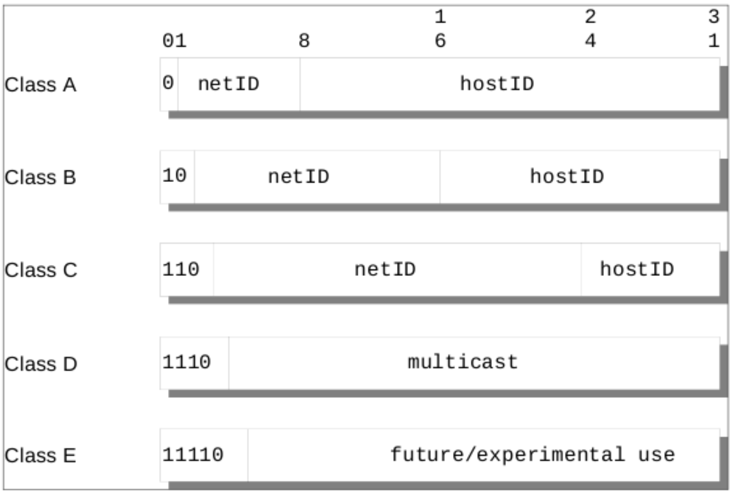
IP Address

The IP address is 32 bits divided into two parts, the network portion and the host portion.
عنوان الآي بي هو رقم من 32 بت مقسوم إلى جزئين الجزء الخاص بالشبكة و الجزء الخاص بالجهاز.



The IP address is two types: public and private.

Public: None Free Internet Ips.

private: Free to use in your network but no Internet connectivity

The Private Range

10.0.0.0/8

172.16.0.0/12

192.168.0.0/16

Subnetting

Subnetting is dividing your network range into multiple ranges by borrowing bits from the host portion to the network portion; ie. Increasing network bits by decreasing host bits.
السبنيتينج هو تقسيم نطاق الآي بي الخاص بالشبكة الى مجموعات متعددة و ذلك عن طريق زيادة البتس التي تدل على الشبكة و تقليل البيتس التي تدل على الجهاز.
The Prefix
Its The number of bits from left to right that determines the network portion. When you subnet you increase the prefix.
البريفكس هو عدد البتس من اليسار الى اليمين التي تدل على الشبكة. عندما تجزئ الشبكة فانك تزيد البريفكس.
Each class has a default prefix:
A: 8
B: 16
C: 24
for example a class C address with prefix 24 means that 24 out of 32 bits are the network portion that leaves 8 bits for the host portion which means that the number of possibilities for the hosts are 2^8 = 256 from 00000000 – 11111111 the all zeros host portion is called the network ID and the all ones host portion is called the limited broadcast address and they are not allowed to be used on hosts. The 256 number is called the block size, so the number of valid host IP is 256 – 2 = 254.
على سبيل المثال عنوان من الفئة سي ذو بريفكس 24 من 32 بت يعني وجود 8 بتس تدل على الجهاز مما يعني ان عدد الاحتمالات هو 2^8 = 256 احتمال من 00000000 – 11111111. عندما تكون كل ال 8 بتس اصفار هذا يسمى هوية الشبكة

و عندما تكون كلها واحد يسمى ذلك عنوان البرودكاست المحدود، هذان الرقمان لا يجوز استخدامهما لجهاز في الشبكة. الرقم 256 يسمى حجم النطاق اي ان عدد الآي بي المسموح هو 256 – 2 = 254.

If we want to divide our network into two parts that means the 256 block size is divided into two blocks each with a size 128 (256/2 = 128); that means the number of host bits is 7 (2^7 = 128) ==> the network prefix is 32 – 7 = 25, so the network portion is increased by one while the host portion is decreased by one. Now we have two ranges 0 – 127 and 128 – 255 each one has an ID and a broadcast address.

Ex:

ID	Range	Broadcast
192.168.10.0/24	192.168.10.1 – 192.168.10.254	192.168.10.255

one bit borrowed:

ID	Range	Broadcast
192.168.10.0/25	192.168.10.1 – 192.168.10.126	192.168.10.127
192.168.10.128/25	192.168.10.129 – 192.168.10.254	192.168.10.255

اذا اردنا تقسيم الشبكة الخاصة بنا الى اثنتين هذا يعني ان عدد الاحتمالات 256 سيتم تقسيمه الى اثنين كل واحد حجمه 128. اي ان عدد البتس التي تدل على الجهاز سيصبح 7 حيث ان 2^7 = 128 اي ان البريفكس الخاص بالشبكة هو 32 – 7 = 25 اي اننا اقترضنا بت من الجزء الخاص بالجهاز و اعطيناه للشبكة. الآن لدينا نطاقان 0 – 127 و 128 – 255 الرقم الاول فيهما هو الهوية الجديدة و الثاني هو البرودكاست.

The Subnet Mask

The way to write your prefix is by writing a number of 32 bits called the subnet mask. The bits corresponding to the network portion are made ones while the host portion bits are zeros. So a prefix of 24 is : 11111111.11111111.11111111.00000000 = 255.255.255.0.

لتمثيل البريفكس نكتب رقم من 32 بت يسمى قناع الشبكة. البتس المقابلة لجزء الشبكة تكون قيمتها 1 و المقابلة لجزء الجهاز تكون صفر.

The Block Size

since the smallest network has two hosts with a network ID and broadcast address that means the smallest block size is 4 ie. Two bits for the host portion leaving 30 for the network. And since each class has it's minimum prefix (default subnet mask) that means each class has a range of prefixes:

A: 8- 30
B: 16 – 30
C: 24 – 30

بما ان اصغر شبكة هي المكونة من جهازين لهما هوية شبكة و عنوان برودكاست هذا يعني ان اصغر حجم نطاق هو 4 بمعنى ان هنالك بتين يدلان على الجهاز و 30 تدل على الشبكة. و بما ان كل فئة لها حد ادنى يسمى قناع الشبكة الافتراضي هذا يعني ان هنالك مجموعة احتمالات لكل فئة:

A: 8- 30
B: 16 – 30
C: 24 – 30

Classful and Classless Networks

Whe we use the same subnet mask in all subnets our network is called a classful network. And when we use different subnet masks in our subnets then our network is classless.

عندما نستخدم نفس قناع الشبكة في كل اجزاء الشبكة تسمى الشبكة كلاسفل و عندما نستخدم قناع شبكة مختلف في شبكاتنا الفرعية تسمى الشبكة كلاسلس.

Rules

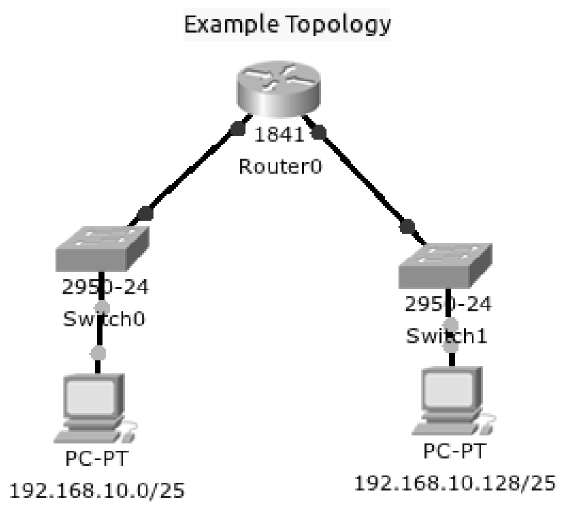
Number of subnets = 2^n where n: the number of borrowed bits
Block size = 2^n where n: the number of zeros left

valid host IP = Block size – 2 (Net ID and Broadcast address)

Subnetting Class C (25 - 30)

Ex1:192.168.10.0/25
Solution:
Number of borrowed bits = 25 – 24 = 1
Number of subnets = 2^1 = 2 subnets
Number of zeros = 32 – 25 = 7
Block size = 2^7 = 128 (0 – 127 and 128 - 255)
Valid Host IP = 128 – 2 = 126
192.168.10.0 = **11000000.10101000.00001010.0** 0000000
192.168.10.127 = **11000000.10101000.00001010.0** 1111111
192.168.10.128 = **11000000.10101000.00001010.1** 0000000
192.168.10.255 = **11000000.10101000.00001010.1** 1111111

ID	Subnet Mask	Range	Broadcast
192.168.10.0	255.255.255.128	192.168.10.1 – 192.168.10.126	192.168.10.127
192.168.10.128	255.255.255.128	192.168.10.129 – 192.168.10.254	192.168.10.255



Ex2:192.168.10.0/26
Solution:
Number of borrowed bits = 26 – 24 = 2
Number of subnets = 2^2 = 4 subnets
Number of zeros = 32 – 26 = 6
Block size = 2^6 = 64 (0 – 63 , 64 – 127, 128 – 191 , 192 - 255)
Valid Host IP = 64 – 2 = 62
192.168.10.0 = **11000000.10101000.00001010.00** 000000

192.168.10.63 = **11000000.10101000.00001010.00** 111111
192.168.10.64 = **11000000.10101000.00001010.01** 000000
192.168.10.127 = **11000000.10101000.00001010.01** 111111

192.168.10.128 = **11000000.10101000.00001010.10** 000000
192.168.10.191 = **11000000.10101000.00001010.10** 111111
192.168.10.192 = **11000000.10101000.00001010.11** 000000
192.168.10.255 = **11000000.10101000.00001010.11** 111111

ID	Subnet Mask	Range	Broadcast
192.168.10.0	255.255.255.192	192.168.10.1 – 192.168.10.62	192.168.10.63
192.168.10.64	255.255.255.192	192.168.10.65 – 192.168.10.126	192.168.10.127
192.168.10.128	255.255.255.192	192.168.10.129 – 192.168.10.190	192.168.10.191
192.168.10.192	255.255.255.192	192.168.10.193 – 192.168.10.254	192.168.10.255

Ex3:192.168.10.0/27
Solution:
Number of borrowed bits = 27 – 24 = 3
Number of subnets = 2^3 = 8 subnets
Number of zeros = 32 – 27 = 5
Block size = 2^5 = 32 (0 – 31 , 32-63 , 64-95, 96 – 127, 128 – 159, 160 – 191 , 192-223,224 - 255)
Valid Host IP = 32 – 2 = 30

ID	Subnet Mask	Range	Broadcast
192.168.10.0	255.255.255.224	192.168.10.1 – 192.168.10.30	192.168.10.31
192.168.10.32	255.255.255.224	192.168.10.33 – 192.168.10.62	192.168.10.63
192.168.10.64	255.255.255.224	192.168.10.65 – 192.168.10.94	192.168.10.95
192.168.10.96	255.255.255.224	192.168.10.97 – 192.168.10.126	192.168.10.127
192.168.10.128	255.255.255.224	192.168.10.129 – 192.168.10.158	192.168.10.159
192.168.10.160	255.255.255.224	192.168.10.161 – 192.168.10.190	192.168.10.191
192.168.10.192	255.255.255.224	192.168.10.193 – 192.168.10.222	192.168.10.223
192.168.10.224	255.255.255.224	192.168.10.225 – 192.168.10.254	192.168.10.255

Ex4:192.168.10.0/28
Solution:
Number of borrowed bits = 28 – 24 = 4
Number of subnets = 2^4 = 16 subnets
Number of zeros = 32 – 28 = 4
Block size = 2^4 = 16
Valid Host IP = 16 – 2 = 14

ID	Subnet Mask	Range	Broadcast
192.168.10.0	255.255.255.240	192.168.10.1 – 192.168.10.14	192.168.10.15
192.168.10.16	255.255.255.240	192.168.10.17 – 192.168.10.30	192.168.10.31
192.168.10.32	255.255.255.240	192.168.10.33 – 192.168.10.46	192.168.10.47
192.168.10.48	255.255.255.240	192.168.10.49 – 192.168.10.62	192.168.10.63
192.168.10.64	255.255.255.240	192.168.10.65 – 192.168.10.78	192.168.10.79
192.168.10.80	255.255.255.240	192.168.10.81 – 192.168.10.94	192.168.10.95
192.168.10.96	255.255.255.240	192.168.10.97 – 192.168.10.110	192.168.10.111
192.168.10.112	255.255.255.240	192.168.10.113 – 192.168.10.126	192.168.10.127
192.168.10.128	255.255.255.240	192.168.10.129 – 192.168.10.142	192.168.10.143
192.168.10.144	255.255.255.240	192.168.10.145 – 192.168.10.158	192.168.10.159
192.168.10.160	255.255.255.240	192.168.10.161 – 192.168.10.174	192.168.10.175
192.168.10.176	255.255.255.240	192.168.10.177– 192.168.10.190	192.168.10.191
192.168.10.192	255.255.255.240	192.168.10.193 – 192.168.10.206	192.168.10.207
192.168.10.208	255.255.255.240	192.168.10.209 – 192.168.10.222	192.168.10.223
192.168.10.224	255.255.255.240	192.168.10.225 – 192.168.10.238	192.168.10.239
192.168.10.240	255.255.255.240	192.168.10.241 – 192.168.10.254	192.168.10.255

Ex5:192.168.10.0/29
Solution:
Number of borrowed bits = 29 – 24 = 5
Number of subnets = 2^5 = 32 subnets
Number of zeros = 32 – 29 = 3
Block size = 2^3 = 8
Valid Host IP = 8 – 2 = 6
Subnet Mask: 255.255.255.248
IDs: 0,8,16,24,32,40,48,.......,248

Ex6:192.168.10.0/30
Solution:
Number of borrowed bits = 30 – 24 = 6
Number of subnets = 2^6 = 64 subnets
Number of zeros = 32 – 30 = 2
Block size = 2^2 = 4
Valid Host IP = 4 – 2 = 2
Subnet Mask: 255.255.255.252
IDs: 0,4,8,12,16,20,24,28,32,36,40,44,48,.......,248,252

Subnetting Class B (17 – 30)

Ex1:172.16.0.0/17
Solution:
Number of borrowed bits = 17 – 16 = 1
Number of subnets = 2^1 = 2 subnets
Number of zeros = 32 – 17 = 15
Block size = 2^15 = 32k = 32568
Valid Host IP = 32568 – 2 = 32566
Subnet Mask: 255.255.128.0
since the subnet mask is 16>17<25 that means we are working in the 3rd octet so inorder to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 3rd byte = 8-1 = 7
Block size in the 3rd octet = 2^7 = 128

ID	Subnet Mask	Range	Broadcast
172.16.0.0	255.255.128.0	172.16.0.1 – 172.16.127.254	172.16.0.127.255
172.16.128.0	255.255.128.0	172.16.128.1 – 172.16.255.254	172.16.255.255

Ex2:172.16.0.0/18
Solution:
Number of borrowed bits = 18 – 16 = 2
Number of subnets = 2^2 = 4 subnets
Number of zeros = 32 – 18 = 14
Block size = 2^14 = 16k
Valid Host IP = 16k-2
Subnet Mask: 255.255.192.0

since the subnet mask is 16>18<25 that means we are working in the 3rd octet so inorder to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 3rd byte = 8-2 = 6
Block size in the 3rd octet = 2^6 = 64

ID	Subnet Mask	Range	Broadcast
172.16.0.0	255.255.192.0	172.16.0.1 – 172.16.63.254	172.16.0.63.255
172.16.64.0	255.255.192.0	172.16.64.1 – 172.16.127.254	172.16.127.255
172.16.128.0	255.255.192.0	172.16.128.1 – 172.16.191.254	172.16.191.255
172.16.192	255.255.192.0	172.16.192.1 – 172.16.255.254	172.16.255.255

Ex3:172.16.0.0/19
Solution:
Number of borrowed bits = 19 – 16 = 3
Number of subnets = 2^3 = 8 subnets
Number of zeros = 32 – 19 = 13
Block size = 2^13 = 8k
Valid Host IP = 8k-2
Subnet Mask: 255.255.224.0
since the subnet mask is 16>19<25 that means we are working in the 3rd octet so inorder to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 3rd byte = 8-3 = 5
Block size in the 3rd octet = 2^5= 32

ID	Subnet Mask	Range	Broadcast
172.16.0.0	255.255.224.0	172.16.0.1 – 172.16.31.254	172.16.0.31.255
172.16.32.0	255.255.224.0	172.16.32.1 – 172.16.63.254	172.16.63.255
172.16.64.0	255.255.224.0	172.16.64.1 – 172.16.95.254	172.16.95.255
172.16.96.0	255.255.224.0	172.16.96.1 – 172.16.127.254	172.16.127.255
172.16.128.0	255.255.224.0	172.16.128.1 – 172.16.159.254	172.16.159.255
172.16.160.0	255.255.224.0	172.16.160.1 – 172.16.191.254	172.16.191.255
172.16.192.0	255.255.224.0	172.16.192.1 – 172.16.223.254	172.16.223.255
172.16.224.0	255.255.224.0	172.16.224.1 – 172.16.255.254	172.16.255.255

Ex4:172.16.0.0/20
Solution:
Number of borrowed bits = 20 – 16 = 4
Number of subnets = 2^4 = 16 subnets
Number of zeros = 32 – 20 = 12
Block size = 2^12 = 4k
Valid Host IP = 4k-2
Subnet Mask: 255.255.240.0
since the subnet mask is 16>20<25 that means we are working in the 3^{rd} octet so inorder to find the ID it is easier to find the block size in the 3^{rd} byte.
Number of zeros in the 3^{rd} byte = 8-4 =4
Block size in the 3^{rd} octet = 2^4= 16
IDs: 0.0, 16.0, 32.0,...., 240.0

Ex5:172.16.0.0/21
Solution:
Number of borrowed bits = 21 – 16 = 5
Number of subnets = 2^5 = 32 subnets
Number of zeros = 32 – 21 = 11
Block size = 2^11 = 2k
Valid Host IP = 2k-2
Subnet Mask: 255.255.248.0
since the subnet mask is 16>21<25 that means we are working in the 3^{rd} octet so inorder to find the ID it is easier to find the block size in the 3^{rd} byte.
Number of zeros in the 3^{rd} byte = 8-5 =3
Block size in the 3^{rd} octet = 2^3= 8
IDs: 0.0, 8.0,16.0,24.0, 32.0,...., 248.0

Ex6:172.16.0.0/22
Solution:
Number of borrowed bits = 22 – 16 = 6
Number of subnets = 2^6 = 64 subnets
Number of zeros = 32 – 22 = 10
Block size = 2^10 = 1k
Valid Host IP = 1k-2
Subnet Mask: 255.255.252.0
since the subnet mask is 16>22<25 that means we are working in the 3^{rd} octet so inorder to find the ID it is easier to find the block size in the 3^{rd} byte.
Number of zeros in the 3^{rd} byte = 8-6 =2
Block size in the 3^{rd} octet = 2^2= 4
IDs: 0.0, 4.0,8.0,12.0, 16.0,...., 252.0

Ex7:172.16.0.0/23
Solution:
Number of borrowed bits = 23 – 16 = 7
Number of subnets = 2^7 = 128 subnets
Number of zeros = 32 – 23 = 9
Block size = 2^9 = 512
Valid Host IP = 512-2 = 510
Subnet Mask: 255.255.254.0

since the subnet mask is 16>23<25 that means we are working in the 3rd octet so inorder to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 3rd byte = 8-7 =1
Block size in the 3rd octet = 2^1= 2
IDs: 0.0, 2.0,4.0,6.0, 8.0,...., 254.0

Ex8:172.16.0.0/24
Solution:
Number of borrowed bits = 24 – 16 = 8
Number of subnets = 2^8 = 256 subnets
Number of zeros = 32 – 24 = 8
Block size = 2^8 = 256
Valid Host IP = 256-2 = 254
Subnet Mask: 255.255.255.0
since the subnet mask is 16>24<25 that means we are working in the 3rd octet so inorder to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 3rd byte = 8-8 =0
Block size in the 3rd octet = 2^0= 1
IDs: 0.0, 1.0,2.0,3.0, 4.0,...., 255.0

Ex9:172.16.0.0/25
Solution:
Number of borrowed bits = 25 – 16 = 9
Number of subnets = 2^9 = 512 subnets
Number of zeros = 32 – 25 = 7
Block size = 2^7 = 128
Valid Host IP = 128-2 = 126
Subnet Mask: 255.255.255.128
IDs: 0.0, 0.128,1.0,1.128, 2.0,...., 255.0,255.128

Ex10:172.16.0.0/26
Solution:
Number of borrowed bits = 26 – 16 = 10
Number of subnets = 2^10 = 1024 subnets
Number of zeros = 32 – 26 = 6
Block size = 2^6 = 64
Valid Host IP = 64-2 = 62
Subnet Mask: 255.255.255.192
IDs: 0.0, 0.64,0.128,0.192,1.0,1.64,1.128, 1.192,..., 255.0,255.64,255.128,255.192

Ex11:172.16.0.0/27
Solution:
Number of borrowed bits = 27 – 16 = 11
Number of subnets = 2^11 = 2048 subnets
Number of zeros = 32 – 27 = 5
Block size = 2^5 = 32
Valid Host IP = 32-2 = 30
Subnet Mask: 255.255.255.224
IDs: 0.0, 0.32,0.64,0.96,0.128,0.160,0.192,0.224,1.0,..., 255.160,255.192,255.224

Ex12:172.16.0.0/28
Solution:
Number of borrowed bits = 28 – 16 = 12
Number of subnets = 2^12 = 4096 subnets
Number of zeros = 32 – 28 = 4
Block size = 2^4 = 16
Valid Host IP = 16-2 =14
Subnet Mask: 255.255.255.240
IDs: 0.0,0.16,..., 255.240

Ex13:172.16.0.0/29
Solution:
Number of borrowed bits = 29 – 16 = 13
Number of subnets = 2^13 = 8192 subnets
Number of zeros = 32 – 29 = 3
Block size = 2^3 = 8
Valid Host IP = 8-2 =6
Subnet Mask: 255.255.255.248
IDs: 0.0,0.8,0.16,..., 255.248

Ex14:172.16.0.0/30
Solution:
Number of borrowed bits = 30 – 16 = 14
Number of subnets = 2^14 = 16k subnets
Number of zeros = 32 – 30 = 2
Block size = 2^2 = 4
Valid Host IP = 4-2 =2
Subnet Mask: 255.255.255.252
IDs: 0.0,0.4,0.8,0.12,0.16,..., 255.252

Subnetting Class A (9 – 30)

Ex1:10.0.0.0/9
Solution:
Number of borrowed bits = 9 – 8 = 1
Number of subnets = 2^1 = 2 subnets
Number of zeros = 32 – 9 = 23
Block size = 2^23 = 8M
Valid Host IP =8M – 2
Subnet Mask: 255.128.0.0
since the subnet mask is 8>9<17 that means we are working in the 2rd octet so in order to find the ID it is easier to find the block size in the 2rd byte.
Number of zeros in the 2rd byte = 8-1 = 7
Block size in the 3rd octet = 2^7 = 128

ID	Subnet Mask	Range	Broadcast
10.0.0.0	255.128.0.0	10.0.0.1 – 10.127.255.254	10.127.255.255
10.128.0.0	255.128.0.0	10.128.0.1 – 10.255.255.254	10.255.255.255

Ex2:10.0.0.0/10
Solution:
Number of borrowed bits = 10 – 8 = 2
Number of subnets = 2^2 = 4 subnets
Number of zeros = 32 – 10 = 22
Block size = 2^22 = 4M
Valid Host IP =4M – 2
Subnet Mask: 255.192.0.0
since the subnet mask is 8>10<17 that means we are working in the 2rd octet so in order to find the ID it is easier to find the block size in the 2rd byte.
Number of zeros in the 2rd byte = 8-2 = 6
Block size in the 3rd octet = 2^6 = 64

ID	Subnet Mask	Range	Broadcast
10.0.0.0	255.192.0.0	10.0.0.1 – 10.63.255.254	10.63.255.255
10.64.0.0	255.192.0.0	10.64.0.1 – 10.127.255.254	10.127.255.255
10.128.0.0	255.192.0.0	10.128.0.1 – 10.191.255.254	10.191.255.255
10.192.0.0	255.192.0.0	10.192.0.1 – 10.255.255.254	10.255.255.255

Ex2:10.0.0.0/11
Solution:
Number of borrowed bits = 11 – 8 = 3
Number of subnets = 2^3 = 8 subnets
Number of zeros = 32 – 11 = 21
Block size = 2^22 = 2M
Valid Host IP =2M – 2
Subnet Mask: 255.224.0.0
since the subnet mask is 8>11<17 that means we are working in the 2rd octet so in order to find the ID it is easier to find the block size in the 2rd byte.
Number of zeros in the 2rd byte = 8-3 = 5
Block size in the 3rd octet = 2^5= 32
IDS:
10.0.0.0
10.32.0.0
10.64.0.0
….
10.224.0.0

Ex3:10.0.0.0/12

Solution:
Number of borrowed bits = 12 – 8 = 4
Number of subnets = 2^4 = 16 subnets
Number of zeros = 32 – 12 = 20
Block size = 2^20 = 1M
Valid Host IP =1M – 2
Subnet Mask: 255.240.0.0
since the subnet mask is 8>12<17 that means we are working in the 2rd octet so in order to find the ID it is easier to find the block size in the 2rd byte.
Number of zeros in the 2rd byte = 8-4 = 4
Block size in the 3rd octet = 2^4= 16
IDS:
10.0.0.0
10.16.0.0
10.32.0.0
….
10.240.0.0

Ex4:10.0.0.0/13
Solution:
Number of borrowed bits = 13 – 8 = 5
Number of subnets = 2^5 = 32 subnets
Number of zeros = 32 – 13 = 19
Block size = 2^19 = 512k
Valid Host IP =512k – 2
Subnet Mask: 255.248.0.0
since the subnet mask is 8>13<17 that means we are working in the 2rd octet so in order to find the ID it is easier to find the block size in the 2rd byte.
Number of zeros in the 2rd byte = 8-5 = 3
Block size in the 3rd octet = 2^3= 8
IDS:
10.0.0.0
10.8.0.0
10.16.0.0
….
10.248.0.0

Ex5:10.0.0.0/14
Solution:
Number of borrowed bits = 14 – 8 = 6
Number of subnets = 2^6 = 64 subnets
Number of zeros = 32 – 14 = 18
Block size = 2^18 = 256k
Valid Host IP =256k – 2
Subnet Mask: 255.252.0.0
since the subnet mask is 8>14<17 that means we are working in the 2rd octet so in order to find the ID it is easier to find the block size in the 2rd byte.
Number of zeros in the 2rd byte = 8-6 = 2
Block size in the 3rd octet = 2^2= 4
IDS:
10.0.0.0

10.4.0.0
10.8.0.0
….
10.252.0.0

Ex6:10.0.0.0/15
Solution:
Number of borrowed bits = 15 – 8 = 7
Number of subnets = 2^7 = 128 subnets
Number of zeros = 32 – 15 = 17
Block size = 2^17 = 128k
Valid Host IP =128k – 2
Subnet Mask: 255.254.0.0
since the subnet mask is 8>15<17 that means we are working in the 2^{rd} octet so in order to find the ID it is easier to find the block size in the 2^{rd} byte.
Number of zeros in the 2^{rd} byte = 8- 7 = 1
Block size in the 3^{rd} octet = 2^1= 2
IDS:
10.0.0.0
10.2.0.0
10.4.0.0
….
10.254.0.0

Ex7:10.0.0.0/16
Solution:
Number of borrowed bits = 16 – 8 = 8
Number of subnets = 2^8 = 256 subnets
Number of zeros = 32 – 16 = 16
Block size = 2^16 = 64k
Valid Host IP =64k – 2
Subnet Mask: 255.255.0.0
since the subnet mask is 8>16<17 that means we are working in the 2^{rd} octet so in order to find the ID it is easier to find the block size in the 2^{rd} byte.
Number of zeros in the 2^{rd} byte = 8- 8 = 0
Block size in the 3^{rd} octet = 2^0= 1
IDS:
10.0.0.0
10.1.0.0
10.2.0.0
….
10.255.0.0

Ex8:10.0.0.0/17
Solution:
Number of borrowed bits = 17 – 8 = 9
Number of subnets = 2^9 = 512 subnets
Number of zeros = 32 – 17 = 15
Block size = 2^15 = 32k
Valid Host IP =32k – 2
Subnet Mask: 255.255.128.0

since the subnet mask is 16>17<25 that means we are working in the 3rd octet so in order to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 2rd byte = 8- 1 = 7
Block size in the 3rd octet = 2^7= 128
IDS:
10.0.0.0
10.0.128.0
10.1.0.0
10.1.128.0
….
10.255.0.0
10.255.128.0

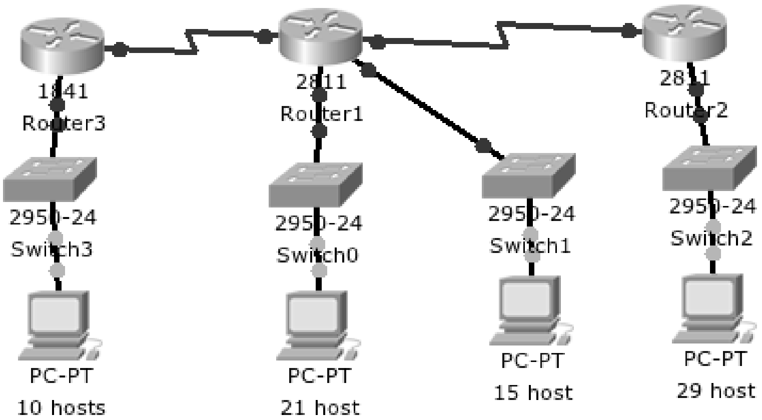
Ex9:10.0.0.0/18
Solution:
Number of borrowed bits = 18 – 8 = 10
Number of subnets = 2^10 = 1024 subnets
Number of zeros = 32 – 18 = 14
Block size = 2^14 = 16k
Valid Host IP =16k – 2
Subnet Mask: 255.255.192.0
since the subnet mask is 16>18<25 that means we are working in the 3rd octet so in order to find the ID it is easier to find the block size in the 3rd byte.
Number of zeros in the 2rd byte = 8- 2 = 6
Block size in the 3rd octet = 2^6= 64
IDS:
10.0.0.0
10.0.64.0
10.0.128.0
10.0.192.0
10.1.0.0
10.1.64.0
….
10.255.128.0
10.255.192.0

Ex10:10.0.0.0/25
Solution:
Number of borrowed bits = 25 – 8 = 17
Number of subnets = 2^17 = 128k subnets
Number of zeros = 32 – 25 = 7
Block size = 2^7 = 128
Valid Host IP = 128 – 2 =126
Subnet Mask: 255.255.255.128

1st Octet	2nd Octet	3rd Octed	4th Octet
10	0,1,....,255	0,1,....,255	0,128

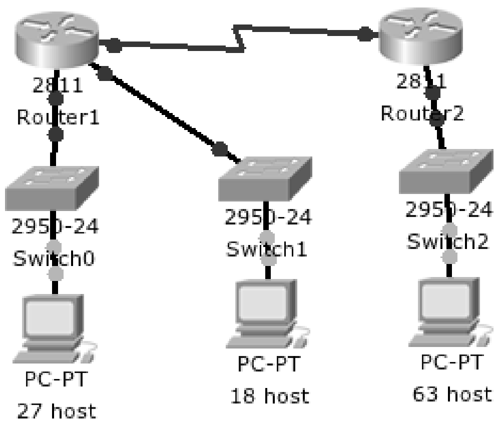
Topology Design

Example 1:



Solution:From the topology above the number of networks is 6 (4 LANs and 2 WANs) that means we need to subnet our network into 8 subnets. The maximum number of hosts is 29 which means we need a block size of 32.
subnets = 8
Block size = 32
the total network size = 8 x 32 = 256 that means class C network is enough
for the subnetting refer to Subnetting Class C EX3.

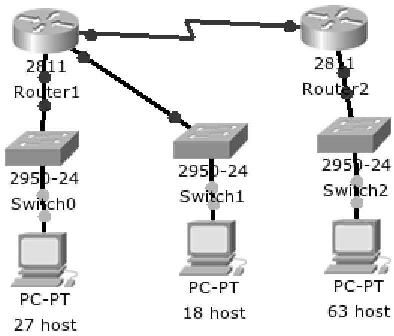
Example 2:



Solution:From the topology above the number of networks is 4 (3 LANs and 1 WAN) that means we need to subnet our network into 4 subnets. The maximum number of hosts is 63 which means we need a block size of 128.
subnets = 4
Block size = 128
the total network size = 4 x 128 = 512 that means class C network is not enough then we select a class B network.
Two solution : 4 subnets each of size 16K (Subnetting Class B EX2)
or 512 subnet each of block size 128 (Subnetting Class B Ex9)

CIDR (Classless Inter-Domain Routing)

CIDR means that network subnets could have different Subnet Masks. So the concept is to use variable length subnet masks (VLSM).
VLSM is actually subnetting a subnet.
Suppose we have the following topology

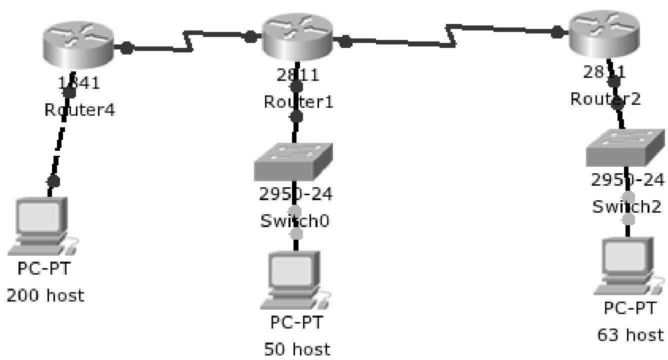


when we tried to use subnetting we found that class C is not enough. Now lets try and use VLSM.
1. The first step is to give names to the network from largest to smallest and find their block sizes:
A: 63 hosts block size: 128
B: 27 hosts block size: 32
C: 18 hosts block size: 32
D: 2 hosts block size: 4

2. The sum of all blocks = 128+32+32+4 = 196 which is less than the block size of a class C network then class C is enough.
3. The first round is to subnet a class C network according to the largest block size (128)
IDs: 192.168.10.0, 192.168.10.128 SM: 255.255.255.128
A: 192.168.10.0/27

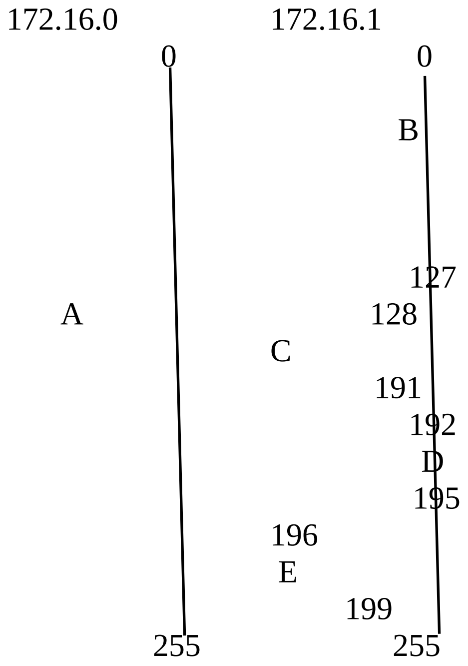
this leaves the subnet 128 unused
4. Then we subnet 128 according to the second largest block size (32):
IDs: 192.168.10.128, 192.168.10.160, 192.168.10.192, 192.168.10.224 SM:255.255.255.224
B: 192.168.10.128/27
C: 192.168.10.160/27
this leaves the 3rd and 4th subnets unused.
5. Then we take one (192) and subnet it to next block size (4):
IDs: 192.168.10.192/30, 192.168.10.196/30, ..., 192.168.10.252/30
E: 192.168.10.192/30
6. That means we used the range 192.168.10.0 – 192.168.10.195 to address all of our subnets and we have 192.168.10.196 – 192.168.10.255 for future use.

Example 2:



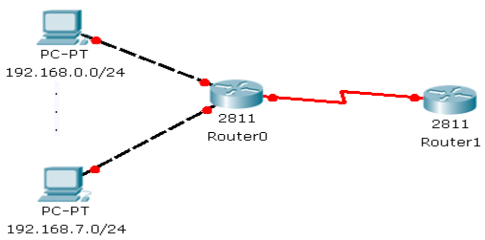
Subnet	Hosts	Block Size	Subnet mask	ID
A	200	256	24	172.16.0.0
B	63	128	25	172.16.1.0
C	50	64	26	172.16.1.128
D	2	4	30	172.16.1.192
E	2	4	30	172.16.1.196

The Sum of block sizes = 256+128+64+4+4= 456 > 256 then class C is not enough. Move to class B.



Summarization

Summarization is the grouping of multiple networks into one super network (supernet), this is also called router summarization it's done by routers advertising multiple continuous networks representing a block of networks. This means that the resulting route will include a prefix less than the minimum default prefix (for example 10.0.0.0 /7 or 172.16.0.0/13 or 192.168.0.0/22).
التلخيص هو تجميع مجموعة من الشبكات في شبكة واحدة كبيرةتسمى السوبرنت و تسمى هذه العملية تلخيص الطرق حيث تقوم الراوترات التي تريد الاعلان عن مجموعة من الشبكات المتتالية بتلخيصها هذا يعني ان الشبكة الناتجة سيكون قناع الشبكة الخاص بها اقل من القناع الافتراضي.
Example:
suppose we have 8 networks connected to Router0 ranging from 192.168.0.0/24 to 192.168.7.0/24 now when router0 wants to advertise these networks to router1 it will summarize them to one supernet route 192.168.0.0/21.



how is it done?
Write all the network IDs in binary and find out the shared bits.
11000000.10101000.00000000.00000000 192.168.0.0
11000000.10101000.00000001.00000000 192.168.1.0
11000000.10101000.00000010.00000000 192.168.2.0
11000000.10101000.00000011.00000000 192.168.3.0
11000000.10101000.00000100.00000000 192.168.4.0
11000000.10101000.00000101.00000000 192.168.5.0
11000000.10101000.00000110.00000000 192.168.6.0
11000000.10101000.00000111.00000000 192.168.7.0
the number of shared bits indicated by the bold font is 21 this represents the new prefix. Now zero all remaining bits and you will get the new ID 192.168.0.0. so the supernet route is 192.168.0.0/24.
Example 2:
Suppose that router0 has the following networks attached to its fastethernet interfaces:
172.16.0.0/16
172.17.0.0/16
172.18.0.0/16
172.19.0.0/16
10101100.00010000.00000000.00000000 172.16.0.0
10101100.00010001.00000000.00000000 172.17.0.0
10101100.00010010.00000000.00000000 172.18.0.0
10101100.00010011.00000000.00000000 172.19.0.0
the bold bits represent shared bits between the subnets this means the summary prefix is 14 now to find the new ID leave the first 14 bits as is and zero the others this gives us 172.16.0.0 so the supernet route is 172.16.0.0/14.
Example 3:
Find a summary route for:
172.20.0.0/16
172.21.0.0/16
172.22.0.0/16
172.23.0.0/16
172.24.0.0/16
Solution:
10101100.00011000.00000000.00000000 172.20.0.0
10101100.00011001.00000000.00000000 172.21.0.0
10101100.00011010.00000000.00000000 172.22.0.0
10101100.00011011.00000000.00000000 172.23.0.0

*10101100.00011*100.00000000.00000000 172.24.0.0
The first 4 networks have 14 shared bits now if we try to include the forth that means 13 bits are shared.
First summary 172.20.0.0/14 is for 172.20.0.0 – 172.23.0.0
Second summary 172.20.0.0/13 is for 172.20.0.0 – 172.27.0.0
we could use the first one to summarize only 172.20.0.0 – 172.23.0.0 and 172.24.0.0/16 should be advertised alone. If we use the second summary 172.20.0.0/13 we will be saying that we have 172.20.0.0 – 172.27.0.0 which we don't. So the first option is better.
إذا من باب الاختصار عملية السمرايزيشن (التلخيص) هي عبارة عن إيجاد عدد البتس المشتركة بين الشبكات المختلفة لإيجاد قناع شبكة و هوية تضم كافة عناوين الآيبي التي تضمها الشبكات المختلفة بشرط أن لا نشمل أي عناوين ليست موجودة عندنا.