



TCP/IP Services

“The value of networking is in the services it provides”

CIS 68C2

UNIX Network Administration

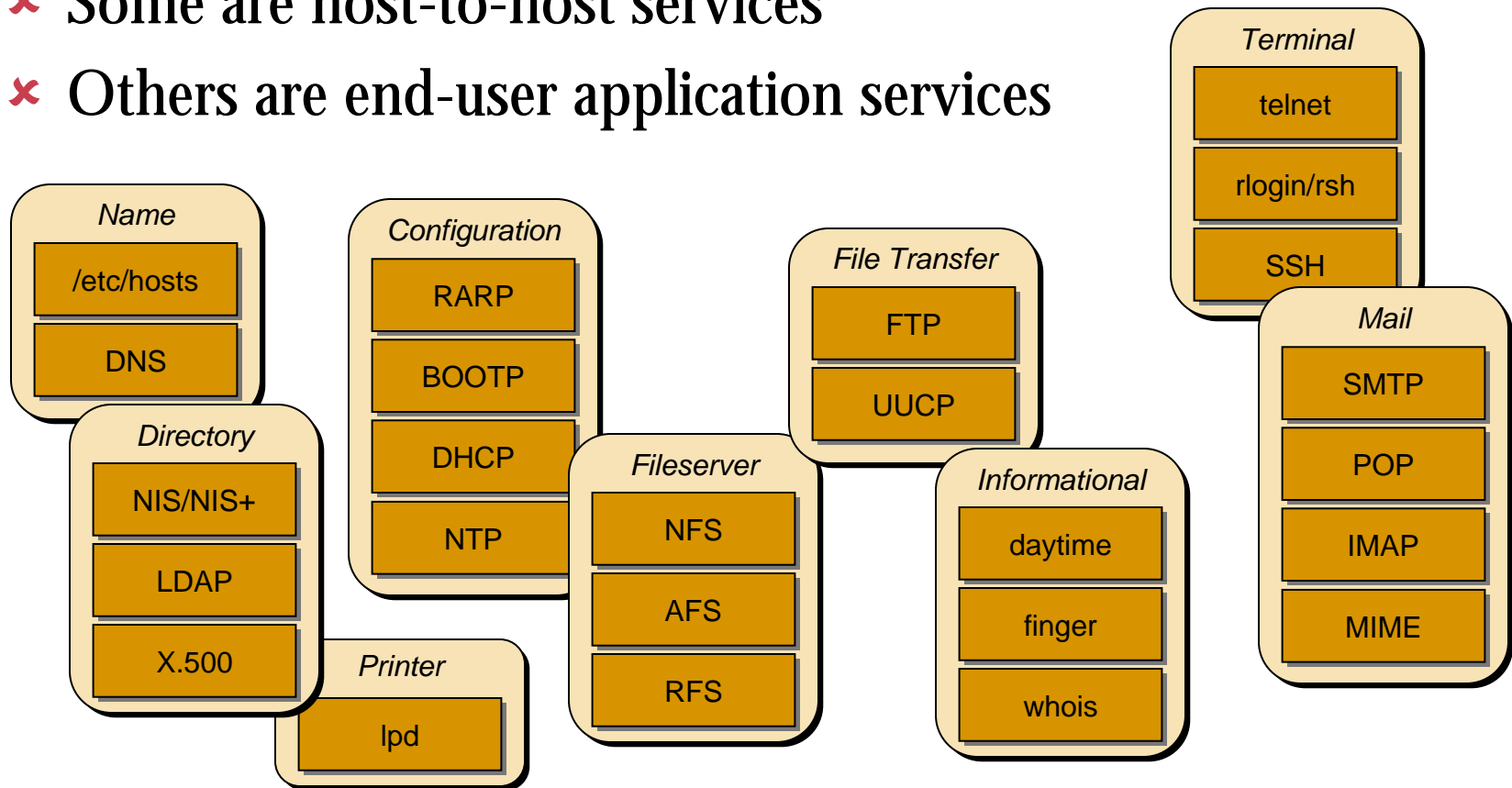
TCP/IP Services

□ Services and Applications

- ✗ The value of networking is in the services it provides
- ✗ TCP/IP provides a wealth of services and applications
- ✗ Systems can be *both* client and server
 - ✗ Contrast with traditional PC LAN servers that serve only
 - ✗ Any system may run any server application
 - ✗ Network does not have to depend on any one particular server
 - ✗ Multiple systems can provide services
 - ✗ Systems are co-equal

TCP/IP Services

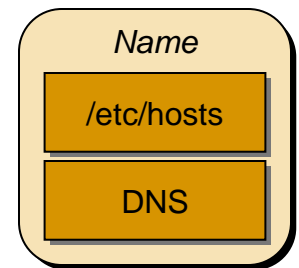
- TCP/IP provides a plethora of services!
 - ✗ Some are host-to-host services
 - ✗ Others are end-user application services



Name Services

□ Name Services

- ✗ TCP/IP networking uses IP addresses, not hostnames
 - ✗ Source / destination IP addresses in the IP datagram header
- ✗ Two translation mechanisms exist today
 - ✗ The **hosts** table /etc/hosts
 - ✗ NIS provides network distribution of /etc/hosts
 - ✗ DNS – Domain Name Service
- ✗ Name service(s) selected via /etc/nsswitch.conf
 - ✗ Applications use standard library routines to access
 - ✗ gethostbyname(), gethostbyaddr(), etc.



Name Services - /etc/hosts

- The hosts table /etc/hosts
 - ✗ Required during boot, before NIS or DNS is unavailable
 - ✗ Simple ASCII table
 - ✗ Each line associates an IP address with one or more hostnames
 - ✗ Format
 - ✗ *ipaddr hostname [alias ...]*
 - ✗ Whitespace separated
 - ✗ # used for comments
 - ✗ Aliases allow for shorter or generic names
 - ✗ Generic names
 - ✗ Eg. lprhost, loghost, mailhost, dumphost

Name Services - /etc/hosts

- The hosts table /etc/hosts
 - ✗ Generally superseded by DNS (due to its limitations)
 - ✗ Inefficient for Internet – table becomes huge
 - ✗ No automatic distribution of new entries
 - ✗ NIS helps, but only locally, and updates are not frequent
 - ✗ Still widely used...
 - ✗ internally for small or isolated sites
 - ✗ as main NIS database
 - ✗ during early boot
 - ✗ Must always contain the loopback / localhost entry

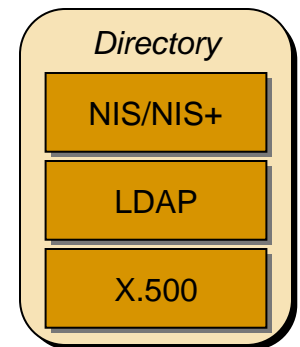
```
# Do not remove the following line, or various programs
# that require network functionality will fail.
127.0.0.1          localhost
```

Name Services – DNS

- Domain Name Service - DNS
 - ✗ Hierarchical resolution of hostnames and IP addresses
 - ✗ Overcomes the two shortcomings of the hosts table
 - ✗ Scales very well globally
 - ✗ Guarantees automatic, global distribution of data
 - ✗ Port 53
 - ✗ Obsoletes older port 42 service called *nameserver* or *name*
 - ✗ *More on DNS in future lectures!*

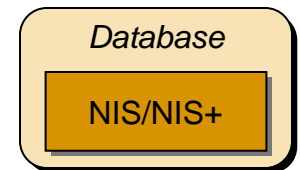
Directory Services

- Network distributed database
 - ✗ NIS/NIS+ - Network Information Systems
 - ✗ LDAP – Lightweight Directory Access Protocol
 - ✗ RFC: 1777 standards track
 - ✗ X.500
 - ✗ Directory servers that ran on OSI servers
 - ✗ Not widely used



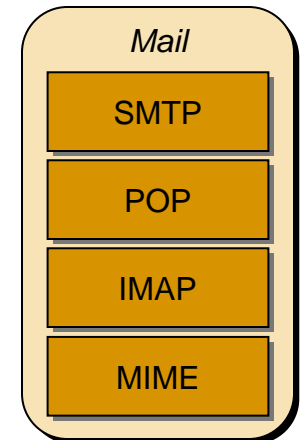
Directory Services – NIS

- Network Information Service – NIS/NIS+
 - ✗ Simple network lookup of data stored in standard UNIX administrative files
 - ✗ Eg. /etc/hosts, /etc/group, /etc/passwd, ...
 - ✗ LAN-only
 - ✗ Does not replace DNS (can be used together)
 - ✗ Port 111
 - ✗ RPC program numbers: 100004, 100007, 100009, 100028, 100300, 100303
 - ✗ NIS+ is an entire redesign, re-write of NIS
 - ✗ Servers only available on Solaris and HP-UX



Mail Services & Protocols

- Defines the protocols used by various email Agents
 - ✗ User, Transport, Submission, Delivery and Access
- SMTP – Simple Mail Transfer Protocol
 - ✗ Also ESMTP – Extended SMTP
- POP – Post Office Protocol
- IMAP – Interactive Mail Access Protocol
- MIME – Multipurpose Internet Mail Extensions



Mail Services & Protocols – SMTP

- SMTP - Simple Mail Transfer Protocol
 - ✗ A mail delivery protocol
 - ✗ Implemented in the widely used **sendmail**
 - ✗ Uses simple ASCII commands
 - ✗ Defines mail headers
 - ✗ ESMTP extends SMTP
 - ✗ Provides end-to-end delivery
 - ✗ Contrast with store and forward
 - ✗ Offline hosts cause connection errors
 - ✗ Solution: DNS helps route messages to a mail server
 - ✗ Hosts pick up email when online using POP or IMAP
 - ✗ Port 25 (and 587 for mail submission)

Mail Services & Protocols– POP

- POP - Post Office Protocol
 - ✗ Moves messages from server to host
 - ✗ All messages are typically downloaded at once
 - ✗ Two versions of POP
 - ✗ POP2
 - ✗ POP3
 - ✗ The more common version
 - ✗ Incompatible with each other
 - ✗ Both use simple ASCII commands
 - ✗ Neither is very secure
 - ✗ Ports 109 (pop2) and 110 (pop3)

Mail Services & Protocols– IMAP

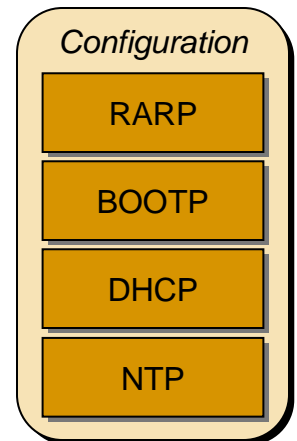
- IMAP - Interactive Mail Access Protocol
 - ✗ Moves messages from server to host
 - ✗ One message at a time
 - ✗ Allows download of mail headers first
 - ✗ Manages multiple folders on multiple sites
 - ✗ Mail can be retained on servers
 - ✗ Has had security problems

Mail Services & Protocols – MIME

- MIME - Multipurpose Internet Mail Extensions
 - ✗ Defines complex message bodies
 - ✗ Extends original TCP/IP mail system
 - ✗ Original specification ...
 - ✗ Only supported 7-bit data
 - ✗ Unsuitable for binary data or multi-byte character sets
 - ✗ Did not support complex message bodies
 - ✗ Focused on the mail headers
 - ✗ Specifies new headers to indicate the content of the body

Configuration Services

- Protocols to obtain TCP/IP configuration data
 - ✗ RARP - Reverse Address Resolution Protocol
 - ✗ BOOTP - Bootstrap Protocol
 - ✗ DHCP - Dynamic Host Configuration Protocol
- Protocols to synchronize system clocks
 - ✗ NTP – Network Time Protocol
 - ✗ XNTP – Updated NTP



Configuration Services – RARP

- RARP - Reverse Address Resolution Protocol
 - ✗ Converts physical address into IP address
 - ✗ Limited – only provides IP addresses
 - ✗ A request for an IP address is broadcasted
 - ✗ Server responds with IP address
 - ✗ Configuration file: /etc/ethers
 - ✗ Maps Ethernet addresses to hostnames
 - ✗ Server then resolves hostname to an IP address
 - ✗ Port: None
 - ✗ Implemented at the data-link level

Configuration Services – BOOTP

- BOOTP - Bootstrap Protocol
 - ✗ Provides essential TCP/IP configuration information
 - ✗ RARP not needed when BOOTP used
 - ✗ Client broadcasts request for information
 - ✗ BOOTREQUEST packet
 - ✗ Server responds with information
 - ✗ BOOTREPLY packet
 - ✗ Uses *limited broadcast address* of 255.255.255.255
 - ✗ Ports: 67 (server) and 68 (client)

Configuration Services – DHCP

- DHCP - Dynamic Host Configuration Protocol
 - ✗ Provides all TCP/IP configuration information
 - ✗ Same capabilities as BOOTP, plus
 - ✗ Automatic and dynamic IP allocation
 - ✗ Returns all necessary TCP/IP configuration information
 - ✗ Compatible with BOOTP
 - ✗ Interaction problems possible in mixed environments
 - ✗ Ports: 67 (server) and 68 (client)

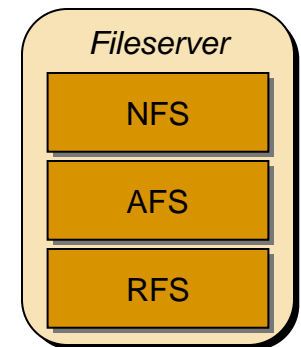
Configuration Services – NTP

- NTP – Network Time Protocol
 - ✗ Synchronizes a set of network clocks
 - ✗ With each other, within milliseconds
 - ✗ With atomic clocks
 - ✗ Essential for
 - ✗ Log files
 - ✗ End-user applications
 - ✗ RFC 1305
 - ✗ Port: 123

File Services

□ File Sharing Services

- ✗ Transparent access to files over network
- ✗ NFS – Network File System
 - ✗ Sun Microsystems
- ✗ RFS – Remote File System
 - ✗ AT&T – antiquated and rarely used
- ✗ AFS – Andrew File System
 - ✗ Carnegie Mellon University – not widely used

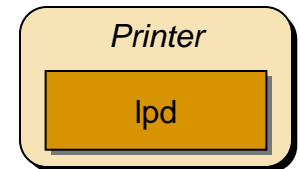


File Services – NFS

- NFS – Network File System
 - ✗ Available under all UNIXes, Linux and most other systems
 - ✗ Two versions in use today
 - ✗ Version 2
 - ✗ Version 3
 - ✗ Increased performance, better support for large files
 - ✗ Uses a number of different components
 - ✗ Port: RPC 111
 - ✗ RPC program numbers: 100003, 100005, etc.

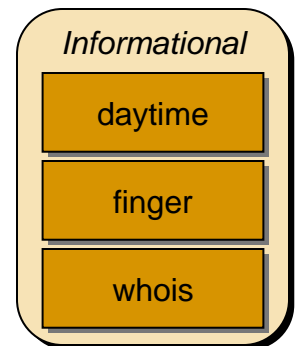
Print Services

- Originally there were no print services defined
 - ✗ Printers were not networked printers
 - ✗ Today, Ethernet printers are common
- lpd – line printer daemon
 - ✗ Berkeley define printer daemon
 - ✗ Commonly implemented today in laser printers
 - ✗ Ports: 515, and 721 - 731
 - ✗ RCF 1179 (informational)



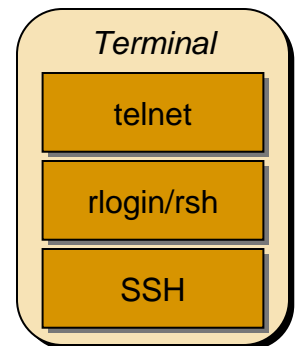
Informational Services

- Some services that provide user-readable information
 - ✗ daytime
 - ✗ Returns the time of day in an ASCII string
 - ✗ RFC 867
 - ✗ Port: 13
 - ✗ whois
 - ✗ Directory services
 - ✗ RFC 954
 - ✗ Port: 43
 - ✗ finger
 - ✗ Exchange of user information
 - ✗ Port: 79
 - ✗ RFC 1288



Terminal Services

- Terminal Services allow CLI session to remote host
 - ✗ telnet
 - ✗ rlogin/rsh – remote login / remote shell
 - ✗ SSH – Secure Shell



Terminal Services – telnet

- telnet
 - ✗ Early protocol allowing remote terminal connection to a hosts
 - ✗ Widely implemented
 - ✗ Used to connect to many devices for administration
 - ✗ Security issue!
 - ✗ Passwords are plain-text
 - ✗ Should disable telnet service and use ssh instead
 - ✗ RFC: many
 - ✗ Port 23

Terminal Services – rsh/rlogin

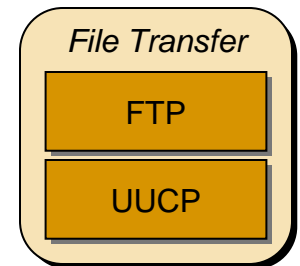
- rsh/rlogin – remote login / remote shell
 - ✗ remote shell / remote login protocol
 - ✗ Available on most all UNIX / Linux systems
 - ✗ Part of Berkeley's *r-commands*
 - ✗ Security issue!
 - ✗ Passwords are plain-text
 - ✗ Should disable rsh/rlogin service and use ssh instead
 - ✗ RFC 1282
 - ✗ Port 512, 513, 514

Terminal Services – ssh

- SSH – Secure Shell
 - ✗ Replacement for telnet, rlogin, rsh, rcp
 - ✗ Provides very secure encryption of data transactions
 - ✗ Passwords are not plain-text
 - ✗ Two versions - SSH1 and SSH2
 - ✗ Incompatible with each other
 - ✗ SSH2 is commercial product, with some licensing and usage restrictions
 - ✗ OpenSSH supports both protocol versions
 - ✗ Provides port *tunneling*
 - ✗ RFC: draft
 - ✗ Port: 22

File Transfer Services

- Provide host-to-host file transfers
- FTP - File Transfer Protocol
 - ✗ Provides simple upload/download file transfer
 - ✗ Very widely implemented
 - ✗ Security issue - passwords are plain-text
 - ✗ Can use sftp instead
- UUCP - Unix to UNIX Copy
 - ✗ Basically obsolete
 - ✗ Used for mail / news delivery between various stations



TCP/IP Services

□ Additional Reading

× TCP/IP Port Numbers

× <http://www.iana.org/assignments/port-numbers>

× Overview of Services

× <http://www.itprc.com/tcpipfaq/faq-2.htm>

× The RFCs

× <http://www.faqs.org/rfcs/index.html>

× SSH

× OpenSSH: <http://www.openssh.com/>

× Commercial: <http://www.ssh.fi/>