Subnetting

- To understand this lecture, think about it from the point of view of the originally intended IPv4 design again, where all hosts which can communicate on the Internet have a public IP address.

- Let's say we're the network designer for a small business with four departments spread over two offices, and we want to manage our own public address space.

- Rather than purchasing separate address ranges for the different departments, we can purchase a single range and subnet it into smaller portions.

Borrowing Host Bits

- Let's say we've been allocated Class C 200.15.10.0/24

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
1	1	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0

- To subnet the network into smaller subnets, we need to 'borrow' host bits and add them to the network portion of the address

- The network address line always moves to the right when we subnet

- The further to the right we go, the more subnets we'll have of that size but less hosts

Calculating the Number of Networks

- To calculate the number of available subnets, the formula is $2^{subnet-bits}$
- If a Class C network uses a /28 subnet mask then we've borrowed 4 bits from the default of /24
- 2^4 = 16 available subnets
- If a Class B network uses a /28 subnet mask then we've borrowed 12 bits from the default of /16
- 2^{12} = 4096 available subnets
- Hosts on different subnets need to go via a router if they want to communicate with each other

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Calculating the Number of Hosts

- To calculate the number of available hosts, the formula is $2^{\text{host-bits}}$ minus 2

- We subtract 2 because the network address and broadcast address cannot be assigned to hosts

- If a Class C network uses a /28 subnet mask then we have 4 bits left for hosts

- $2^4 - 2 = 14$

- If a Class B network uses a /28 subnet mask then we have 4 bits left for hosts

- $2^4 - 2 = 14$

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A Quick Note on `ip subnet-zero`

- Just like we have to subtract 2 to get the number of valid hosts, we used to have to subtract 2 to get the number of available networks also

- In the original Internet standards, it was not allowed to use network bits of all 0's or all 1's (just like we can't use all host bits of all 0's or all 1's)

- There wasn't really any practical need for this and it wasted address space

- The `ip subnet-zero` command on a router overrides the limitation, and is enabled by default