Addressing and Forwarding

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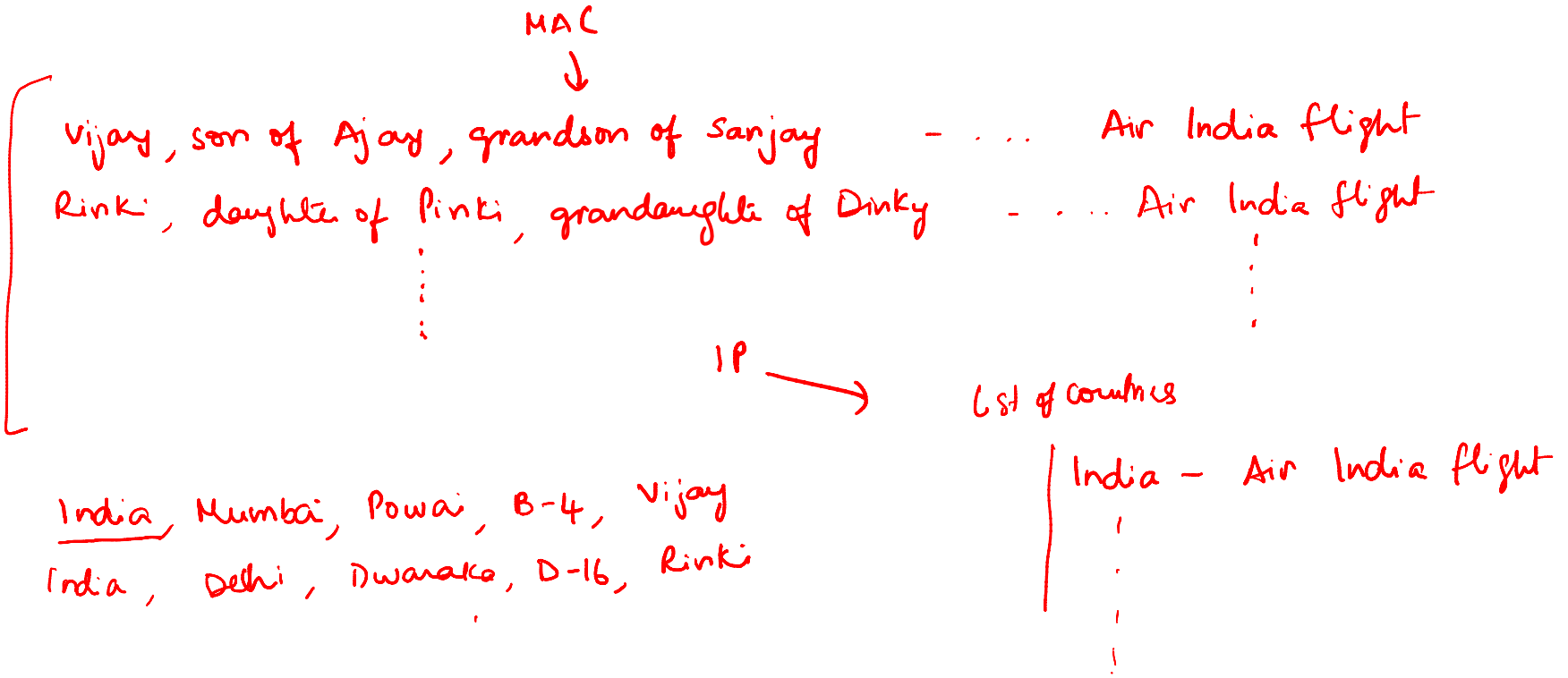
Problem Statement

- Flat Addressing: N hosts needs N entries in the table (MAC addresses)
- Millions of hosts, address lookup in forwarding becomes a bottleneck
- Need a method of reducing entries in the forwarding table for scalability purposes


MAC
Vijay, son of Ajay, grandson of Sanjay - ... Air India flight
Rinki, daughter of Pinki, grandaughter of Dinky - ... Air India flight
IP
List of countries
India - Air India flight
India, Mumbai, Powai, B-4, Vijay
India, Delhi, Dwaraka, D-16, Rinki

Solution: Hierarchical Addressing

- Structure to addresses: Address captures location in the network topology
- IP address (32 bits) consists of two parts: network and host
  - Network part identifies the network to which host is connected
  - Host part uniquely identifies each host in the network
- How does this help?
  - An entire network (in some specific direction) could be represented by a single entry at a router

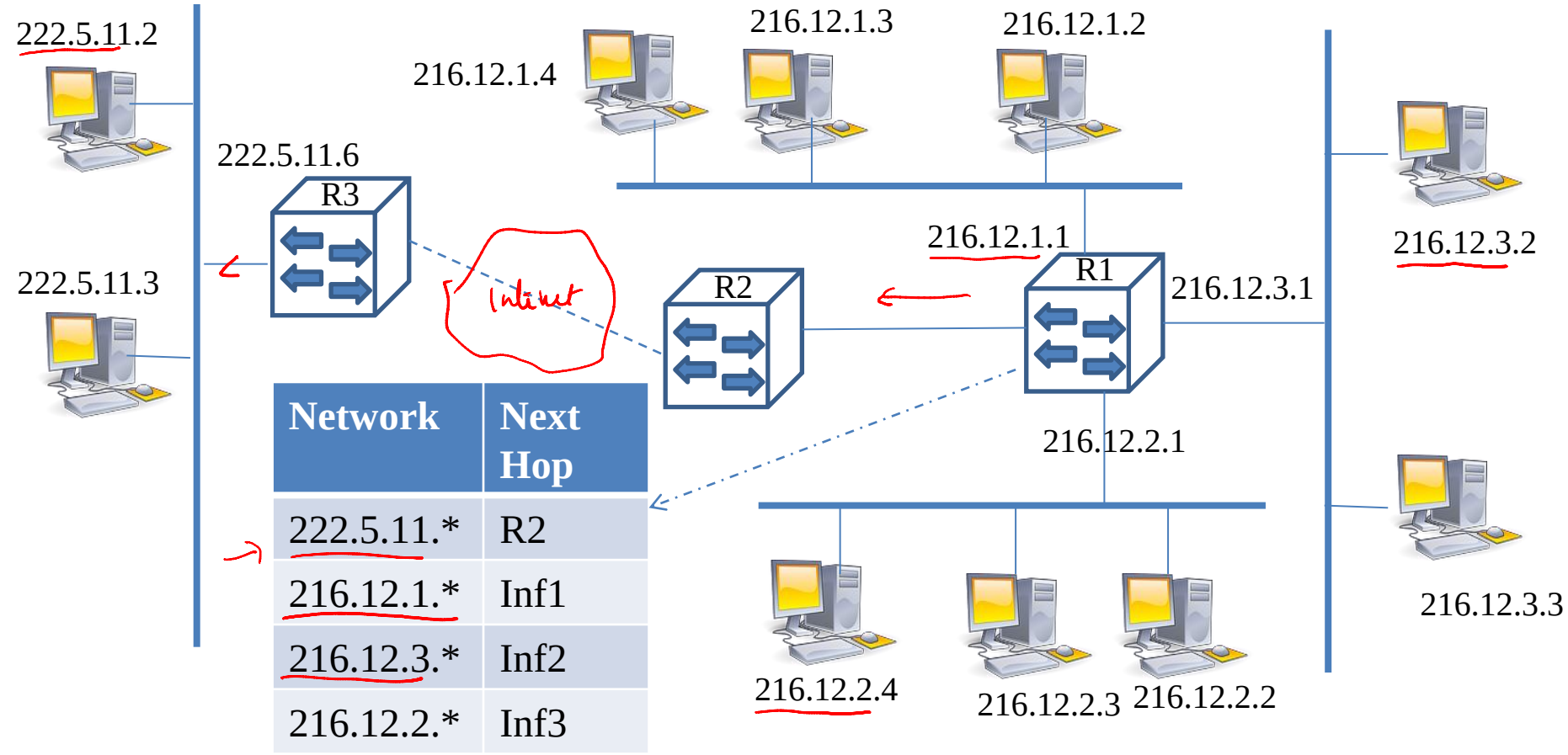
IP Address

- Size of network and host part are not the same
- Organizations obtain set of addresses of a given class
- Divided into five classes
  - Class A: 0, network(7), host(24); Mask 8
  - Class B: 10, network(14), host(16); Mask 16
  - Class C:110, network(21), host(8); Mask 24
  - Class D: 1110, bits-28 (Multicast)
  - Class E: 1111, bits 28 (Reserved)

IP Address

- Private IP addresses:
  - A: 10.0.0.0 through 10.255.255.255
  - B: 172.16.0.0 through 172.31.0.0
  - C: 192.168.0.0 through 192.168.255.0.
  - 127.0.0.1 is loopback address.

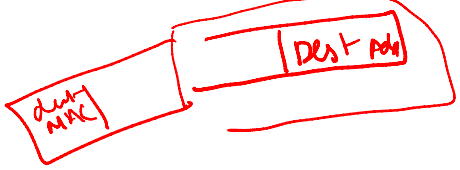
Example: Class C



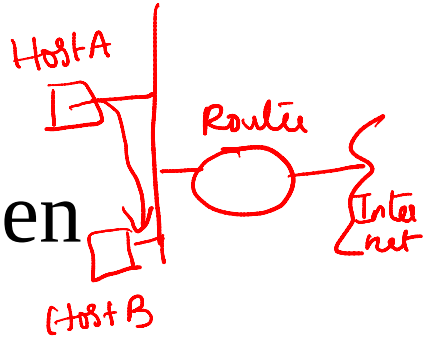
Network	Next Hop
222.5.11.*	R2
216.12.1.*	Inf1
216.12.3.*	Inf2
216.12.2.*	Inf3

Points to Note

- Every datagram contains IP address of destination host
  - Network part of IP address uniquely identifies a single physical network
- All nodes that share the same network part are connected to the same physical network
- Every physical network has at least one router that is connected to at least one other physical network.



Forwarding at Host

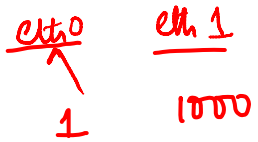


- If (NetNum of Dest = my NetNum) then
  - deliver packet to destination directly
  - use ARP to get MAC address corresponding to dest IP address

Else deliver packet to default router

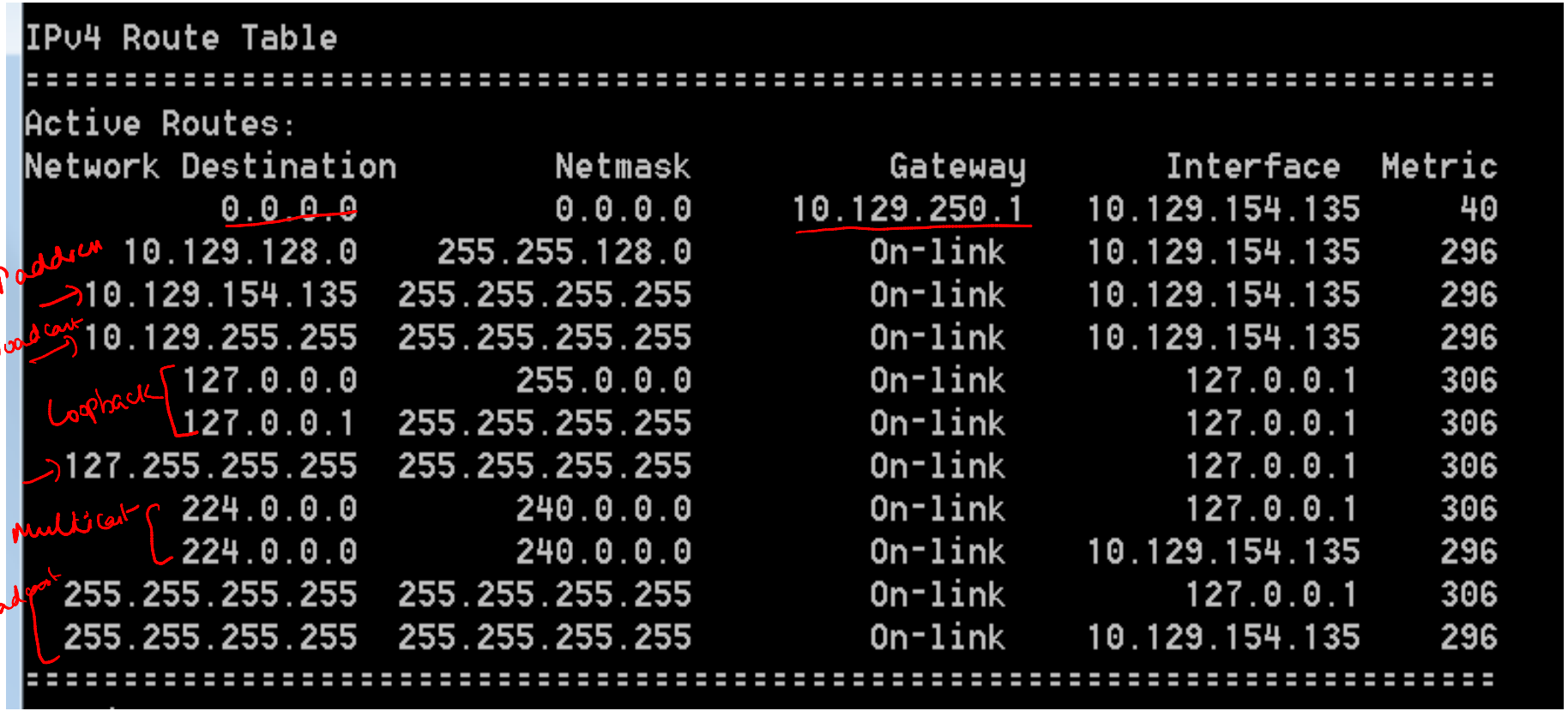
- use ARP to get MAC address corresponding to router IP address

Linux Usage




```
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:~$
```

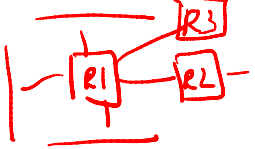
Windows Usage



```
IPv4 Route Table
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0      10.129.250.1    10.129.154.135     40
        10.129.128.0      255.255.128.0      On-link     10.129.154.135    296
        10.129.154.135    255.255.255.255    On-link     10.129.154.135    296
        10.129.255.255    255.255.255.255    On-link     10.129.154.135    296
        127.0.0.0         255.0.0.0          On-link         127.0.0.1     306
        127.0.0.1         255.255.255.255    On-link         127.0.0.1     306
        127.255.255.255   255.255.255.255    On-link         127.0.0.1     306
        224.0.0.0         240.0.0.0          On-link         127.0.0.1     306
        224.0.0.0         240.0.0.0          On-link     10.129.154.135    296
        255.255.255.255   255.255.255.255    On-link         127.0.0.1     306
        255.255.255.255   255.255.255.255    On-link     10.129.154.135    296
===========================================================================
```


Obtained via “route print” command

Forwarding at Router



- If (NetNum of Dest = NetNum of one of my interfaces) then
  - deliver packet to destination over that interface

  Else if (NetNum of Dest is in my forwarding table) then
  - deliver packet to NextHop router

  Else deliver packet to default router

Summary

- Top concern: Scalability
- Handled via hierarchical addressing
  - IP address has a network and a host part
  - Significantly reduces entries in forwarding table
- Looked at how forwarding is done at host and router based on the addressing scheme
- Ahead: Address assignment inefficiency