U1. Review
IP v4 Subnetting

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OSI vs TCP/IP

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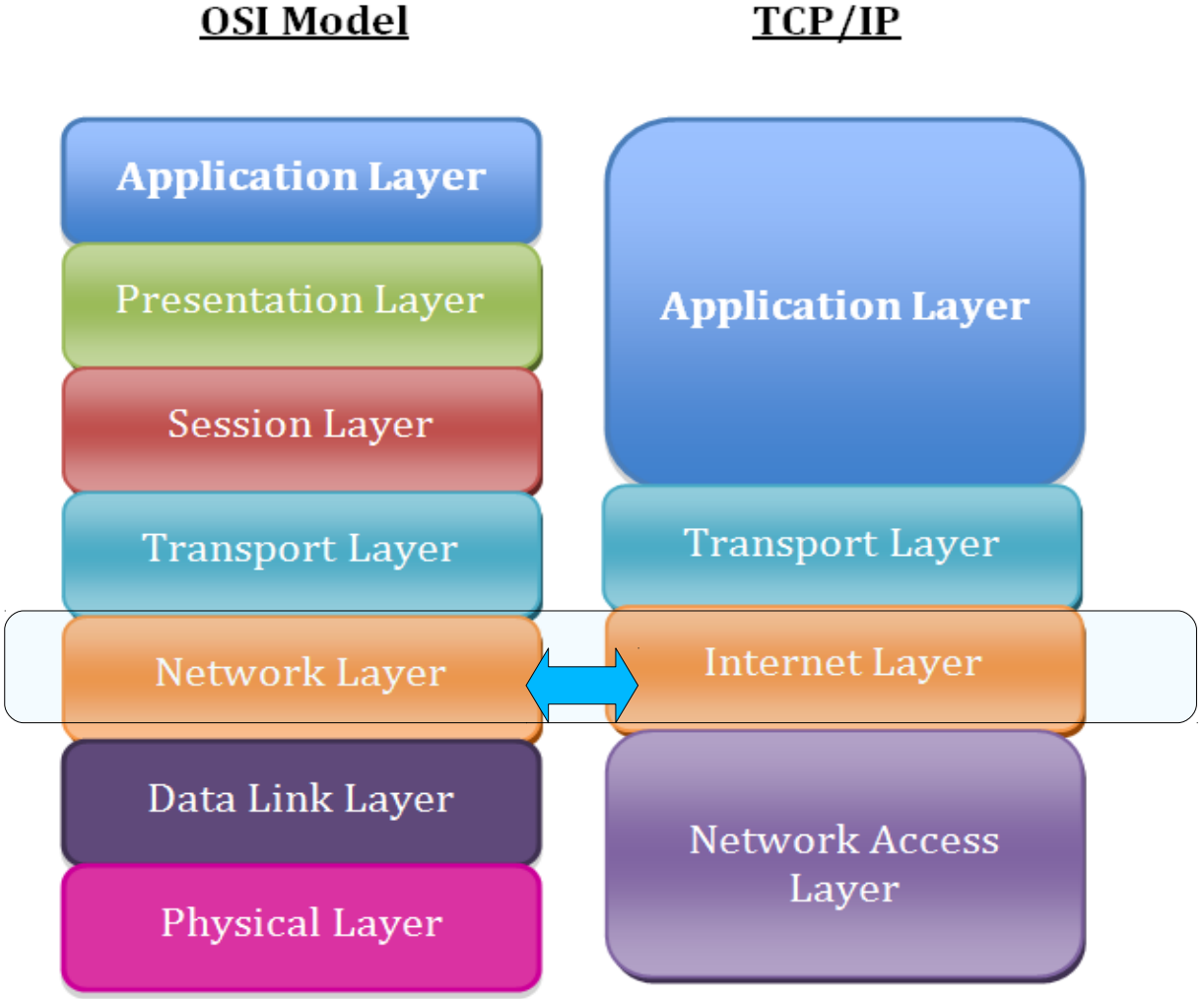

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TCP/IP Layer	Protocols
Internet	IPv4, IPv6, RIP, OSPF
Transport	TCP, UDP
Application	DNS, HTTP, POP, FTP

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IP v4 Addressing

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- An IP address is a unique identity of an interface in IP network. IP addresses are just like postal addresses.
- To send and receive IP packets in IP network, every interface needs a unique IP address
- The IP address is just a 32-bit binary number: a set of 32 ones or zeroes
- Usually, they are expressed by dividing the 32 bits into four bytes and converting each to decimal, then separating these numbers with dots to create dotted decimal notation.

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- Example:

  11010111000000001111111111001100

  11010111 00000000 11111111 11001100

  215 0 255 204

- Since IP addresses are 32 bits long, the total address space of IPv4 is 2^32 or 4,294,967,296 addresses. However, not all of these addresses can be used, for a variety of reasons.

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SUBNET MASK

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- One IP address can be logically split into network ID and host ID components
- The dividing logical point of the 32-bit address is not fixed, but rather, depends on a number of factors, and can occur in a variety of places, including in the middle of a dotted-decimal octet.
- In an IP address, how many bits are used in network address and how many bits are left for host address is determined by a **subnet mask**.

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- The bits of the mask in any given network are chosen so that, the bits used for either the network ID are ones, while the bits used for the host ID are zeroes.
- Just like an IP address, subnet mask is also a 32 bits long address and can be written in both binary and decimal notations.
- Examples
  - 11111111.11111111.11111111.00000000 → 255.255.255.0 →/24
  - 11111111.11111111.11110000.00000000 →255.255.240.0 → /20

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IP Subnetting Concepts

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- **IP Subnetting** is a process of dividing a large IP network in smaller IP networks.
- Subnetting advantages:
  - To improve network performance and speed
  - To improve security
  - To reduce network congestion
  - Not to waste IP address

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- IP addresses must be broken into three elements instead of two:
  - the network ID
  - a subnet ID * (stolen bits from the host ID of the former network)
  - host ID*
- The more bits we “steal” from the host ID for the subnet ID, the more subnets we can have, but the fewer hosts we can have for each subnet.

*dividing the host ID into a subnet ID and host ID. We reduce the size of the host ID portion of the address

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IP Subnetting Process

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Deciding How Many Subnet Bits to Use

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- The decision of how many bits to use for each of the subnet ID and host ID represents a fundamental trade-off in subnet addressing:
  - Each bit taken from the host ID for the subnet ID **doubles** the number of subnets that are possible in the network.
  - Each bit taken from the host ID for the subnet ID **halves** the number of hosts that are possible within each subnet on the network.

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- . Example Subnetting a /16 network

Número de subredes requeridas	Número bits extendidos	Máscara de Subred	Número de host por subred
1-2	1	255.255.128.0 ó /17	32.766
3-4	2	255.255.192.0 ó /18	16.382
5-8	3	255.255.224.0 ó /19	8.190
9-16	4	255.255.240.0 ó /20	4.094
17-32	5	255.255.248.0 ó /21	2.046
33-64	6	255.255.252.0 ó /22	1.022
65-128	7	255.255.254.0 ó /23	510
129-256	8	255.255.255.0 ó /24	254
257-512	9	255.255.255.128 ó /25	126
513-1.024	10	255.255.255.192 ó /26	62
1.025-2.048	11	255.255.255.224 ó /27	30
2.049-4.096	12	255.255.255.240 ó /28	14
4.097-8.192	13	255.255.255.248 ó /29	6
8.193-16.384	14	255.255.255.252 ó /30	2

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Hosts allowed in each subnet

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- The number of hosts allowed in each subnet is the binary power of the number of host ID bits remaining after subnetting, less two.
- The reduction by two occurs because the all-zeroes and all-ones host IDs within each subnet are reserved for two “special meaning” addresses: to refer to the subnetwork itself and its local broadcast address.
- Example

192.168.3.5 255.255.255.128 ---> 7 bits for host ID

Nº host for each subnet: $2^7 - 2 = 126$

network ID

broadcast ID

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IP Subnetting Step #2: The Key Design Trade-off: Partitioning Network Address Host Bits

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- If there is more than one combination of subnet ID and host ID sizes that will meet requirements, try to choose a “middle-of-the-road” option that best anticipates future growth requirements

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- Suppose we have a network, 211.77.20.0 /24 , and we would like a total of 7 subnets. The maximum number of hosts per would be 25.

Last byte (only 8 bits for host ID, from 25th to 32nd)

$2^3=8 \rightarrow$ 3 bits subnet id

$2^5=32 \rightarrow$ 5 bits host id **There is only one solution**

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Determining The Custom Subnet Mask

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- 211.77.20.0, with a total of 7 subnets and 25 hosts per subnet.

0	8	16	24	27	32
211	77	20	Subnet ID (3 bits)	Host ID (5 bits)	

1 for each bit of Network id, or subnetwork id and 0 for each bit of host, that is /27

11111111	11111111	11111111	111	00000

Binary subnet mask converted to dotted decimal

255	255	255	224

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Determining Subnet Identifiers and Subnet Addresses

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- Our Class C network, 211.77.20.0. The network address in binary is:

11010011 01001101 00010100 **000**00000 subnet id

- To find the address, we start with the network address in binary, and substitute “000” for the subnet ID bits

11010011 01001101 00010100 **000**00000 → 211.77.20.0 /27

11010011 01001101 00010100 **001**00000→ 211.77.20.32 /27

11010011 01001101 00010100 **010**00000→ 211.77.20.64 /27

11010011 01001101 00010100 … 00000 ....

11010011 01001101 00010100 **111**00000→ 211.77.20.224 /27

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Determining Host Addresses For Each Subnet

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- The first is found by substituting the last 5 bits for the host ID bits. For the first subnet it will be

11010011 01001101 00010100 **00000001**

- To find the address, we start with the host bits address in binary, and substitute “00000” for the host ID

11010011 01001101 00010100 **00000001** → 211.77.20.1

11010011 01001101 00010100 **00000010** → 211.77.20.2

11010011 01001101 00010100 **00000011** → 211.77.20.3

11010011 01001101 00010100 … ....

11010011 01001101 00010100 **00011110** → 211.77.20.30

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TO CONCLUDE...

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To conclude: Given the subnet 211.77.20. 96/27,

11010011 01001101 00010100 **011 00000**

(211) (77) (20) (96)

- **What is the broadcast IP address?**

Change by "1" all bits of the host ID section, it will be the last IP address of this subnet range.

11010011 01001101 00010100 **011 11111** → **211.77.20.127/27**

- **What is the valid range for hosts IP addresses?**

All the IP addresses between subnet ID(211.77.20.96 /27) and broadcast IP address(211.77.20.127 /27), that is

From 211.77.20.97 /27 to 211.77.20.126/27

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TIP AND TRICKS

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TIP1: How to know if two or more IP addresses belong to the same network

Just checking the network ID of these IP addresses, if they are the same, they belong to the same network, otherwise they don't belong to the same network.

Example: 122.133.144.47 /27, 122.133.144.57 /27, 122.133.144.67 / 27,122.133.144.47 /27, 122.133.144.7 /27,

122.133.144.7 → 01111010 10000101 10010000 000 00111

122.133.144.47 → 01111010 10000101 10010000 001 01111

122.133.144.57 → 01111010 10000101 10010000 001 11001

122.133.144.67 → 01111010 10000101 10010000 010 00011

As in this case the first tree octets match, it would be only necessary to test the last one.

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TIP2: How to know the subnet id for each subnet

At the beginning we have the 211.77.20.0/24 network, after split it into 8(2^3) subnets, the range of these subnets will be 2^5=32. So we can get each subnet id adding 32 to the previous subnet id. Pay attention, the first one is the same that the former, just change de subnet mask:

211.77.20.0 /27

211.77.20.32 /27

211.77.20.64 /27

211.77.20.96 /27

211.77.20.128 /27

211.77.20.160 /27

211.77.20.192 /27

211.77.20.224 /27