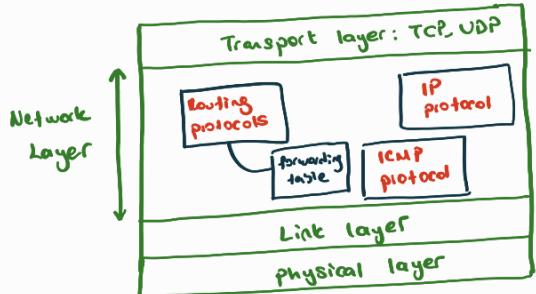


NETWORK LAYER

The Internet Network Layer



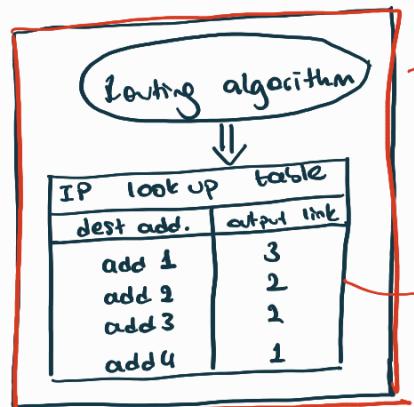
Routing: process of planning trip from source to dest.
in control plane



Forwarding: process of getting through single interchange
in data plane



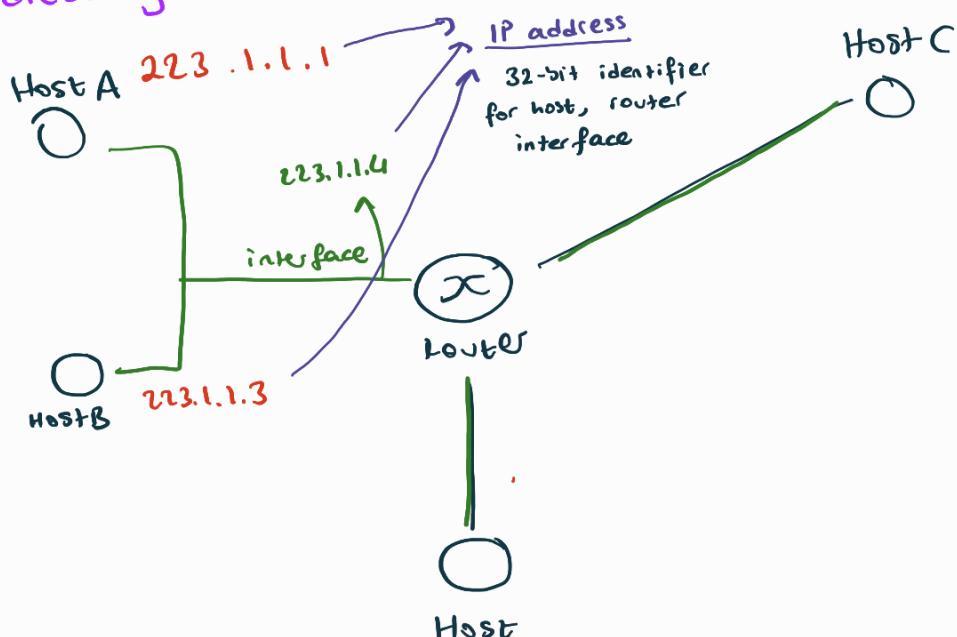
IP Router and IP address lookup



Control Plane:
Routing Algorithm determines end-end-path through network
(software)

Data Plane:
Table lookup for each packet
(hardware)

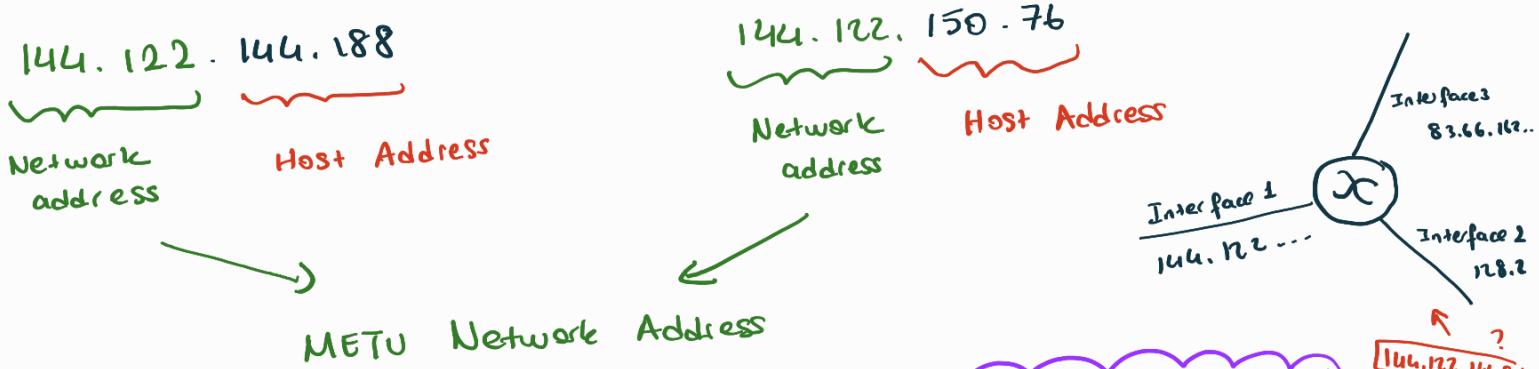
Part I: Data Plane Addressing



* Router can not keep track of all individual destination host address

↓
Instead routers keep the addresses of networks

destination networks are responsible for the delivery to the final destination
(Later will be discussed.)



How does the router find out about the "destination network"?

The router should find how many most significant bits make up the network address for an incoming IP packet.

Then it can extract the network address

Network Address finding: CIDR → Classless Inter Domain Routing

223.24.16.0 /21
 ↓
 first 21 bits of 223.24.16.0
 $\begin{array}{cccc} 11101111 & 00011000 & 00010000 & 00000000 \\ \hline 111\cdots & 111\cdots & 1111 & \rightarrow \text{mask} \end{array}$

Ex Routing Table - IP lookup

Subnet	Interface
A	1
B	2
C	3

A packet comes in addressed to 223.24.19.167

223.24.0001 0011 10100111 ↗ destination address

Mask A: $\begin{array}{ccccccc} 1 & 1 & 1 & \cdots & 1 & 1 & 1 \end{array}$

223.24.0001 → no match with A

Mask B: $\begin{array}{ccccccc} 1 & 1 & 1 & \cdots & 1 & \cdots & \cdots \end{array}$

223.24.000100 → no match with B

Mask C: $\begin{array}{ccccccc} 1 & 1 & 1 & \cdots & 1 & \cdots & \cdots \end{array}$

223.24.00010011 → match with C ✓

* (If there is more than one match: select the match with longer prefix)

Special IP addresses

- IP broadcast address: 255.255.255.255 (limited-reserved)
↳ A message sent to a broadcast address is typically received by all network-attached hosts

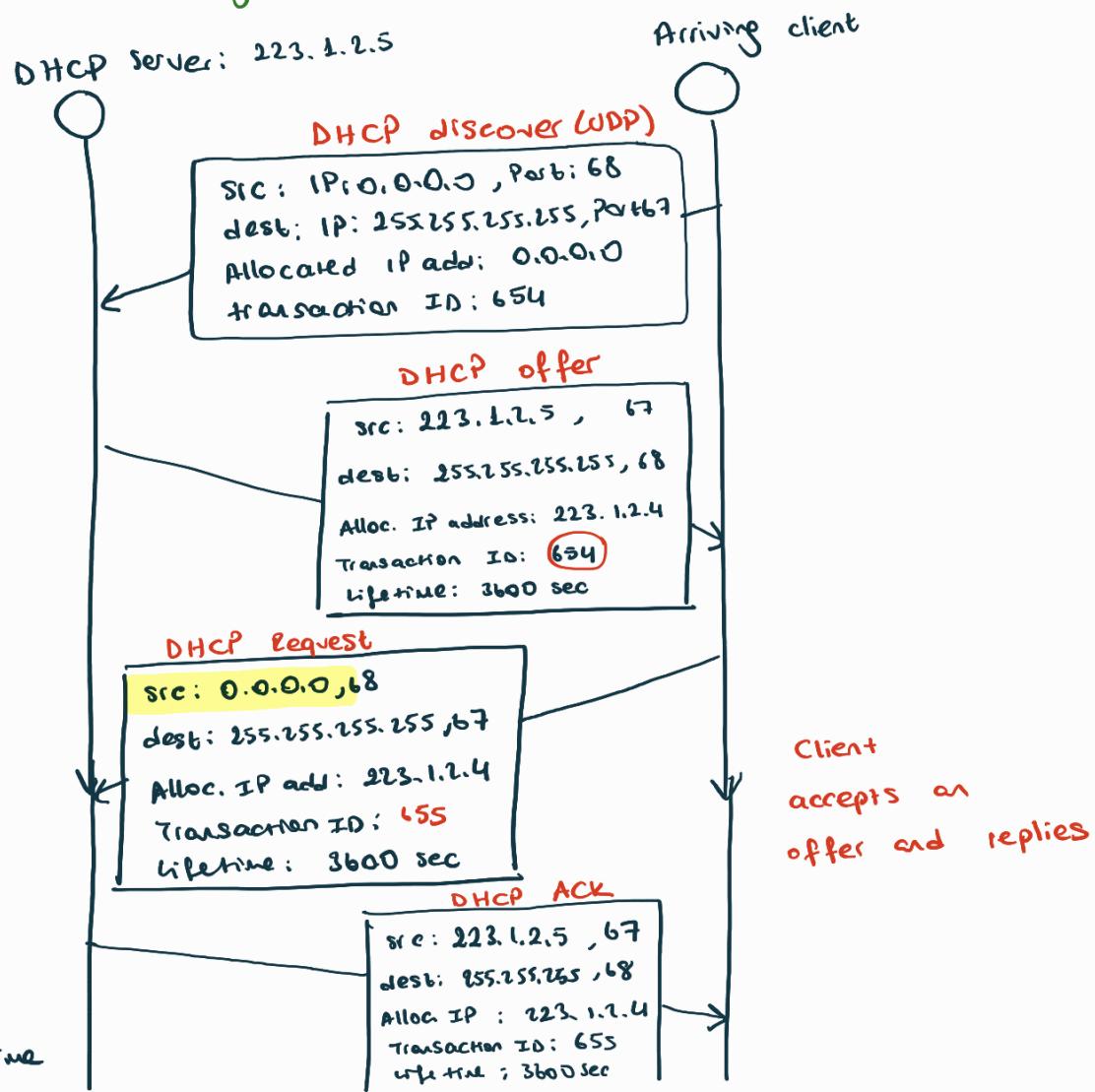
- Subnet broadcast address



- "this" host on "this" network
0.0.0.0 (reserved)

How to get an IP address?

- hard-coded by system admin in a file
- DHCP : Dynamic Host Configuration Protocol



Part II : Control Plane : Routing

Routing: OSPF, BGP, RIP

Global Algorithm: A Link-State Routing

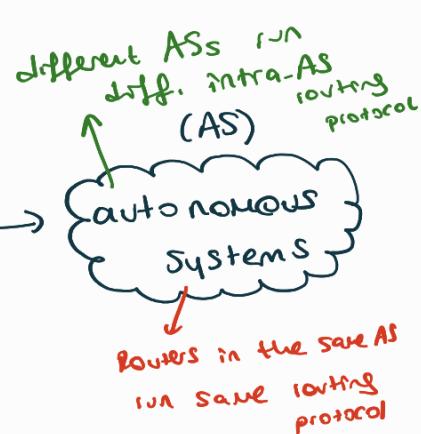
↓
Dijkstra's Algorithm

↓
 $O(n^2)$

A Distance Vector Algorithm: Bellman-Ford's Algorithm

Hierarchical Routing

- Aggregate routers into regions →
- Border Gateway Router
 ↓
 direct link to router in another AS



Intra-AS Routing (Intra-AS Routing)

- Most common Intra-AS Routing protocols
- RIP
 - OSPF → uses link state algorithm
 - IGRP
 - IS-IS