CSF 432: Intro to Network and System Security

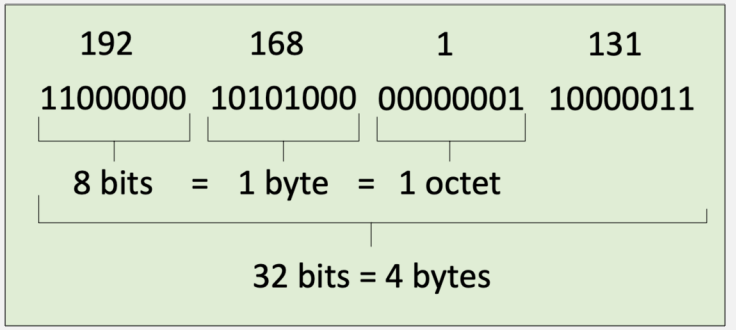
Week 03 - Review

Michael Conti

Department of Computer Science and Statistics
University of Rhode Island

Sources: Professor Messer's CompTIA N10-007 Network+ Course Notes

IPv4 and IPv6 Addressing



IPv4 and IPv6 Addressing

The IP address of a device

- IP Address, e.g., 192.168.1.165
  - Every device needs a unique IP address
- Subnet mask, e.g., 255.255.255.0
  - Used by the local workstation to determine what subnet it's on
  - The subnet mask isn't (usually) transmitted across the network
- You'll ask for the subnet mask all the time
  - What's the subnet mask of this network?

IPv4 and IPv6 Addressing

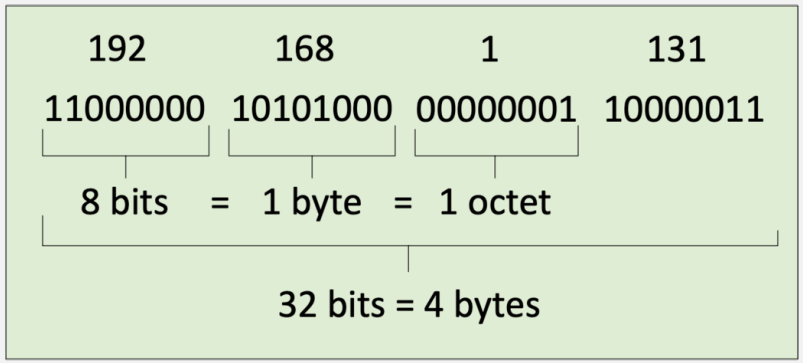
The secret behind the IP address

- The IP address isn't really a single address.
- An IP address is a combination of a network ID and a host ID
  - The subnet mask determines what part of the IP address is the network and which part is the host
  - The subnet mask is just as important as your IP address!
- The best way to see this work is in binary
  - This is the (very easy) math part

IPv4 and IPv6 Addressing

IPv4 addresses - Internet Protocol version 4

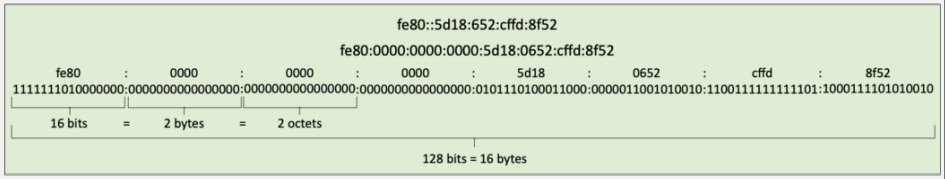
- ☑ OSI Layer 3 address
- ☑ Since one byte is 8 bits, the maximum decimal value for each byte is 255



IPv4 and IPv6 Addressing

IPv6 addresses

- ☑ Internet Protocol v6 - 128-bit address
- ☑ 340,282,366,920,938,463,463,374,607,431,768,211,456 addresses (340 undecillion)
- ☑ 6.8 billion people could have 5,000,000,000,000,000,000,000,000,000 addresses each

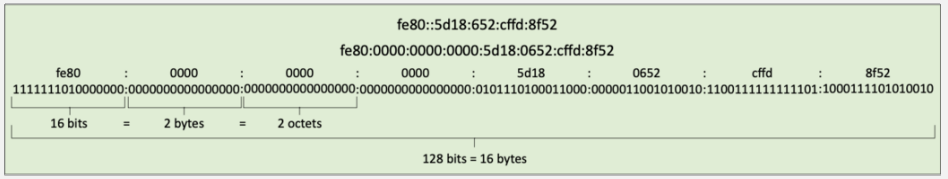


IPv4 and IPv6 Addressing

IPv6 address compression

- ☑ Your DNS will become very important!
- ☑ Groups of zeros can be abbreviated with a double colon ::
  - ☑ Only one of these abbreviations allowed per address
- ☑ Leading zeros are optional

Configuring IPv6



Configuring IPv6

Dual-stack routing

- Dual-stack IPv4 and IPv6
  - Run both at the same time
  - Interfaces will be assigned multiple address types
- IPv4
  - Configured with IPv4 addresses
  - Maintains an IPv4 routing table
  - Uses IPv4 dynamic routing protocols
- IPv6
  - Configured with IPv6 addresses
  - Maintains a separate IPv6 routing table
  - Uses IPv6 dynamic routing protocols

Configuring IPv6

Tunneling IPv6

- 6-to-4 addressing
  - Send IPv6 over an existing IPv4 network
  - Creates an IPv6 based on the IPv4 address
  - Requires relay routers -
    - IP protocol 41 - a transition technology
- No support for NAT
- 4-in-6
  - Tunnel IPv4 traffic on an IPv6 network

Configuring IPv6

Teredo/Miredo

- Tunnel IPv6 through NATed IPv4
  - End-to-end IPv6 through an IPv4 network
  - No special IPv6 router needed
    - Temporary use
  - We'll have IPv6 native networks soon
- Miredo - Open-source Teredo for Linux,
- BSD Unix, and Mac OS X
  - Full functionality

Configuring IPv6

NDP (Neighbor Discovery Protocol)

- No broadcasts!
  - Operates using multicast over ICMPv6
- Neighbor MAC Discovery
  - Replaces the IPv4 ARP
- SLAAC (Stateless Address Autoconfiguration)
  - Automatically configure an IP address without a DHCP server
- DAD (Duplicate Address Detection)
  - No duplicate IPs!
- Discover routers
  - Router Solicitation (RS) and Router Advertisement (RA)

Configuring IPv6

Finding Router

- ICMPv6 adds the Neighbor Discovery Protocol
- Routers also send unsolicited RA messages
  - From the multicast destination of ff02::1
- Transfers IPv6 address information, prefix value, and prefix length, etc.
  - Sent as a multicast
- Neighbor Advertisement (NA)

Configuring IPv6

Howdy Neighbor

- There's no ARP in IPv6
  - So how do you find out the MAC address of a device?
- Neighbor Solicitation (NS)
  - Sent as a multicast
- Neighbor Advertisement (NA)

Prioritizing Traffic

Prioritizing Traffic

Managing Network Traffic

- Many different devices
  - Desktop, laptop, VoIP phone, mobile devices
- Many different applications
  - Mission critical applications, streaming video, streaming audio
- Different apps have different network requirements
  - Voice is real-time
  - Recorded streaming video has a buffer
  - Database application is interactive
- Some applications are "more important" than others
  - Voice traffic needs to have priority over YouTube

Prioritizing Traffic

Packet shaping

- Packet shaping, traffic shaping
- Control by bandwidth usage or data rates
- Set important applications to have higher priorities than other apps

QoS (Quality of Service)

- Prioritize traffic performance
  - Voice over IP traffic has priority over web-browsing
  - Prioritize by maximum bandwidth, traffic rate, VLAN, etc.
- Quality of Service
  - Describes the process of controlling traffic flows
- Many different methods - Across many different topologies

Prioritizing Traffic

Managing QoS

- CoS (Class of Service)
  - OSI Layer 2
  - Ethernet frame header in an 802.1q trunk
  - Usually applied in the intranet (not from an ISP)
- Differentiated Services (DiffServ)
  - OSI Layer 3
  - QoS bits are enabled in the IPv4 header
  - Bits are set external to the application
  - Routers and switches have to play along
- DSCP (Differentiated Services Code Point)
  - DS (Differentiated Services) field in the IP header

Network Address Translation (NAT)

IP address range	Number of addresses	Classful description	Largest CIDR block (subnet mask)	Host ID size
10.0.0.0 – 10.255.255.255	16,777,216	single class A	10.0.0.0/8 (255.0.0.0)	24 bits
172.16.0.0 – 172.31.255.255	1,048,576	16 contiguous class Bs	172.16.0.0/12 (255.240.0.0)	20 bits
192.168.0.0 – 192.168.255.255	65,536	256 contiguous class Cs	192.168.0.0/16 (255.255.0.0)	16 bits

Network Address Translation (NAT)

NAT (Network Address Translation)

- It is estimated that there are over 20 billion devices connected to the Internet (and growing)
  - IPv4 supports around 4.29 billion addresses
- The address space for IPv4 is exhausted
  - There are no available addresses to assign
- How does it all work?
  - Network Address Translation
- This isn't the only use of NAT
  - NAT is handy in many situations

IP address range	Number of addresses	Classful description	Largest CIDR block (subnet mask)	Host ID size
10.0.0.0 – 10.255.255.255	16,777,216	single class A	10.0.0.0/8 (255.0.0.0)	24 bits
172.16.0.0 – 172.31.255.255	1,048,576	16 contiguous class Bs	172.16.0.0/12 (255.240.0.0)	20 bits
192.168.0.0 – 192.168.255.255	65,536	256 contiguous class Cs	192.168.0.0/16 (255.255.0.0)	16 bits

Network Address Translation (NAT)

Port Forwarding

- 24x7 access to a service hosted internally
  - Web server, gaming server, security system, etc.
- External IP/port number maps to an internal IP/port
  - Does not have to be the same port number
- Also called Destination NAT or Static NAT
  - Destination address is translated from a public IP to a private IP
  - Does not expire or timeout

IP address range	Number of addresses	Classful description	Largest CIDR block (subnet mask)	Host ID size
10.0.0.0 – 10.255.255.255	16,777,216	single class A	10.0.0.0/8 (255.0.0.0)	24 bits
172.16.0.0 – 172.31.255.255	1,048,576	16 contiguous class Bs	172.16.0.0/12 (255.240.0.0)	20 bits
192.168.0.0 – 192.168.255.255	65,536	256 contiguous class Cs	192.168.0.0/16 (255.255.0.0)	16 bits

Access Control Lists

Access Control Lists

Packet filtering

- Used to allow or deny traffic
  - Also used for NAT, QoS, etc.
- Defined on the ingress or egress of an interface
  - Incoming or outgoing
- ACLs can evaluate on certain criteria
  - Source IP, Destination IP, TCP port numbers, UDP port numbers, ICMP
- Deny or permit
  - What happens when an ACL matches the traffic?
- ACLs have evolved through the years
  - More options and features available for traffic filtering

Access Control Lists

Firewall rules

- Access control lists (ACLs)
  - Allow or disallow traffic based on tuples
  - Groupings of categories
    - Source IP, Destination IP, port number, time of day, application, etc.
- A logical path
  - Usually top-to-bottom
- Can be very general or very specific
  - Specific rules are usually at the top
- Implicit deny
  - Most firewalls include a deny at the bottom
    - Even if you didn't put one

Circuit Switching and Packet Switching

Circuit Switching and Packet Switching

Circuit switching

- Circuit is established between endpoints before data passes
  - Like a phone call
- Nobody else can use the circuit when it's idle
  - Inefficient use of resources
- Connection is always there
  - It's mine. You can't use it.
- Capacity is guaranteed
  - You'd better use it, you paid for it.
- POTS (plain old telephone service)
- PSTN (public switched telephone network)
- T1 / E1 / T3 / E3
  - Create a circuit between two sites
- ISDN
  - Use a phone number to call another ISDN modem

Circuit Switching and Packet Switching

Packet switching

- Data is grouped into packets
  - Voice, data, video, etc.
  - Like a network
- The media is usually shared
  - Someone else can use it, even when you don't
- One connection may have more bandwidth allocated than another
  - How much money would you like to spend?
- SONET, ATM
- DSL
- Frame relay
- MPLS
- Cable modem
- Satellite
- Wireless

Software Defined Networking

Software Defined Networking

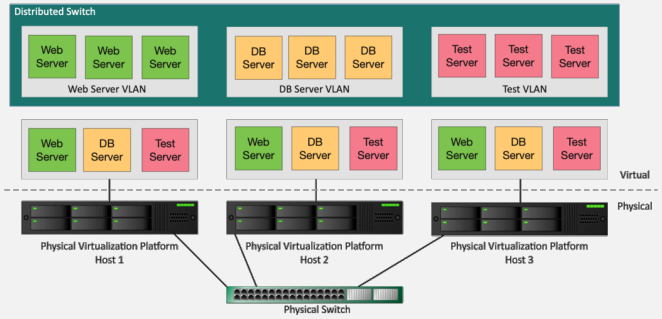
SDN (Software Defined Networking)

- Networking devices have two functional planes of operation
  - Control plane
  - Data plane
- Directly programmable
  - Configuration is different than forwarding
- Agile
  - Changes can be made dynamically
- Centrally managed - Global view, single pane of glass
- Programmatically configured
  - Orchestration - No human intervention
- Open standards / vendor neutral
  - A standard interface to the network

Software Defined Networking

Distributed switching

- Remove the physical segmentation
  - A virtual network distributed across all physical platforms
- When a VM moves, the network doesn't change
  - Servers will always connect to the right VLAN



CSF 432: Intro to Network and System Security

Week 03 - Review

Michael Conti

Department of Computer Science and Statistics
University of Rhode Island

Sources: Professor Messer's CompTIA N10-007 Network+ Course Notes