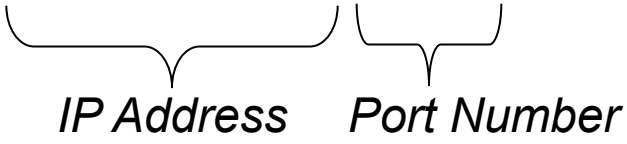
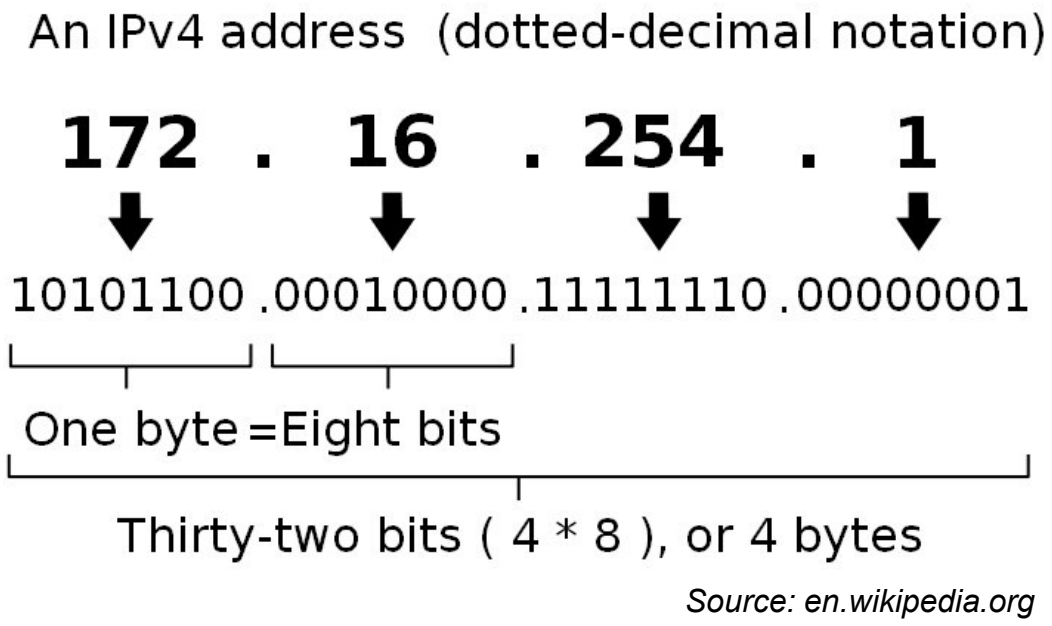
IP Addressing

- Goal: Unambiguous addressing of hosts
- Addressing (within the 4 layers) via:
  - Network Address (e.g., Ethernet Address)
  - Internet Address
  - Transport Protocol Address
  - Port Number
- Example: 192.168.1.5:8080



IP Addresses

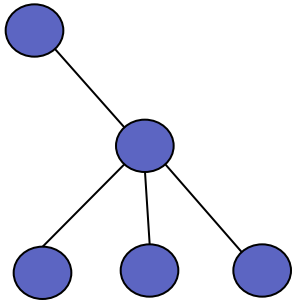
- Numerical Address associated with a network device
- Can be 32-bit number ("original TCP/IP adressing", IPv4) or 128-bit number (IPv6, RFC 1883)
  - IPv4: 2^{32} addresses = 4.294.967.296
  - IPv6: 2^{128} addresses = 3,4 * 10^{38}



Source: en.wikipedia.org

Classful Networks

- Introduced in 1981 with IP protocol
- First Byte (octet) defines network number, rest defines hosts



Class	First octet in binary	Range of first octet	Network ID	Host ID	Possible number of networks	Possible number of hosts
A	0XXXXXXX	0 - 127	a	b.c.d	$128 = 2^7$	$16,777,214 = (2^{24} - 2)$
B	10XXXXXX	128 - 191	a.b	c.d	$16,384 = 2^{14}$	$65,534 = (2^{16} - 2)$
C	110XXXXX	192 - 223	a.b.c	d	$2,097,152 = 2^{21}$	254 = (28 - 2)

Source: en.wikipedia.org

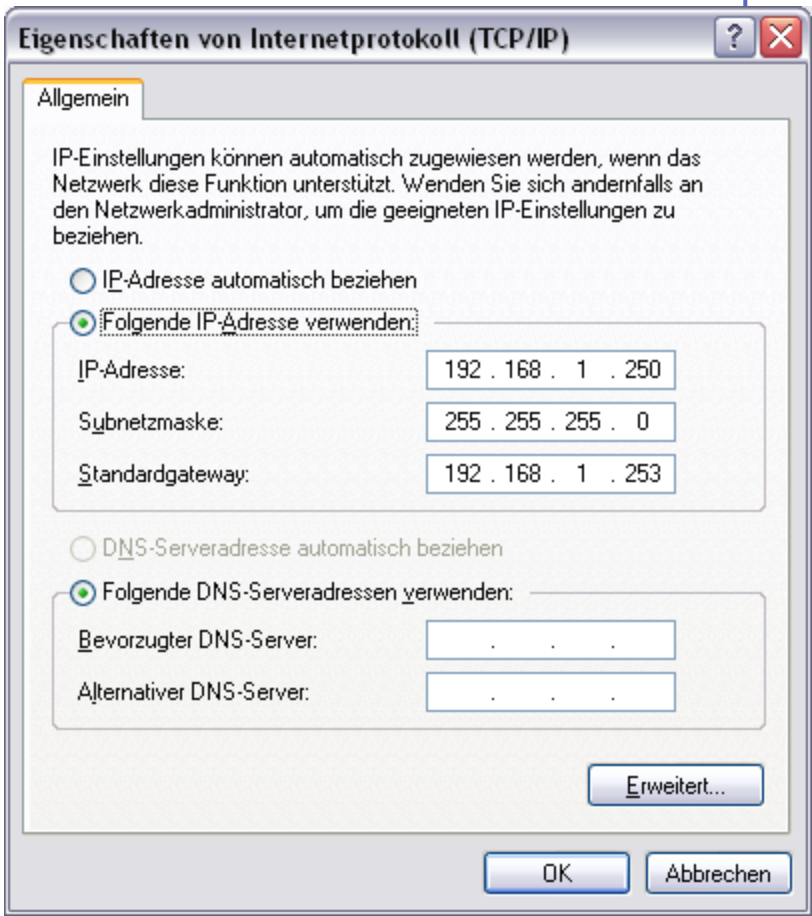
- However, classful networks turned out to be not flexible enough for the Internet

Classless Inter-Domain Routing

- Classless Inter-Domain Routing (CIDR)
- Published in 1993 by IETF (RFC 1518, RFC 1519) to cope with problems of classful networks
- Introduced variable-length subnet masking (VLSM)
  - Address is specified with the number of bits indicating network number, e.g., 192.168.1.253/16

Private Internets

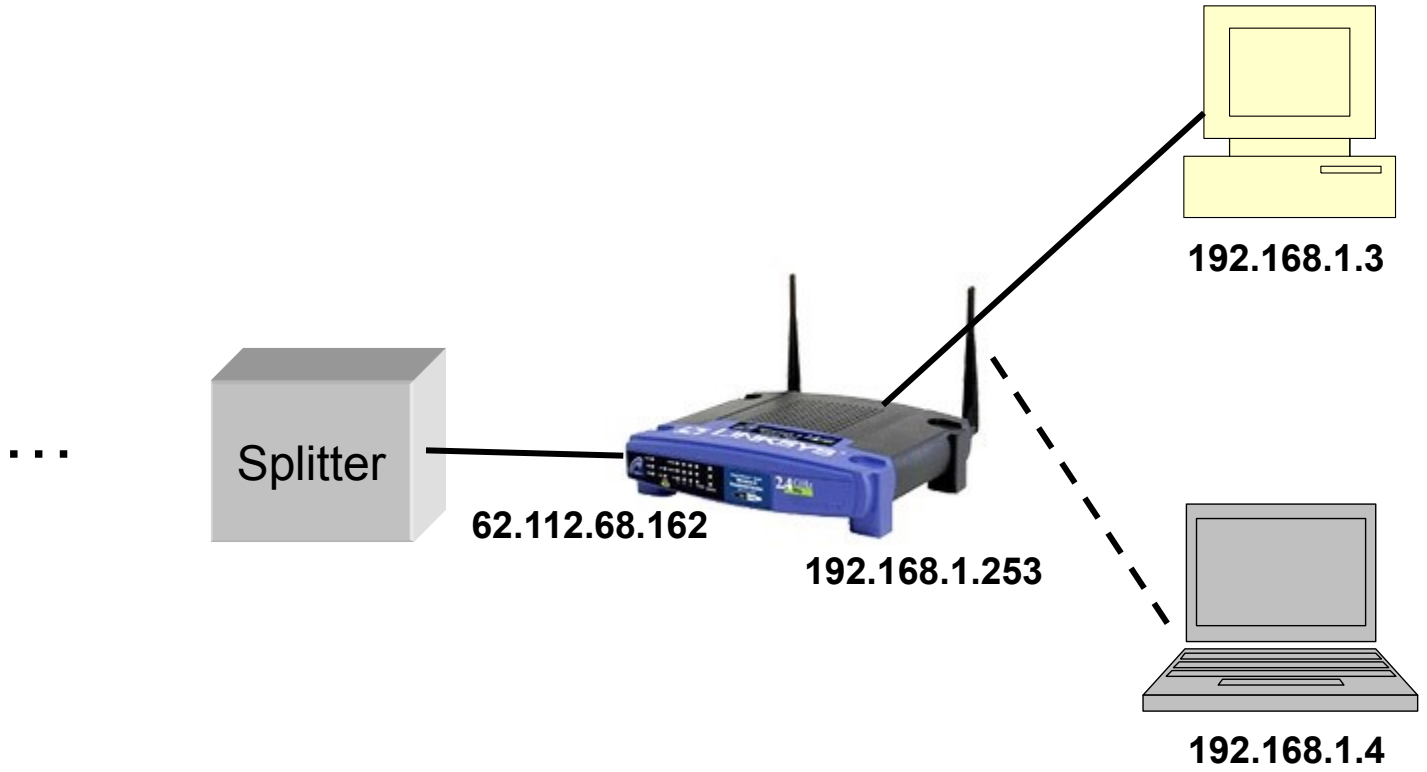
- Internet Assigned Numbers Authority (IANA) reserved three blocks for "private Internets" [RFC 1918]:
  - 10.0.0.0 - 10.255.255.255 (10/8 prefix)
  - 172.16.0.0 - 172.31.255.255 (172.16/12 prefix)
  - 192.168.0.0 - 192.168.255.255 (192.168/16 prefix)
- Hint: Have a look at your Windows TCP/IP Settings



How to get an IP Address

- Bootstrap Protocol (Bootp)
  - used by diskless devices
  - IP Adresses are statically assigned to hosts
- Dynamic Host Configuration Protocol (DHCP)
  - "dynamic bootp"
  - dynamic assignment of IP address range to hosts
  - Time-based assignment ("lease time")

IP Address Translation



What are Ports?

- Ports are conceptual “points of entry” into a host computer.
- They do not correspond with real hardware.
- Usually a service is associated with a port (e.g. http on port 80).
- Servers “listen on a port” for connection attempts.
- Ports provide one level of Internet security.
- Generally, low level ports are reserved for special services.

-> Firewall

TCP Ports

- Adressing of Applications
- Defined Port Numbers:

ftp 21/tcp File Transfer [Control]
telnet 23/tcp Telnet
smtp 25/tcp Simple Mail Transfer
smtp 24/tcp any private mail system
time 37/tcp Time
time 37/udp Time
rap 38/tcp Route Access Protocol
rap 38/udp Route Access Protocol
nicname 43/tcp Who Is
login 49/tcp Login Host Protocol
xns-time 52/tcp XNS Time Protocol
dns 53/tcp Domain Name Server
sql*net 66/tcp Oracle SQL*NET
bootpc 68/udp Bootstrap Protocol Client
tftp 69/udp Trivial File Transfer
gopher 70/tcp Gopher

http 80/tcp World Wide Web HTTP
pop 110/tcp Mail abholen
nntp 119/tcp Network News Transfer Protocol
imap2 143/tcp Interactive Mail Access Protocol v2
https 443/tcp https MCom
microsoft-ds 445/udp Microsoft-DS
login 513/tcp remote login a la telnet
irc 6665-6669/tcp chatting

Exercise 1.3

TCP/IP: Application Layer

- Provides set of standardised application protocols
- Can be used by Software Applications or Users
- Examples:
  - DNS (Domain Name Service)
  - FTP (File Transfer Protocol)
  - HTTP (Hypertext Transfer Protocol)
  - Telnet
  - NFS (Network File System)

DNS - Domain Name Service

- Mapping of human-readable names to IP Addresses

Example: dhbw-mannheim.de

- Sub-Level Domain
  - can contain sub-domains such as staff.dhbw-mannheim.de
- Top-Level Domains, e.g.,
  - de - Germany
  - com - (US-) Companies
  - edu - education
  - org - Organisations
  - biz - businesses
  - tv - TV-related offers

Responsible: national authorities, e.g.,
Deutsches Network Information Center (DENIC)

Domain Names

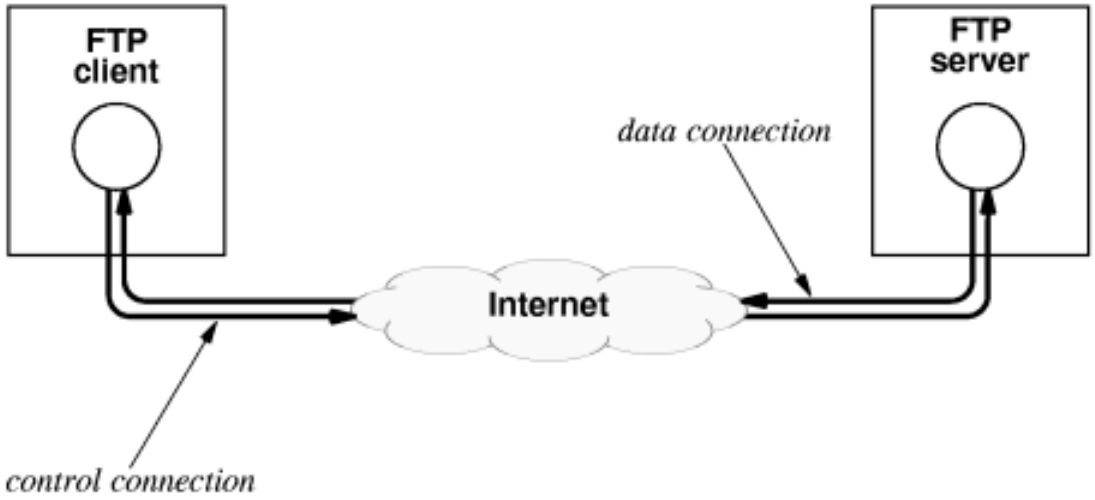
- Usually between 2 and 63 characters long (excluding the suffix such as .com)
- Alphanumeric characters and the hyphen (e.g., 0 to 9, a to z and the hyphen (-)). Some domains can have less than 3 characters, or may not allow as many as 63, but as a general rule these are typical
- A space cannot be used in a domain name, and should not begin or end with a hyphen (-)
- Recommendation: that the domain name be kept short for ease of use and to make it easier to remember

Internet Services: FTP

- File Transfer (FTP)
  - File Transfer Protocol--protocol for transferring files between computers
  - FTP is interactive; it responds to user commands
  - Example FTP commands:
    - Open: connect to a remote computer
    - Get: retrieve a file from the remote computer
    - Put: sends a file to the remote computer
  - Transfer types: text (character encoding considered) and binary data (1:1 copy)
  - Transfer modes: active and passive
    - active: Server handles data flow (and parts of the connection); passive: Client handles everything

FTP uses the client-server paradigm:

- Local application (or browser) is the client
- Remote FTP program is the server;
- The FTP server authorizes the connection, locates the file, and uses TCP to send it.



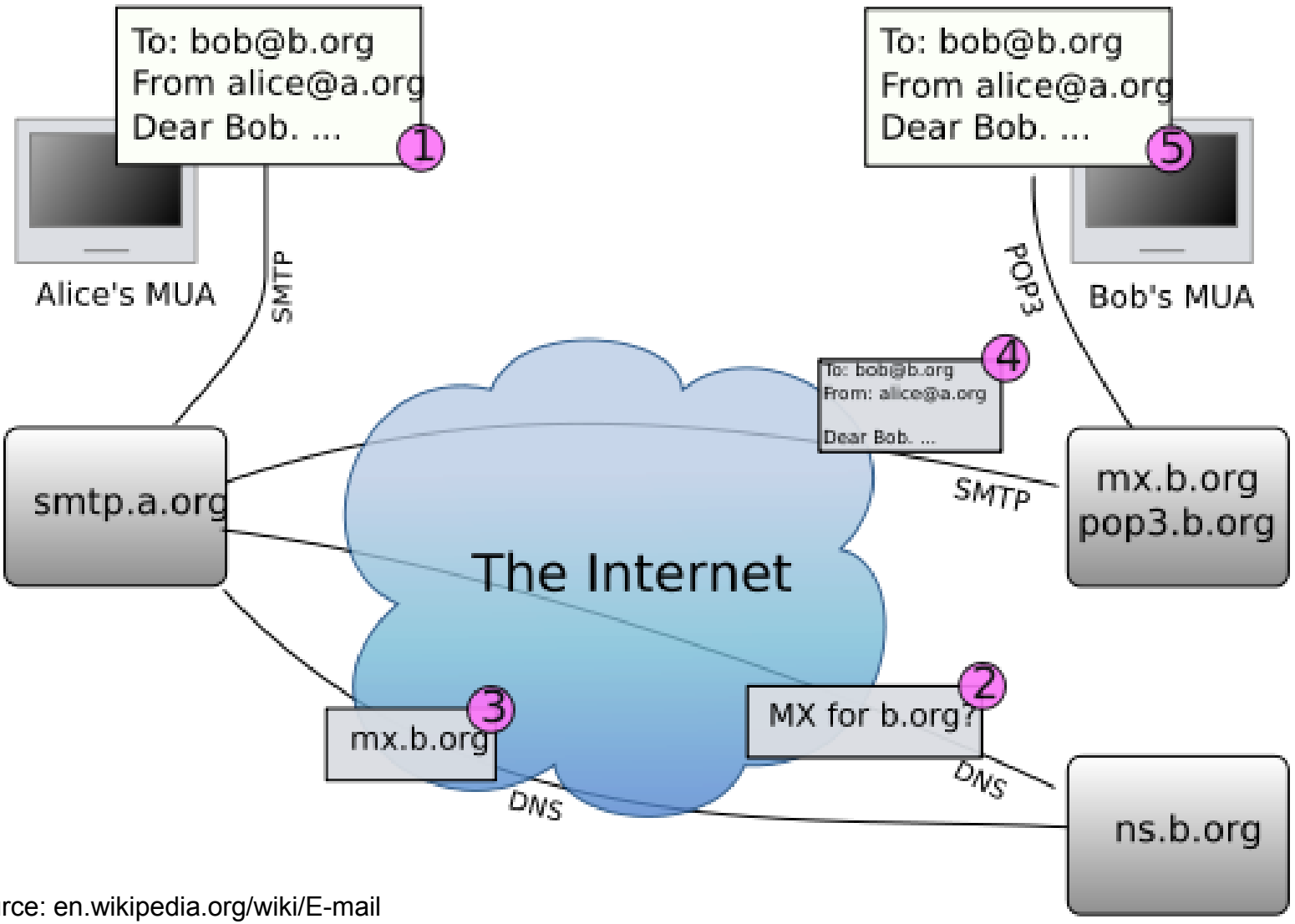
How to use FTP

- User may have an account or not ("anonymous ftp")
- Command line
  - e.g., on the command line enter "ftp" and issue ftp commands
- Browser
  - e.g., enter ftp://ftp.microsoft.com to a Browser's address bar
- FTP client
  - e.g., WS FTP (http://www.wsftp.com/products/ws_ftp_home)

Internet Services: E-Mail

- E-Mail: Exchange of electronic messages
- E-Mail Client Software ("mail user agent", MUA) (e.g., Outlook, Thunderbird) used
- MUA uses SMTP (simple mail transfer protocol) to send e-mails using a "mail transfer agent" (e-mail server)
- Another MUA uses POP (Post Office Protocol) or IMAP (Internet Message Access Protocol) to download e-mails

E-Mail



Source: en.wikipedia.org/wiki/E-mail