**IP Address**

**Useful Link And Resources:**

* https://stevessmarthomeguide.com
* www.steves-internet-guide.com/ipv4-basics/
* www.steves-internet-guide.com/subnetting-subnet-masks-explained/

**IPv4 Address and Structure**

An IP address has 2 components. A network component and a node component. Just like your home address, a network component is equivalent to the street name, a node component is equivalent to a house number.

For IPV4 address, we totally have 5 classes (equivalent to 5 categories type of networks).

5 classes (categories type of networks) are listed below:

* Class A Network

This category of network usage is intended for adopting large number of nodes (you can thought of PC), typically for large size organization.

* Class B Network

This category of network usage is intended for adopting medium number of nodes

(you can thought of PC), typically for medium size of organization.

* Class C Network

This category of network usage is intended for adopting small number of nodes

(you can thought of PC), typically for small size of organization.

* Class D and Class E are reserved

**IPv4 Address Structure**

An IPv4 address structure uses 32 bits (in **binary**) each is separate by decimal point, each part is 8 bits as shown below:

11000000 . 10101000 . 10000000 . 10101000

But computer interpret IPv4 address as binary, for human reading we use decimal:

11000000 . 10101000 . 10000000 . 10101000

192

168

1

168

The IPv4 address as shown above is 192.168.1.168

**Class “A” IPv4 Address Structure**

A class “A” IPv4 address structure uses 8 bits for the network address and 24 bits for node addresses.

Network . Node . Node . Node

Therefore, there can only be 128 () ***not including the left most leading bit*** class A networks but can have 16,777,216 () number of nodes. So that is why it is typically used for large organization which consists large number of nodes.

**Class “B” IPv4 Address Structure**

A class “B” IPv4 address structure uses 16 bits for the network address and 16 bits for node addresses.

Network . Network . Node . Node

Therefore there can only be 16,384 () ***not including the left most leading bits*** class B networks but can have 65,536 () number of nodes. It is typically used for medium size organization which consists medium number of nodes.

**Class “C” IPv4 Address Structure**

A class “C” IPv4 address structure uses 24 bits for the network address and 8 bits for node addresses.

Network . Network . Network . Node

Therefore, there can only be 2,097,152 () ***not including the left most leading bits*** class C networks but can have 256 () number of nodes. Suitable for small size organization which consists of small number of nodes.

After discuss each class of IPv4 address structure. Below listed how we differentiate each class. We use “leading bits” to differentiate each class. This is the **left most** leading bits. For class A, we use “0” one bit, for class B, we use “10” two bits, for class C, we use “110” three bits. Please note the bit used will not be counted as network. Below shows the table of each class leading bits and the corresponding network sizes.

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | **Leading Bits** | **Network sizes** | **Nodes** |
| A | 0 | 128 () | 16,777,216 () |
| B | 10 | 16,384 () | 65,536 () |
| C | 110 | 2,097,152 () | 256 () |

Below table listed each classes IPv4 address range:

|  |  |  |
| --- | --- | --- |
| **Class** | **Start Address** | **End Address** |
| A | 0 . 0 . 0 . 0  to binary  00000000 . 00000000 . 00000000 . 00000000 | 127 . 255 . 255 . 255  to binary  01111111 . 11111111 . 11111111 . 11111111 |
| B | 128 . 0 . 0 . 0  to binary  10000000 . 00000000 . 00000000 . 00000000 | 191 . 255 . 255 . 255  to binary  10111111 . 11111111 . 11111111 . 11111111 |
| C | 192 . 0 . 0 . 0  to binary  11000000 . 00000000 . 00000000 . 00000000 | 223 . 255 . 255 . 255  to binary  11011111 . 11111111 . 11111111 . 11111111 |

**Private And Special Address**

Certain IPv4 address are not routable on the internet and are reserved for internal network, they are known as private address.

* 10 . 0 . 0 . 0 (Class A address)
* All ones and all zeros node addresses
  + E.g.: 192 . 168 . 0 . 0
  + E.g.: 192. 168. 0. 255
* Loopback Address 127 . 0 . 0 . 1
* Link local address range 169 . 254 . 0 . 0 is used to auto assign IP address, when no DHCP server is available.

**Sub Netting**

It is a technique that allows you to split a network into smaller networks.

As discuss before, there are 3 main classes which is:

* Class A - Network . Node . Node . Node
* Class B - Network . Network . Node . Node
* Class C - Network . Network . Network . Node

As discuss before, to determine the class, you need to examine the left most leading bit.

* 0 ~ 127 class A
* 128 ~ 191 class B
* 192 ~ 223 class C

All modern networks use the “**Ethernet**” data link protocol. Ethernet uses a share media and is negatively effected when a large number of node are connected to the same media. So even though a class “A” address can accommodate thousands of nodes. It is totally impractical to put this many nodes on a single network.

The solution to the problem was to split the network into smaller network call “**Sub Networks**” or “**Subnets**” for short. Typically, the network part of the address is only use for routing IP packets on the public internet. Once the packet enters the private network the node address is used and the public network address is not used.

Before Class A:

Network . Node . Node . Node

Sub netting Class A:

Network . Subnet . Subnet . Node

Now the network administrator can interpret the node address anyway they want. So it is possible to split up the node address into sub network and node. The technique used to create sub networks is to use “**Sub net mask**”.

For example, we have a class “A” IP address “11 . 1 . 1 . 21”:

11

21

1

1

Network. Subnet . Subnet . Node

For the class “A” network, the network administrator wants to create a “sub network”. We use **Sub net mask** to hide the first 24 bits (3 bytes).

The sub net mask is:

255 . 255 . 255 . 0

To retrieve the class “A” network and sub network, the best way is to write the numbers out as binary.

11

21

1

1

00001011 . 00000001 . 00000001 . 000010101

the Subnet mask

255

255

255

0

11111111 . 11111111 . 11111111 . 00000000

How to retrieve the sub network from the network. We use a technique call “**Mask**”, by using the binary logical operator “**AND**” for each bit.

Therefore that becomes:

00001011 . 00000001 . 00000001 . 000010101

Logical operator And

11111111 . 11111111 . 11111111 . 00000000

Let take an example for the first left 8 bits:

0 and 1 becomes 0

0 and 1 becomes 0

0 and 1 becomes 0

0 and 1 becomes 0

1 and 1 becomes 1

0 and 1 becomes 0

1 and 1 becomes 1

1 and 1 becomes 1

After using the Logical “**And**” gates that becomes “00001011”, by this way we can “**Mask**” out the “**Network**” and “**Sub Network**”, and retrieve only the “**Node**” address.

### Classless Inter-Domain Routing (CIDR)

**Classless Inter-Domain Routing** was introduced in 1993 to replace the classful network design.

Instead of allocating network addresses using address classes based on 8 bit groups it uses**variable length subnet masking**.

#### Table: CIDR and Subnet Examples

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Address Class** | **No of Network Bits** | **No of Host Bits** | **Subnet mask** | **CIDR Notation** | **IPv4 Ranges** |
| A | 14 | 18 | 255.252.0.0  11111111.11111100.00000000.00000000 | /14 | 127.0.0.0  ~  127.252.255.255 |
| B | 20 | 12 | 255.255.240.0  11111111.11111111.  11110000.00000000 | /20 | 128.0.0.0  ~  191.255.240.255 |
| C | 28 | 4 | 255.255.255.240  11111111.11111111.  11111111.11110000 | /28 | 192.0.0.0  ~  N/A |

Although variable length of subnetting mask, still needs to follow the subnet mask structure. The structure should be “Network.Subnet.Subnet.Node”. The **last byte** should be a “**Node**”. For the above diagram, class “C” cannot be interpreted, because the last byte is being adopted by the subnet and the node cannot be defined. The CIDR notation should be no more than “**/24**”.