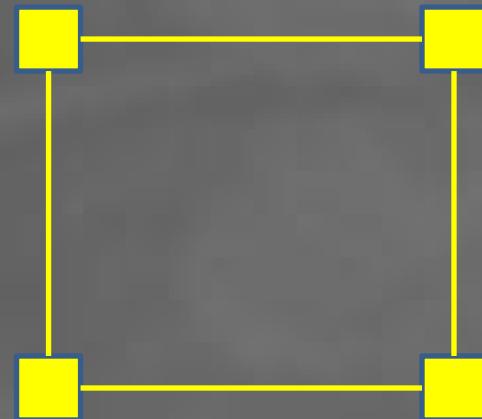
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TYPES OF NETWORKS

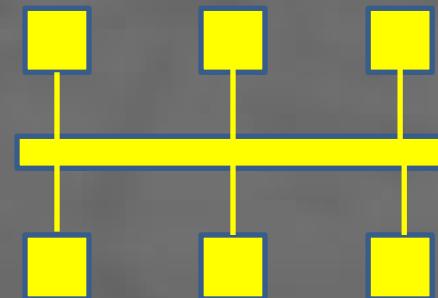


Network Topology

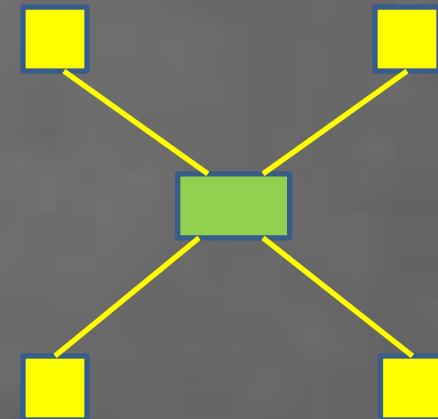
Ring (e.g.
Token ring,
FDDI)



Bus (e.g.
Ethernet
hubs)



Star (e.g.
Ethernet
switches)



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NETWORK ADDRESSING



Hardware Address (Layer 2)

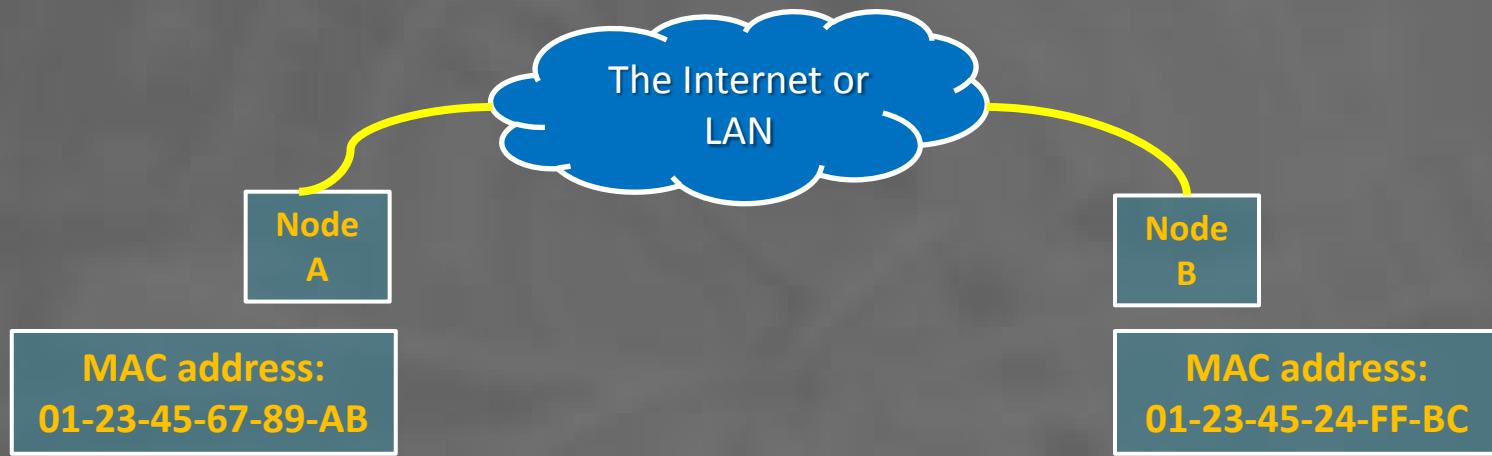
- MAC Address (Media Access Control NOT Macintosh)
- Each hardware device needs a unique address
 - It's like “Identity Card Number” for each device
 - They are all unique



MAC Address

- Media Access Control address
- 48 bit number
- Commonly hard-coded in Device's ROM
 - Read up MAC spoofing
- E.g 01-23-45-67-89-AB
 - In Hexadecimal
- Semi-unique (as long as no 2 devices on the same network share same MAC)





Concept of IP Address (Layer 3)

- **IP = Internet Protocol**
 - Sort of like a telephone number
 - xxx.xxx.xxx.xxx (8 bits . 8 bits . 8 bits . 8 bits)
 - i.e. 172.21.200.100
 - If you know other person's number, you can 'call'
 - Actual communication is a lot more complicated, of course
 - Has a 2nd component called subnet mask
 - More on this on the next slide

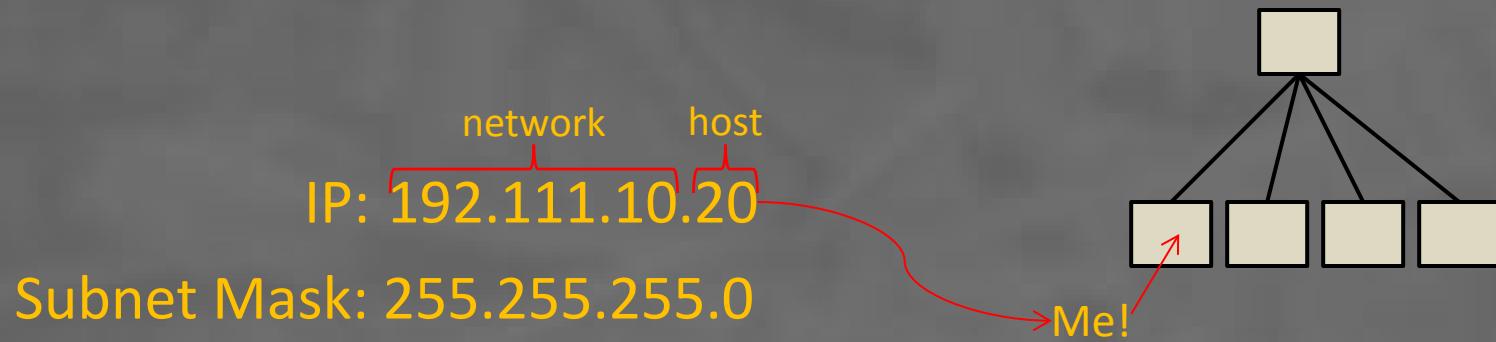


Concept of IP Address

- It's quite similar to the concept of a phone number
 - i.e. for phones : 6xxxxxxxx – landlines
 - 9xxxxxxxx or 8xxxxxxxx – mobile phones
- In a similar sense, IP addresses share this concept
 - Network portion (also called network ID) and host portion (also called host ID)

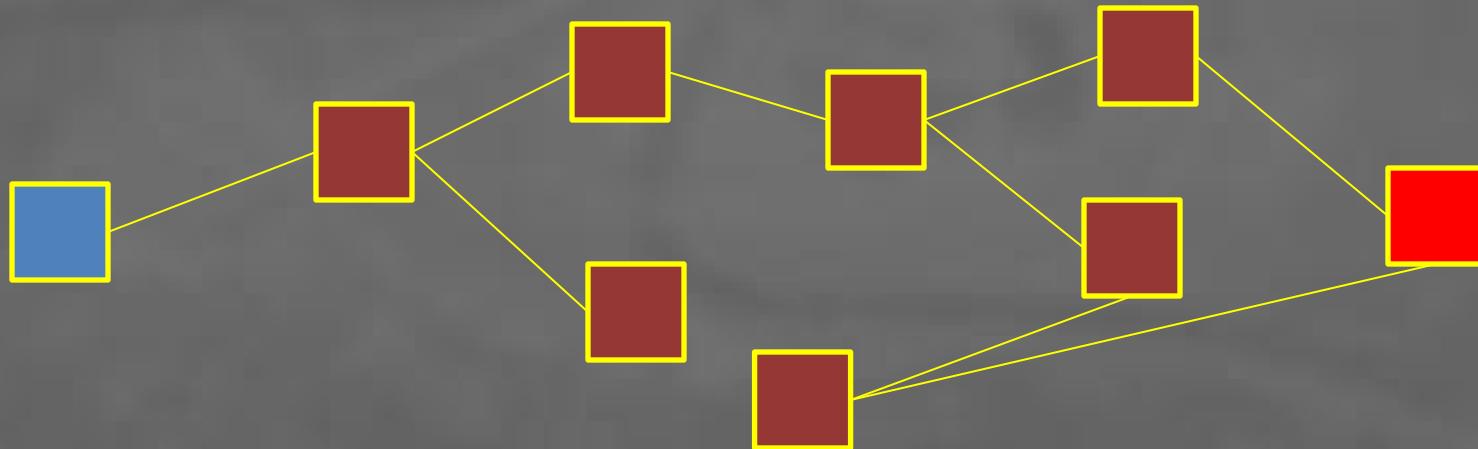


Concept of IP Address



How Does It Work?

- Important assumptions in Internet's design
 1. I know where I am
 2. I know at least 1 path to get to next destination
 3. Next destination knows 1 or more paths to another destination



Concept of Routing

- Try this with your PC
 - Launch command prompt (cmd.exe)
 - Type “netstat –r” without the quotes

A routing table

IPv4 Route Table						
Network	Destination	Netmask	Gateway	Interface	Metric	
0.0.0.0	0.0.0.0	192.168.1.1	192.168.1.3	20		
127.0.0.0	255.0.0.0	On-link	127.0.0.1	306		
127.0.0.1	255.255.255.255	On-link	127.0.0.1	306		
127.255.255.255	255.255.255.255	On-link	127.0.0.1	306		
192.168.1.0	255.255.255.0	On-link	192.168.1.3	276		
192.168.1.3	255.255.255.255	On-link	192.168.1.3	276		
192.168.1.255	255.255.255.255	On-link	192.168.1.3	276		
224.0.0.0	240.0.0.0	On-link	127.0.0.1	306		
224.0.0.0	240.0.0.0	On-link	192.168.1.3	276		
255.255.255.255	255.255.255.255	On-link	127.0.0.1	306		
255.255.255.255	255.255.255.255	On-link	192.168.1.3	276		
Persistent Routes:						
None						
IPv6 Route Table						

A gateway
address



Class-ful IP System

- The whole range of IP addresses were originally segregated into Classes

Class	Start	End	Default Subnet Mask
A	0.0.0.0	127.255.255.255	255.0.0.0
B	128.0.0.0	191.255.255.255	255.255.0.0
C	192.0.0.0	223.255.255.255	255.255.255.0
D	224.0.0.0	239.255.255.255	Not defined
E	240.0.0.0	255.255.255.255	Not defined



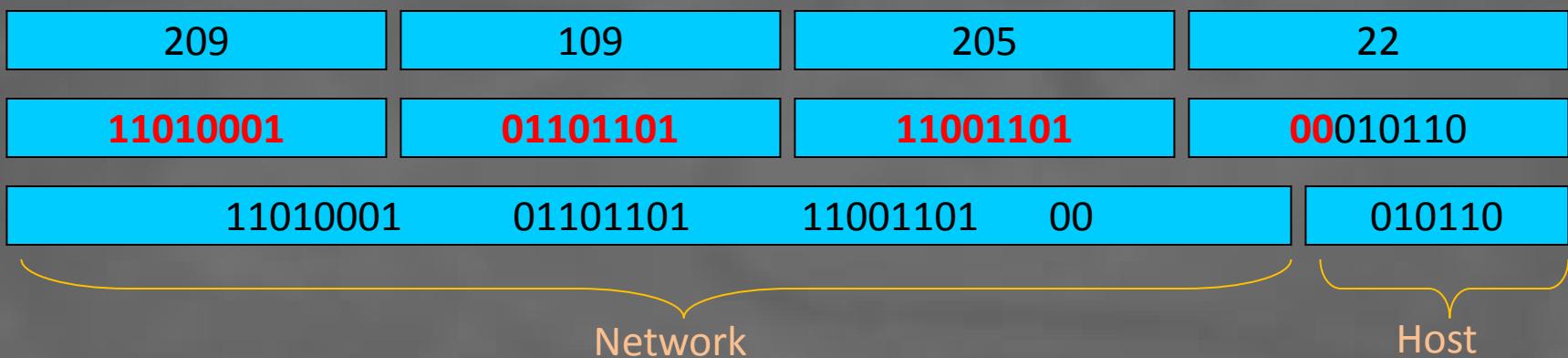
Class-ful to Class-less

- The original ‘classful’ system was wasteful
 - Not very effective for resource allocation
 - Not efficient way to distribute IP addresses
 - E.g. You need 20 IP Addresses.
 - You purchase a Class C range (254 IPs).
 - What do you do with the rest?
 - Of interest to note, a Class A range would have 16,777,216 IPs
- Today's internet work on a Class-less system
 - CIDR (Classless Inter-Domain Routing)



CIDR Notation

- IP Address : **xxx.xxx.xxx.xxx /n**
 - /n – network prefix, also called IP prefix
 - Example: **209.109.205.22/26**
 - First 26 bits – network
 - Last 6 bits - host



Subnet Masks

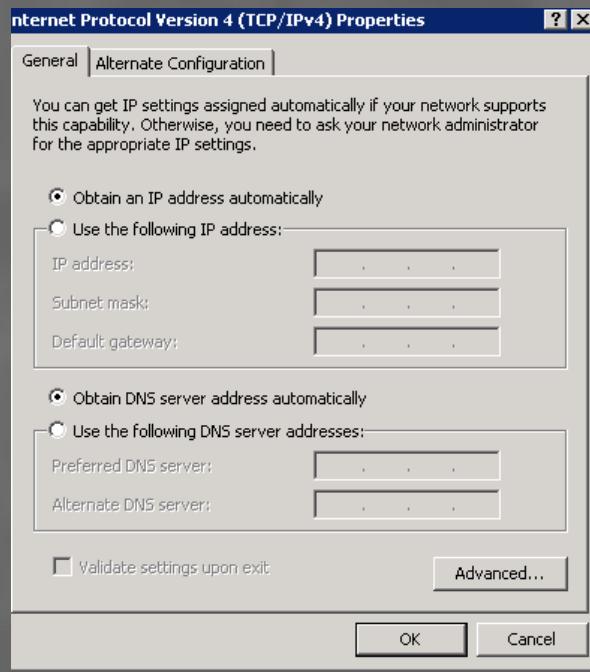
CIDR notation	Network Mask	Available Networks	Number of Hosts	Available Hosts per network	Total usable hosts
/24	255.255.255.0	1	256	254	254
/25	255.255.255.128	2	128	126	252
/26	255.255.255.192	4	64	62	248
/27	255.255.255.224	8	32	30	240
/28	255.255.255.240	16	16	14	224
/29	255.255.255.248	32	8	6	192
/30	255.255.255.252	64	4	2	128
/31	255.255.255.254	128	2	2*	256

* Point to point links only



DHCP

- **Dynamic Host Configuration Protocol is a service on the gateway that automatically assigns an IP address to a host**



How to View IP Address?

- ipconfig

```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Fritz>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:
      Media State . . . . . : Media disconnected

Ethernet adapter Wireless Network Connection 2:
      Connection-specific DNS Suffix . :
      IP Address . . . . . : 192.168.1.6
      Subnet Mask . . . . . : 255.255.255.0
      Default Gateway . . . . . : 192.168.1.1

C:\Documents and Settings\Fritz>
```

This shows that the Ethernet port on this computer isn't connected to the network.

The wireless network card has been configured with these settings.

In Windows, we can view the TCP/IP configuration by launching the command prompt (Start -> Run... -> type 'cmd') and then typing 'ipconfig'.

To view all the details about each NIC's settings, type 'ipconfig/all'.



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IPV4 & IPV6



IPv4 & IPv6

- 202.111.150.5 is an example of an IPv4 / Internet Protocol version 4 address.
- How many IP addresses can IPv4 support?
 - 32-bit number : $2^{32} = 4,294,967,296$
 - Not all are usable
 - Network Address
 - Broadcast Address
 - Private Network Addresses
 - IPv4 doesn't have enough addresses because the Internet is growing and growing
 - Thus IPv6 was created



IPv6

- **128-bit addressing system**
 - **x:x:x:x:x:x:x (x is 0000-FFFF)**
 - E.g : 2001:0db8:85a3:0000:0000:8a2e:0370:7334
 - IPv6 : 3.4×10^{38} addresses
- **IPv6 isn't fully used today.**
 - One of the reasons is that routers and switches need to be upgraded/replaced, which is expensive



WIRELESS NETWORKS



Wireless Networking

- The wireless networking standards are based on the IEEE 802.11 standards.
- The 802.11b and 802.11g standards suffer a lot from interference from other wireless devices and those that operate in the 2.4 GHz frequency band, such as microwave ovens, cordless phones, Bluetooth devices, and baby monitors.

Name of Standard	Max. Theoretical Transfer Speed (megabits per second)	Frequency Band (Gigahertz)
802.11b	11 Mbps (typically 5 Mbps)	2.4 GHz
802.11g	54 Mbps (typically 22 Mbps)	2.4 GHz
802.11n	600 Mbps (typically 144 Mbps)	5 GHz and/or 2.4 GHz



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THE INTERNET & GAMES



The Internet & Games

- Today's games usually have an online play component
- However, Internet gameplay is challenging to implement
 - Latency
 - Making a game for 10ms network vs 1000ms network
 - Security
 - Handling complex connections
 - 2 connections – easy
 - 16 connections – still ok
 - 1000? 10,000? 100,000? 1,000,000?



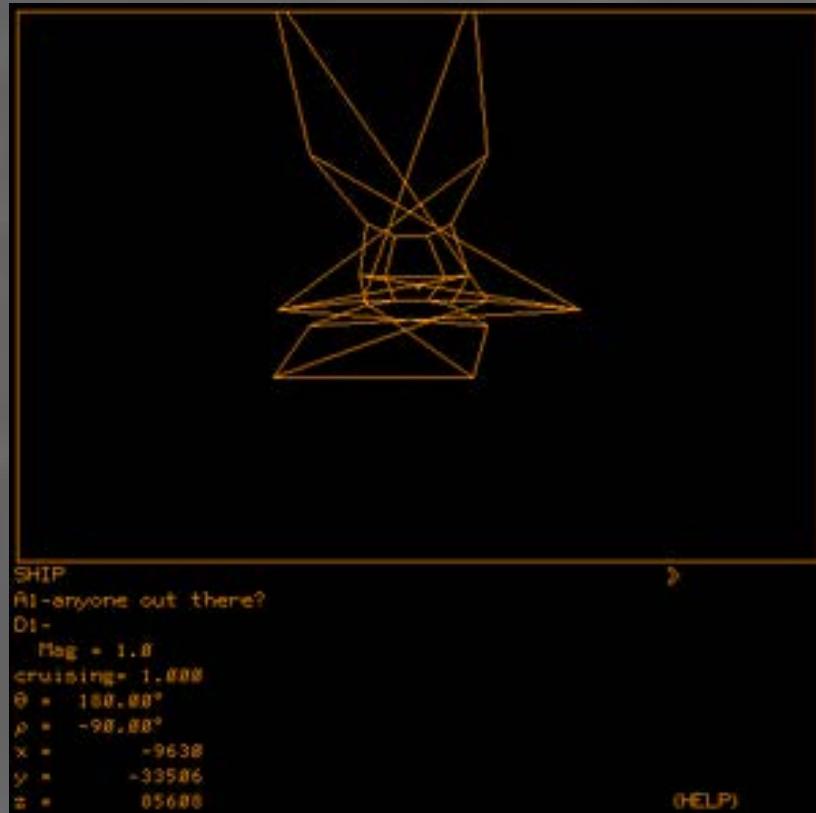
Evolution of Games

- From Text Based Games



1978 - PLATO

• Spasim



Empire



The Grandfather of MMORPG

- 1978



```
Telnet british-legends.com
*n
Path.
You are standing on a path which leads off a road to the north, to a cottage
south of you. To the west and east are separate gardens.
*w
Flower garden.
You are in a well-kept garden. There is an unexpectedly sweet smell here, and
you notice lots of flowers. To the east across a path there is more garden.
*w
Cliff.
You are standing on the edge of a cliff surrounded by forest to the north and
a river to the south. A chill wind blows up the unclimbable and unscaled
heights. At the base of the cliff you can just make out the shapes of jagged
rocks.
*w
As you approach the edge of the cliff the rock starts to crumble. Hurriedly,
you retreat as you feel the ground begin to give way under your feet!
*leap
You are splattered over a very large area, or at least most of you
is. The rest of your remains are, evn now, being eaten by the seagulls
(Especially your eyes). If you'd have looked properly before you leaped you
might have decided not to jump!
Persona updated.
Would you like to play again?
:
```



1984 - MAD

- First world-wide MUD

FILE: MAD NOTEBOOK A0 ECOLE DES MINES - CENTRE DE CALCUL

=====

DATE: 5 MAR 1986, 18:55:48 GMT
FROM: 3ALEXTRA AT FREMP11

TO: XC60021 AT PORTLAND
NAME: CHRIS BIGELOW
SUBJECT: A COPY OF M.A.D. IN PORTLAND

HIS

YOU CAN OF COURSE GET A COPY OF MAD. BUT YOU MUST KNOW THAT THERE ARE SEVERAL CONDITIONS :
THE GAME IS PROTECTED BY A COPYRIGHT, SO, YOU MUST NOT MAKE ANOTHER COPY OF THE GAME. FURTHERMORE, YOU MUST NOT SEND IT TO AN OTHER NODE.
WE'D LIKE TO KNOW ON WHICH ACCOUNT YOU ARE GOING TO RUN IT. IF YOU DON'T MIND THESE LITTLE CONDITIONS, SEND US A NOTE...
WE HOPE TO HEAR FROM YOU SOON...

VINCENT LEXTRAIT, BRUNO CHABRIER

=====

DATE: 7 MARCH 1986, 09:55:23 EST
FROM: CHRIS BIGELOW
TO: 3ALEXTRA AT FREMP11

XC60021 AT PORTLAND

TO THE CREATORS OF THE GAME:
WE ARE GOING TO TAKE A COUPLE DAYS TO LOOK OVER THE PROGRAMMING AND CONV COMMENTS TO ENGLISH. A FEW MINOR MODIFICATION NEED TO BE DONE FIRST SO IT CAN BE RUN AT THIS NODE. AFTER WE HAVE COMPLETED THAT WE WILL CONTACT WITH THE ID THAT IT WILL BE RUN ON.. UNTIL THEN IF YOU HAVE ANY QUESTION CAN BE REACHED AT THIS ACCOUNT.

CHRIS BIGELOW

=====

RECEIVED: BY MAINE (MAILER X1.23) ID 3385; THU, 20 MAR 86 20:19:28 EST
SUBJECT: BUG

TO: 3AJANODEAFREMP11 (ADVENTURE GAME)
FROM: BBAKER@MAINE (BOB BAKER)
DATE: THU, 20 MAR 1986 20:19 EST

HI,

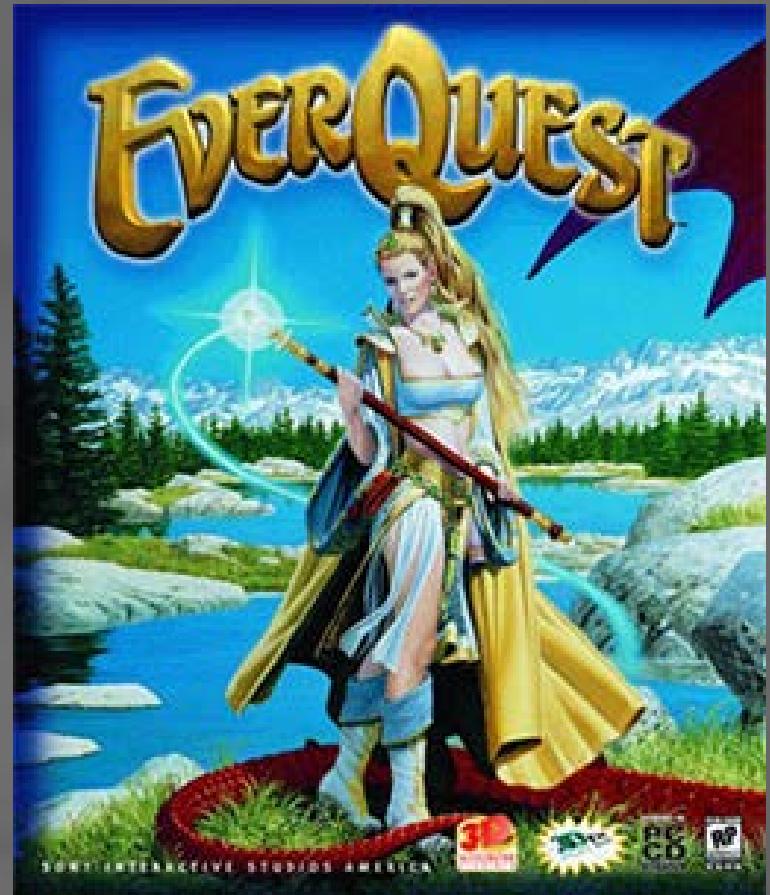
IT APPEARS THAT THE RANKING COMMAND FOR YOUR ADVENTURE GAME DOES NOT WORK. I HAVE WON AT ADVENTURE TWICE TODAY, FOUR TIMES YESTERDAY, AND NUMEROUS OTHER TIMES, YET, THE GAME ALWAYS TELLS ME THAT I AM RANKED NUMBER 8.

I ENJOY USING YOUR ADVENTURE GAME AND WOULD APPRECIATE SEEING THIS BUG FIXED SOON.

SINCERELY,
BOB BAKER



1999 - Everquest



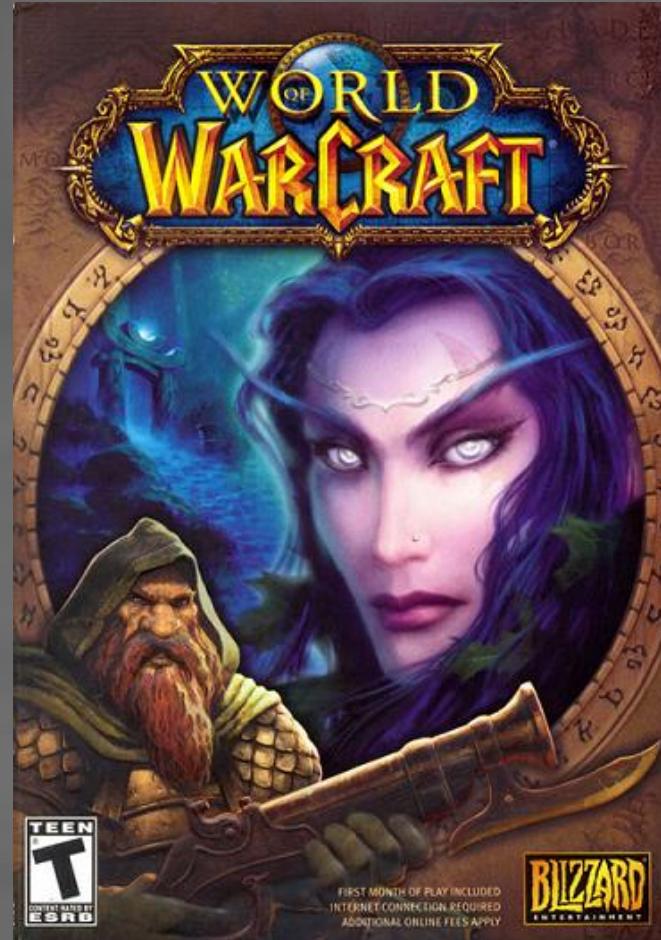
2000 – Counter Strike



2002 – Ragnarok Online



2004 – World of Warcraft



Rise of Social Games

