Address Space Utilization

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Recap

- Hierarchical addressing based on classes (A,B,C) to handle scalability and different network sizes
  - IP address has a network part and a host part
  - Routers maintain entries corresponding to network portion
- What can potentially go wrong now?

Problem Statement

- Network part uniquely identifies a physical network
- Network with just 2 hosts needs Class C address
  - Efficiency: 2/2^8 = 0.7%
- Network with 256 hosts needs a Class B address
  - Efficiency: 256/2^16 = 0.4 %

Problem Statement

- Class B addresses in high demand (keeping future needs in mind)
  - Host addresses ~ 4 billion (2^{32})
  - Class B networks: 2^{14} (~16000)
  - Out of class B addresses, out of addresses to hand out
- Need to solve "Address assignment inefficiency"
  - Challenge: Within IP framework (using 32-bits)

“The gem cannot be polished without friction, nor man perfected without trials.”

---Chinese proverb

“You see a mousetrap; I see free cheese and a ******* challenge!”

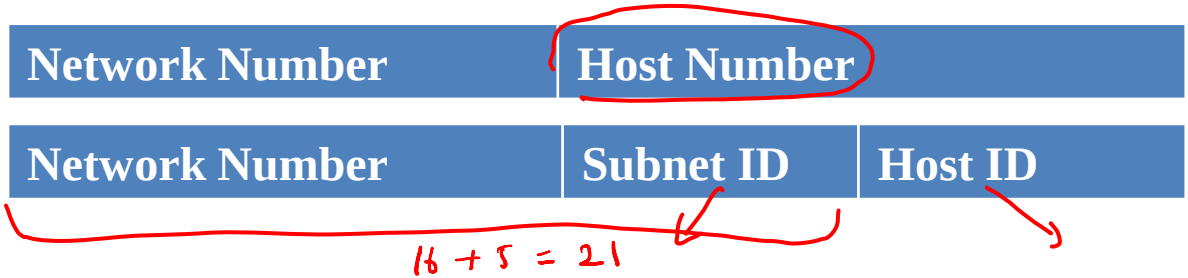
---Scroobius Pip

Specific Scenario –1

- An organization has 30 different physical networks, each network has about 2000 hosts
- Current Allocation: Allocate 30 class B addresses
  - Efficiency = 2000/2^16 = 3%
- Will one class B address suffice?
  - Can support 2^{16} = 65536 hosts > 30*2000

Solution: Subnetting

- Introduce another level of hierarchy
  - Divide host part into subnet id and host id



  - 16 host bits divided into 5 subnet bits (32 physical networks) and 11 host bits (2048 hosts)

- Address format: a.b.c.d/x, where x is # bits in net portion of address
  - Example: 190.23.12.17, mask is 255.255.248.0 (/21)
- ifconfig eth0 190.23.12.17 netmask 255.255.255.240
- The bit-wise end of the IP address and the subnet mask give the subnet number of the host
- All hosts on a given physical network have the same subnet number and mask

Class B Address: 10111110. 00010111. *. *; 190.23.0.0/16

32 Subnets

Subnet ID	Subnet No	Hosts
00000	190.23.0.0	190.23.0.1 – 190.23.7.254
00001	190.23.8.0	190.23.8.1 – 190.23.15.254
…….		
11111	190.23.248.0	190.23.248.1 – 190.23.255.254

- All routers outside organization have one entry (190.23.0.0/16)
- Routers within organization have more detailed entries corresponding to different subnets

Forwarding at a Router

D = Destination IP Address

For each forwarding table entry

T = D & SubnetMask

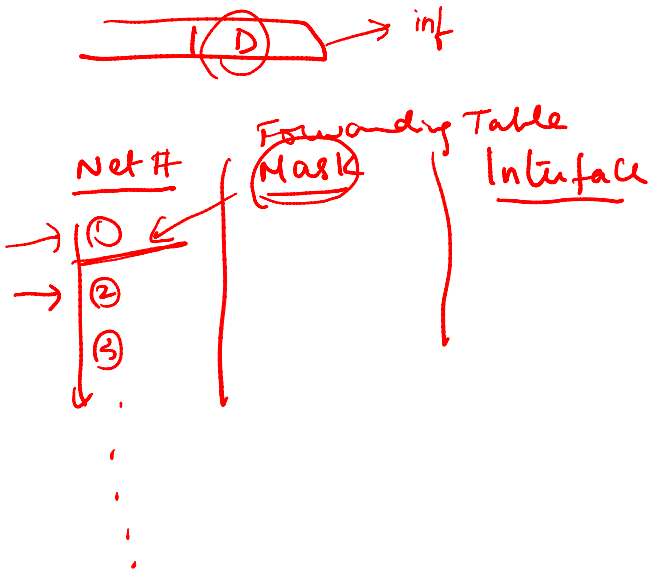
If T == SubnetNum

If Nexthop is an interface

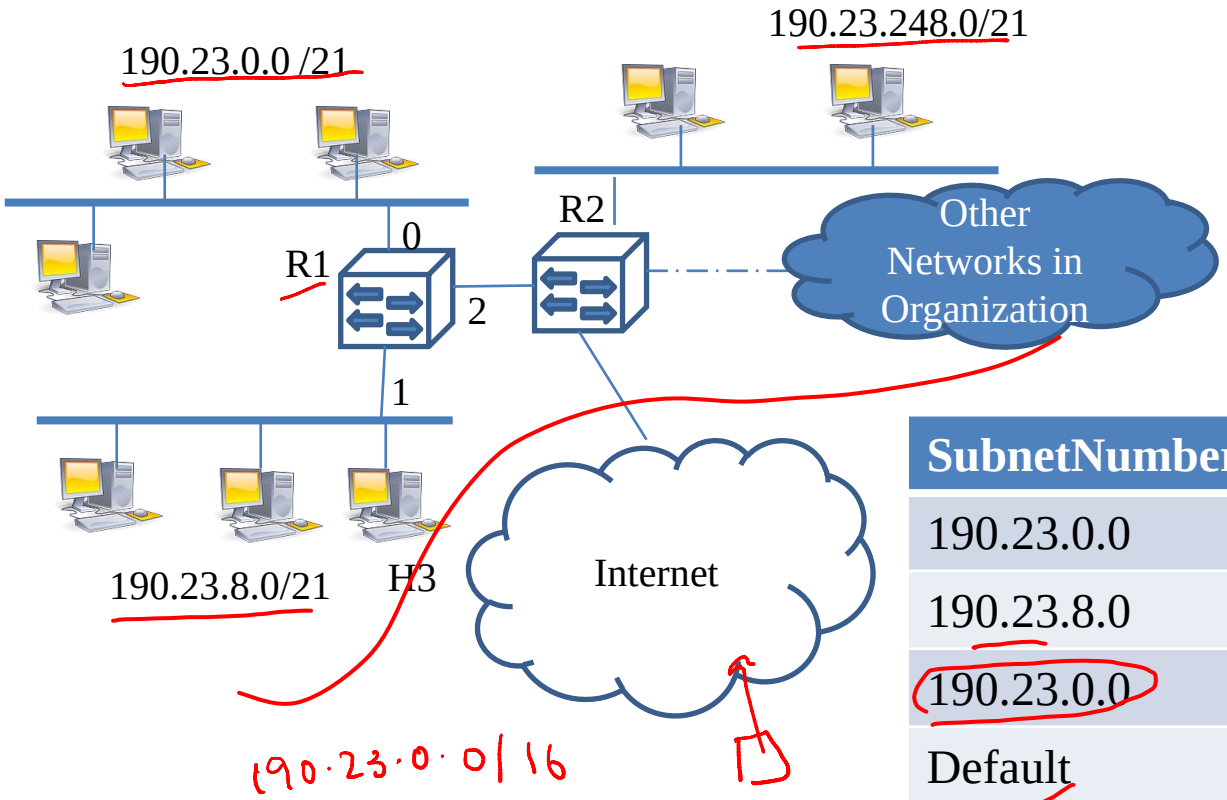
deliver datagram directly to destination

Else

deliver datagram to NextHop (router)



Example



Forwarding

Routing Table at R1

SubnetNumber	Mask	Nexthop
190.23.0.0	255.255.248.0	Inf0
190.23.8.0	255.255.248.0	Inf1
190.23.0.0	255.255.0.0	R2
Default	0.0.0.0	R2

```
kameswari@asterix:~$ route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.129.0.0      *               255.255.0.0     U     1      0        0 eth0
link-local      *               255.255.0.0     U     1000   0        0 eth0
default         router.it.iitb. 0.0.0.0         UG    0      0        0 eth0
kameswari@asterix:~$
kameswari@asterix:~$
kameswari@asterix:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.129.0.0      0.0.0.0         255.255.0.0     U     1      0        0 eth0
169.254.0.0     0.0.0.0         255.255.0.0     U     1000   0        0 eth0
0.0.0.0         10.129.250.1    0.0.0.0         UG    0      0        0 eth0
kameswari@asterix:~$
```