

Advanced Unix System Administration

Lecture 9
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Ethernet

- What is Ethernet?
 - Ken Thompson: “Robert Metcalfe says that if something comes along to replace Ethernet, it will be called 'Ethernet'”
 - The physical layer has varied enormously over the last 30 years: 10 Mbit coaxial cable, 100 Mbit twisted pair, 10 Gbit fiber-optic
 - Actual electrical (optical) standard has varied over the years

Ethernet

- Ethernet topology
 - Classic Ethernet is a bus topology – devices share one medium
 - Only one device can transmit at one time
 - Devices use CSMA/CD to handle access to the medium
 - All devices examine all transmissions to determine whether or not it's intended for them
 - Devices identified by MAC address
 - Doesn't scale well with large networks
 - Switched Ethernet only forwards transmissions to the wanted device

Ethernet

- The Ethernet frame
 - Each Ethernet transmission is packaged into a “frame”
 - Several different Ethernet frame types, which can coexist on the same network
 - “Ethernet II” is most common
 - 14-byte header containing source, destination MAC addresses, and an EtherType
 - Payload; 46-1500 bytes (hence the 1500 byte MTU)
 - 4 byte CRC checksum

Ethernet

- The EtherType
 - Supposedly was originally a length field
 - In Ethernet II, is a 16-bit value greater than 0x0600 used to indicate the network layer protocol contained in the payload
 - Common values:
 - 0x0800 – IPv4
 - 0x0806 – ARP
 - 0x86DD – IPv6

IP: the Internet Protocol

- Packet-switched data protocol for use on unreliable networks
- Responsible for identifying computers and getting packets from A to B
- Addressing
 - 32-bit addresses (4.2 billion possible unique addresses)
 - Usually written in four decimal quads of 8 bits each, for convenience
 - This form is frequently misleading!

IP: the Internet Protocol

- Address resolution
 - There has to be a way of mapping IP addresses to hardware devices
 - The Address Resolution Protocol (ARP) deals with this
 - Devices broadcast an ARP packet: either a request for the physical address of a particular IP address
 - The matching device broadcasts a reply
 - Devices may also broadcast “gratuitous” ARP announcements
 - Address mappings are (or should be) cached by devices

IP: the Internet Protocol

- Networking
 - The IP address is divided into a network portion (n high bits) and a host portion (remaining low bits)
 - Hosts only speak directly to other hosts with the same network ID
 - Network mask (bitmask ANDed with the IP to obtain network ID) is usually written in dotted-quad or in CIDR notation (/n, where n is the number of bits)

IP: the Internet Protocol

- An IP(v4) packet
 - 4-bit version field, 4-bit header length field, 8-bit TOS field (now used for DiffServ and ECN) are first
 - Total length – at least 20 bytes, but can be much larger
 - IPID field – supposed to be used for identifying fragments of an IP packet
 - Flags – 3 bits for fragment control (DF, MF); the high bit is unused (but see RFC 3514)

IP: the Internet Protocol

- An IP(v4) packet con't
 - Fragment offset – 13 bits describing the offset of a fragment in the payload, in 8-byte blocks
 - TTL – 8 bit hop count to ensure that traffic either arrives at its destination or dies
 - Protocol – 8 bits identifying transport layer protocol in the payload
 - Common protocol IDs: 1 (ICMP), 6 (TCP), 17 (UDP), 41 (IPv6 in IPv4)
 - Look in /etc/protocols for a complete list

IP: the Internet Protocol

- An IP(v4) packet con't
 - Checksum – 16 bits for error checking of the header
 - Source address, destination address – 32 bits each
 - Options (optional header fields), padded to an integral multiple of 32 bits
 - Data (on Ethernet, up to 1480 bytes)