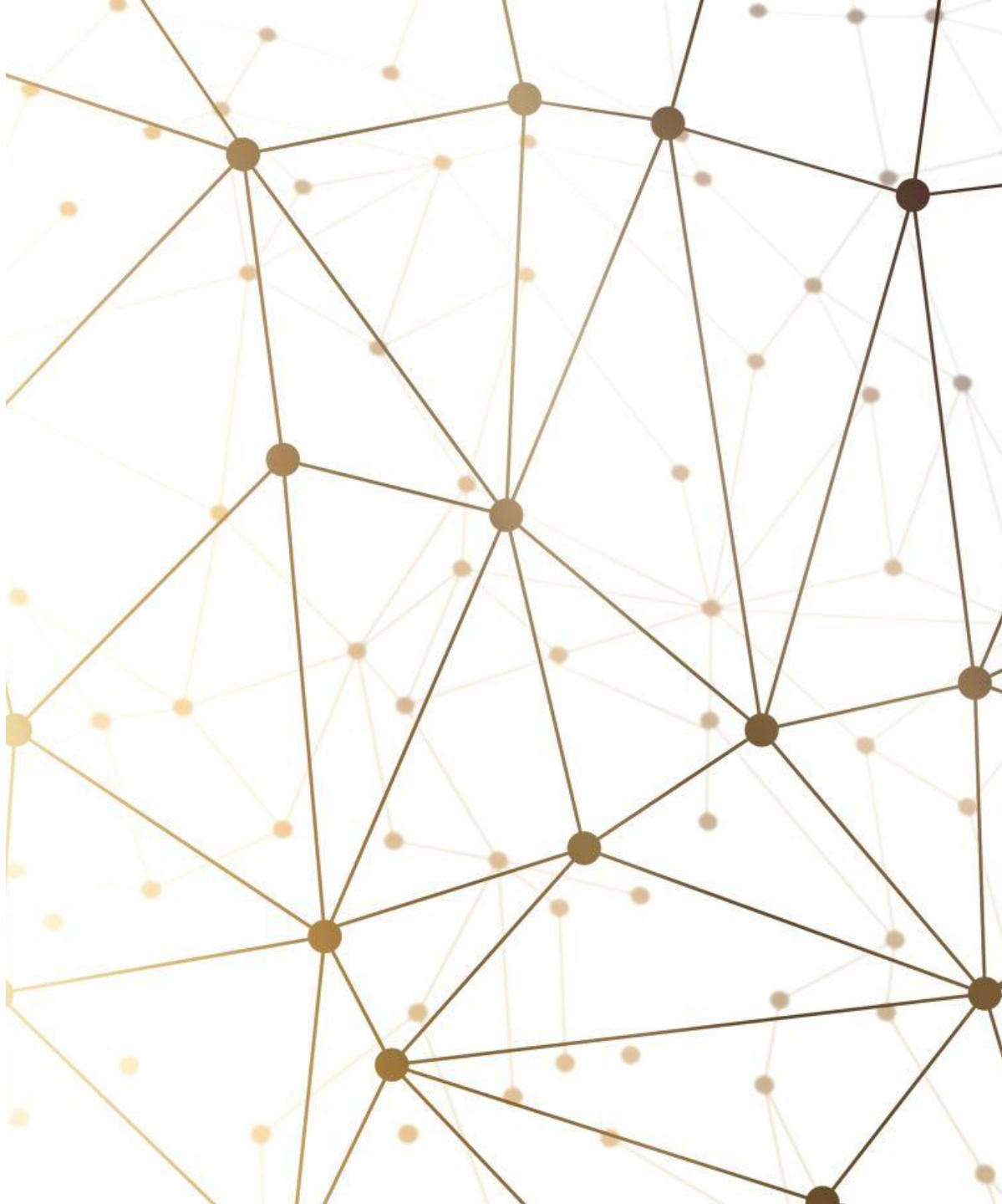
PA2 TUTORIAL

Introduction to Internet Routing and Longest Prefix Matching

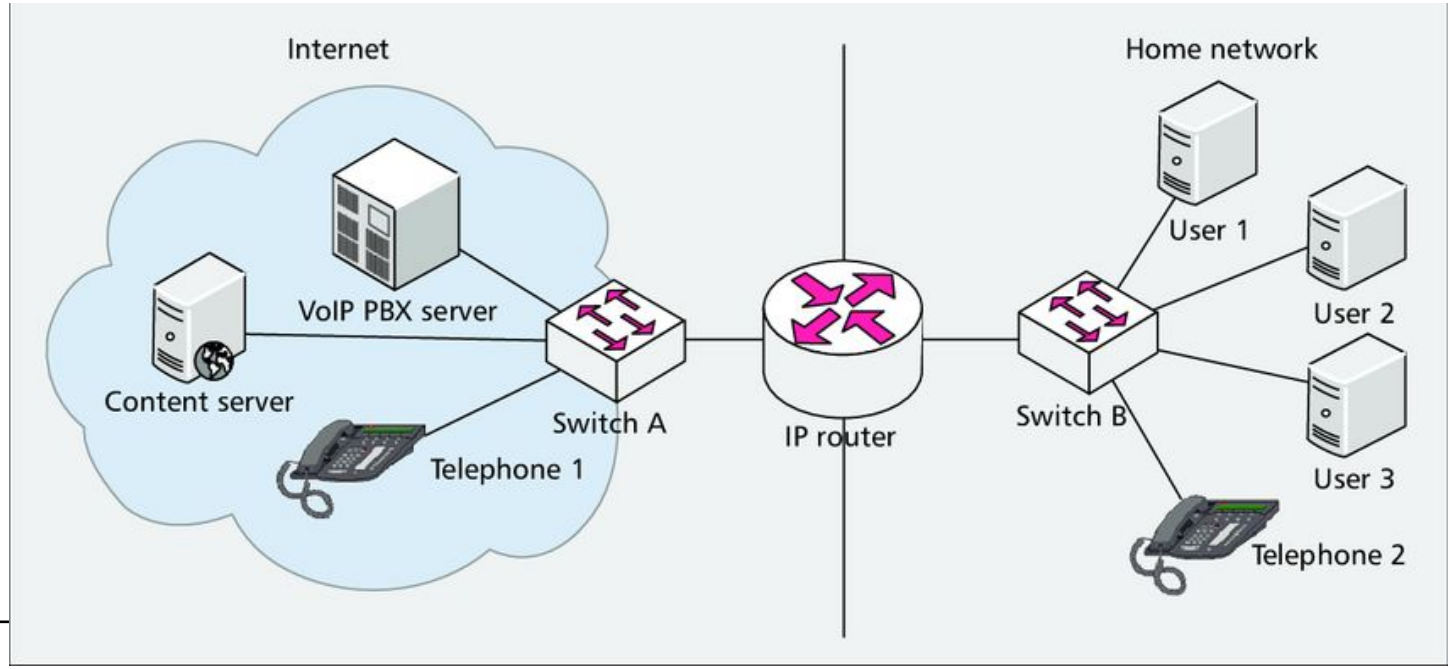
CSC 458

Parsa Pazhooheshy



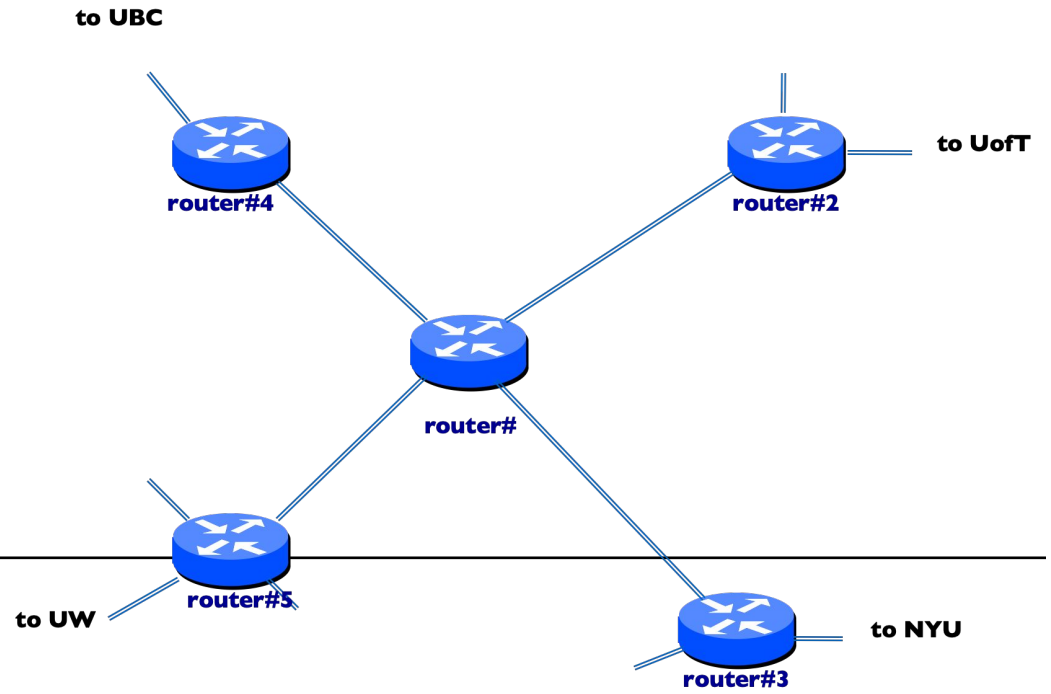
BACKGROUND

- **Internet Overview:** The internet is a global network of connected computers and devices. These devices communicate using routers, which find the best path for each data packet to its destination.



Routers! Edge of the network…

- A router is a device that connects two or more networks or subnetworks.
- Routers direct the traffic on the internet, ensuring that data reaches its correct destination.
- Routers forward packets based on destination IP addresses.



LONGEST PREFIX MATCHING

- Longest prefix matching is a method used by routers to select the best route

- Done by comparing the destination IP to stored routes, choosing the one with the longest prefix match.

LONGEST PREFIX MATCHING

- Each router maintains a unique routing table
- Whenever a new packet arrives, router should find the row that best ***matches*** the packet destination

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.1.32	27	B	0
10.4.2.0	24	C	1
10.0.0.0	8	A	3

A Sample (simplified) Routing Table

ROUTING TABLE Example

- Each router maintains a unique routing table
- Whenever a new packet arrives, router should find the row that best ***matches*** the packet destination
- Assume for an entry of the routing table the prefix length is X:
  - We say a packet matches that entry of:
    - The destination IP of the packet matches the route prefix for the first X most significant bits (MSBs)

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.1.32	27	B	0
10.4.2.0	24	C	1
10.0.0.0	8	A	3

ROUTING TABLE Example

- A Packet arrives with
  - **Destination IP: 10.4.1.45**
- How to find the best matching row of routing table?
- For every row of routing table check if the destination IP of the packet matches the route prefix for the first X most significant bits (MSBs).

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.1.32	27	B	0
10.4.2.0	24	C	1
10.0.0.0	8	A	3

ROUTING TABLE Example

Destination IP: 10.4.1.45

- Route 1
  - Destination IP:10.4.1.45 — 00001010.00000100.00000001.00101101
  - Route Prefix/Prefix Length: 10.4.1.32/27: — 00001010.00000100.00000001.00100000
    - They match

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.1.32	27	B	0

ROUTING TABLE Example

- Route 2:
  - Destination IP: 10.4.1.45: 00001010.00000100.00000001.00101101
  - Route Prefix/Prefix Length: 10.4.2.0/24: 00001010.00000100.00000010.00000000
    - Do they match?

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.2.0	24	C	1

ROUTING TABLE Example

- Route 2:
  - Destination IP: 10.4.1.45: 00001010.00000100.00000001.00101101
  - Route Prefix/Prefix Length: 10.4.2.0/24: 00001010.00000100.00000010.00000000
    - They don't match!

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.2.0	24	C	1

ROUTING TABLE Example

- Route 3:
  - Destination IP: 10.4.1.45: 00001010.00000100.00000001.00101101
  - Route Prefix/Prefix Length:10.0.0.0/8: 00001010.00000000.00000000.000000000
    - Do they match?

Route Prefix	Prefix Length	Next Hop	Interface Num
10.0.0.0	8	A	3

ROUTING TABLE Example

- Route 3:
  - Destination IP: 10.4.1.45: 00001010.00000100.00000001.00101101
  - Route Prefix/Prefix Length:10.0.0.0/8: 00001010.00000000.00000000.000000000
    - They match.

Route Prefix	Prefix Length	Next Hop	Interface Num
10.0.0.0	8	A	3

ROUTING TABLE Example

- Route 1 and 3 matched the packet IP.
- Which one to choose?
  - The route that has the longest prefix length
- So
  - Send on Interface 0

Route Prefix	Prefix Length	Next Hop	Interface Num
10.4.1.32	27	B	0
10.4.2.0	24	C	1
10.0.0.0	8	A	3

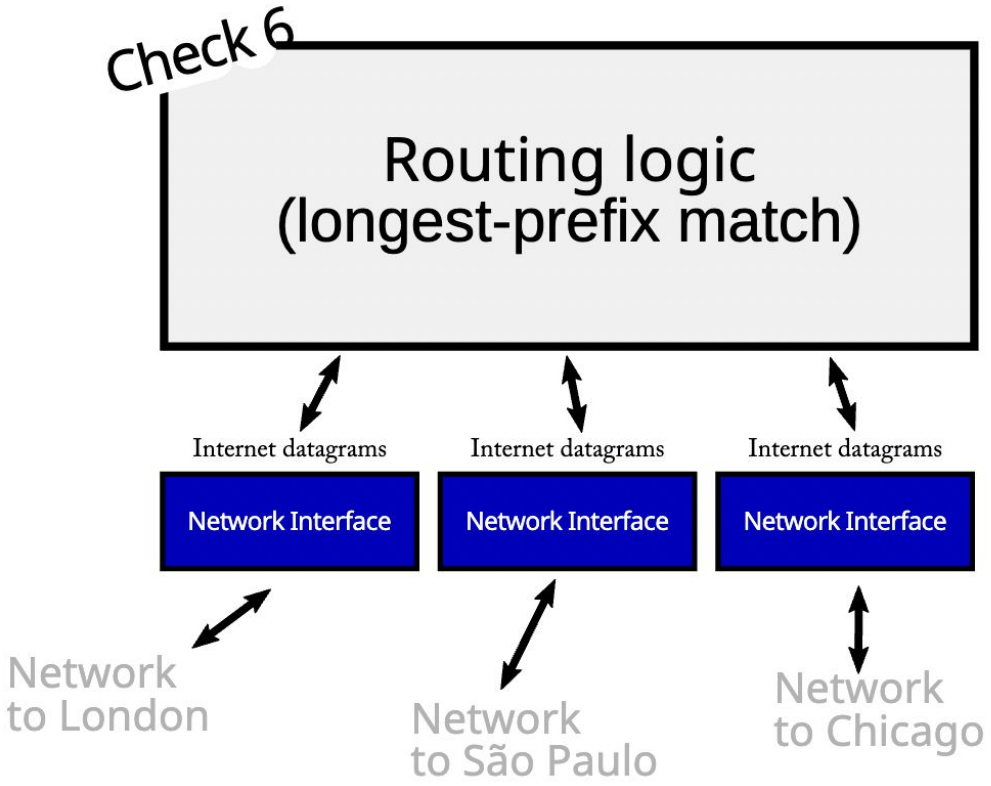
Matched and had largest prefix (27)

Matched but didn't have the largest prefix (8)

Didn't match

ROUTER BLOCK DIAGRAM IN PA2

- A router contains several network interfaces and can receive IP datagrams on any one of them.
- The router forwards any datagram it receives to the next hop, on the appropriate outbound interface.
- The routing table tells the router how to make this decision.



Implement two methods in Router class

1- add_route

- Install new route in routing table of the router
- Each route has 4 parts (same as the table covered in previous slides):
  - route_prefix
  - prefix_length
  - interface_num
  - next_hop:

Implement two methods in Router class

2- route

- Forward each datagram it receives:
  - to the correct next hop
  - on the correct outgoing NetworkInterface.

void Router::route()

- The Router performs Longest-Prefix Matching to find the best rout.
  - If no routes matched, the router drops the datagram.

- The router decrements the datagram's TTL (time to live).
  - If the TTL was zero already, or hits zero after the decrement, the router should drop the datagram.
- The router recalculates the checksum of the packet after reducing TTL.

- The router sends the modified datagram on the appropriate interface (interface(interface num)->send datagram()) to the appropriate next hop.

WHAT TO SUBMIT?

- *network_interface.cc*,
- *network_interface.hh*,
- *router.cc*,
- *router.hh*
- writeups/pa2.md