

CSF 432: Intro to Network and System Security

Week 04 - Review

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Department of Computer Science and Statistics
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Fall 2020



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

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Binary Math

2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
4,096	2,048	1,024	512	256	128	64	32	16	8	4	2	1

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Binary Math

- ✓ A way to represent numbers
 - ✓ numbers are expressed in a certain base
- ✓ Why study number systems in CS, Networking, Security?
 - ✓ to understand data representation
- ✓ Examples of number systems
 - ✓ binary
 - ✓ decimal
 - ✓ octal
 - ✓ hexadecimal

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Binary Math

- ✓ Assuming some base b :

$$\dots d_2 b^2 + d_1 b^1 + d_0 b^0 + d_{-1} b^{-1} + d_{-2} b^{-2} \dots$$

$$43.23 = 4 \cdot 10^1 + 3 \cdot 10^0 + 2 \cdot 10^{-1} + 3 \cdot 10^{-2}$$

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Binary Math

☑ Base 10

☑ Symbols:

0 1 2 3 4 5 6 7 8 9

$$456 = 4 \cdot 10^2 + 5 \cdot 10^1 + 6 \cdot 10^0$$

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Binary Math

☑ Base 2

☑ Symbols:

0 1

Most
Significant Bit

Least
Significant Bit

$$1010 = (1 \cdot 2^3) + (0 \cdot 2^2) + (1 \cdot 2^1) + (0 \cdot 2^0)$$



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Binary Math

☑ Binary to decimal?

☑ 1 0 0 1 0 1 0 0 0
 $2^8 \ 2^7 \ 2^6 \ 2^5 \ 2^4 \ 2^3 \ 2^2 \ 2^1 \ 2^0$

$$(1 \cdot 2^8) + (1 \cdot 2^5) + (1 \cdot 2^3) = 256 + 32 + 8 = 296$$

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Binary Math

☑ Binary to decimal?

☑ 1 0 0 1 0 1 0 0 0
 $2^8 \ 2^7 \ 2^6 \ 2^5 \ 2^4 \ 2^3 \ 2^2 \ 2^1 \ 2^0$

$$(1 \cdot 2^8) + (1 \cdot 2^5) + (1 \cdot 2^3) = 256 + 32 + 8 = 296$$

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Binary Math

☑ Binary to decimal?

$$\begin{array}{r} \text{☑ } 1\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 0 \\ \hline 2^8\ 2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0 \end{array}$$

$$(1 \cdot 2^8) + (1 \cdot 2^5) + (1 \cdot 2^3) = 256 + 32 + 8 = 296$$

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Binary Math

☑ Binary to decimal?

$$\begin{array}{r} \text{☑ } 1\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 0 \\ \hline 2^8\ 2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0 \end{array}$$

$$(1 \cdot 2^8) + (1 \cdot 2^5) + (1 \cdot 2^3) = 256 + 32 + 8 = 296$$

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Binary Math

☑ Binary to decimal?

$$\begin{array}{r} \text{☑ } 1\ 0\ 0\ 1\ 0\ 1\ 0\ 0\ 0 \\ \hline 2^8\ 2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0 \end{array}$$

$$(1 \cdot 2^8) + (1 \cdot 2^5) + (1 \cdot 2^3) = 256 + 32 + 8 = 296$$

☑ Decimal to Binary?

☑ 236

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IPv4 Addresses

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IPv4 Addresses

Networking with IPv4

- ☑ 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 device 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?
- ☑ Default gateway, e.g., 192.168.1.1
 - ☑ The router that allows you to communicate outside of your local subnet
 - ☑ The default gateway must be an IP address on the local subnet

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IPv4 Addresses

Special IPv4 addresses

- ☑ Loopback address
 - ☑ An address to yourself
 - ☑ Ranges from 127.0.0.1 through 127.255.255.254
 - ☑ An easy way to self-reference (ping 127.0.0.1)
- ☑ Reserved addresses
 - ☑ Set aside for future use or testing
 - ☑ 240.0.0.1 through 254.255.255.254
- ☑ Virtual IP addresses (VIP)
 - ☑ Not associated with a physical network adapter
 - ☑ Virtual machine, internal router address

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Classful Subnetting and IPv4 Subnet Masks

Class	Leading Bits	Network Bits	Remaining Bits	Number of Networks	Hosts per Network	Default Subnet Mask
Class A	0xxx (1-126)	8	24	128	16,777,214	255.0.0.0
Class B	10xx (128-191)	16	16	16,384	65,534	255.255.0.0
Class C	110x (192-223)	24	8	2,097,152	254	255.255.255.0
Class D (multicast)	1110 (224-239)	Not defined	Not defined	Not defined	Not defined	Not defined
Class E (reserved)	1111 (240-254)	Not defined	Not defined	Not defined	Not defined	Not defined

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Classful Subnetting and IPv4 Subnet Masks

Classful Subnetting

- ☑ Very specific subnetting architecture
 - ☑ Not used since 1993
 - ☑ But still referenced in casual conversation
- ☑ Used as a starting point when subnetting
 - ☑ Standard values

Class	Leading Bits	Network Bits	Remaining Bits	Number of Networks	Hosts per Network	Default Subnet Mask
Class A	0xxx (1-126)	8	24	128	16,777,214	255.0.0.0
Class B	10xx (128-191)	16	16	16,384	65,534	255.255.0.0
Class C	110x (192-223)	24	8	2,097,152	254	255.255.255.0
Class D (multicast)	1110 (224-239)	Not defined	Not defined	Not defined	Not defined	Not defined
Class E (reserved)	1111 (240-254)	Not defined	Not defined	Not defined	Not defined	Not defined

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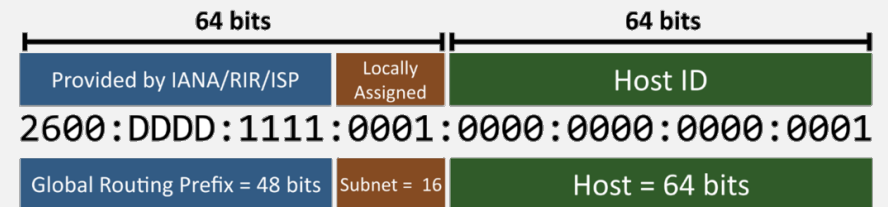
Classful Subnetting and IPv4 Subnet Masks

The construction of a subnet

- ☑ Network address
 - ☑ The first IP address of a subnet - Set all host bits to 0 (0 decimal)
- ☑ First usable host address
 - ☑ One number higher than the network address
- ☑ Network broadcast address
 - ☑ The last IP address of a subnet - Set all host bits to 1 (255 decimal)
- ☑ Last usable host address
 - ☑ One number lower than the broadcast address
- ☑ Example:
 - ☑ 11.74.222.11

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IPv6 Subnet Masks

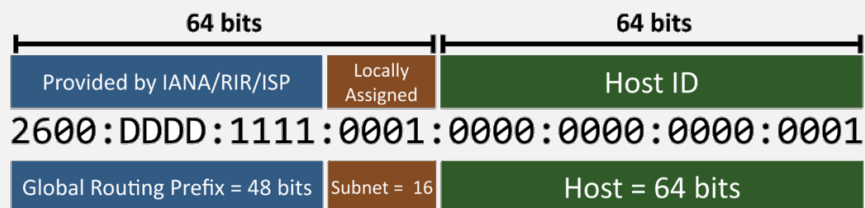


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IPv6 Subnet Masks

Assigning IPv6 Addresses

- ☑ Internet Assigned Numbers Authority (IANA) provides address blocks to RIRs (Regional Internet Registries)
- ☑ RIRs assigns smaller subnet blocks to ISPs (Internet Service Providers)
- ☑ ISP assigns a /48 subnet to the customer



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Calculating IPv4 Subnets and Hosts

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Calculating IPv4 Subnets and Hosts

VLSM (Variable Length Subnet Masks)

- ❑ Class-based networks are inefficient
 - ❑ The subnet mask is based on the network class
- ❑ Allow network administrators to define their own masks
 - ❑ Customize the subnet mask to specific network requirements
- ❑ Use different subnet masks in the same classful network
- ❑ 10.0.0.0/8 is the class A network - 10.0.1.0/24 and 10.0.8.0/26 would be VLSM

$$\begin{aligned}\text{Number of subnets} &= 2^{\text{subnet bits}} \\ \text{Hosts per subnet} &= (2^{\text{host bits}}) - 2\end{aligned}$$

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Seven Second Subnetting

	Masks				Networks	Addresses
/1	/9	/17	/25	128	2	128
/2	/10	/18	/26	192	4	64
/3	/11	/19	/27	224	8	32
/4	/12	/20	/28	240	16	16
/5	/13	/21	/29	248	32	8
/6	/14	/22	/30	252	64	4
/7	/15	/23	/31	254	128	2
/8	/16	/24	/32	255	256	1

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Seven Second Subnetting

Seven second subnetting

- ☒ Convert IP address and subnet mask to decimal
- ☒ Determine network/subnet address
- ☒ Determine broadcast address
- ☒ Calculate first and last usable IP address

Seven Second Subnetting

	Masks				Networks	Addresses
/1	/9	/17	/25	128	2	128
/2	/10	/18	/26	192	4	64
/3	/11	/19	/27	224	8	32
/4	/12	/20	/28	240	16	16
/5	/13	/21	/29	248	32	8
/6	/14	/22	/30	252	64	4
/7	/15	/23	/31	254	128	2
/8	/16	/24	/32	255	256	1

Addresses	
128	0
64	0
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