Computer Networks
COL 334/672

Inter-domain Routing

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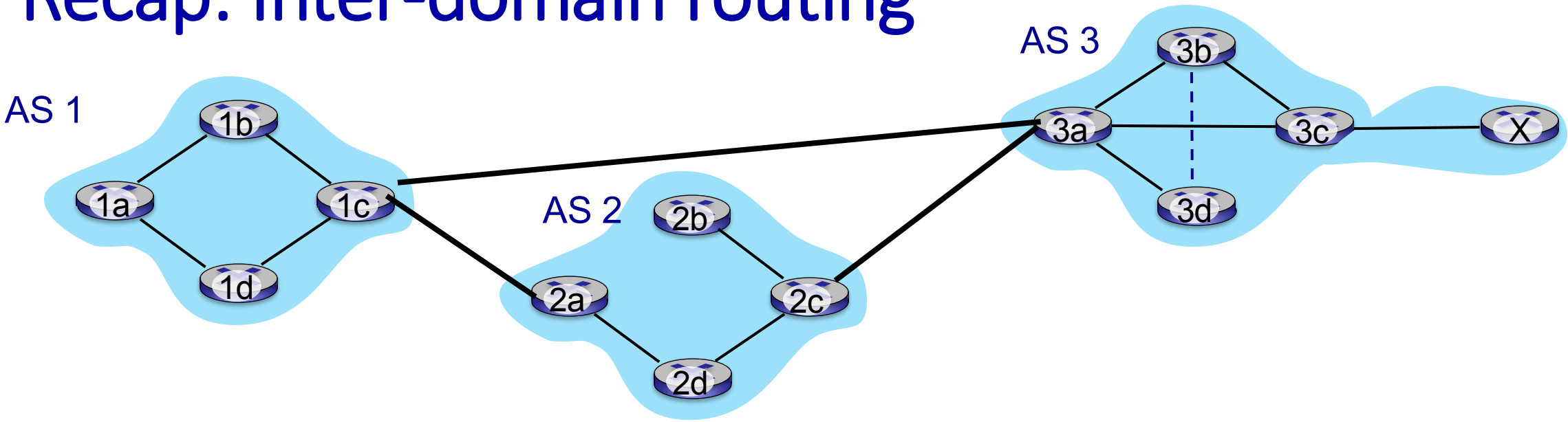
Slides adapted from KR

Sem 1, 2024-25

Recap: Inter-domain routing

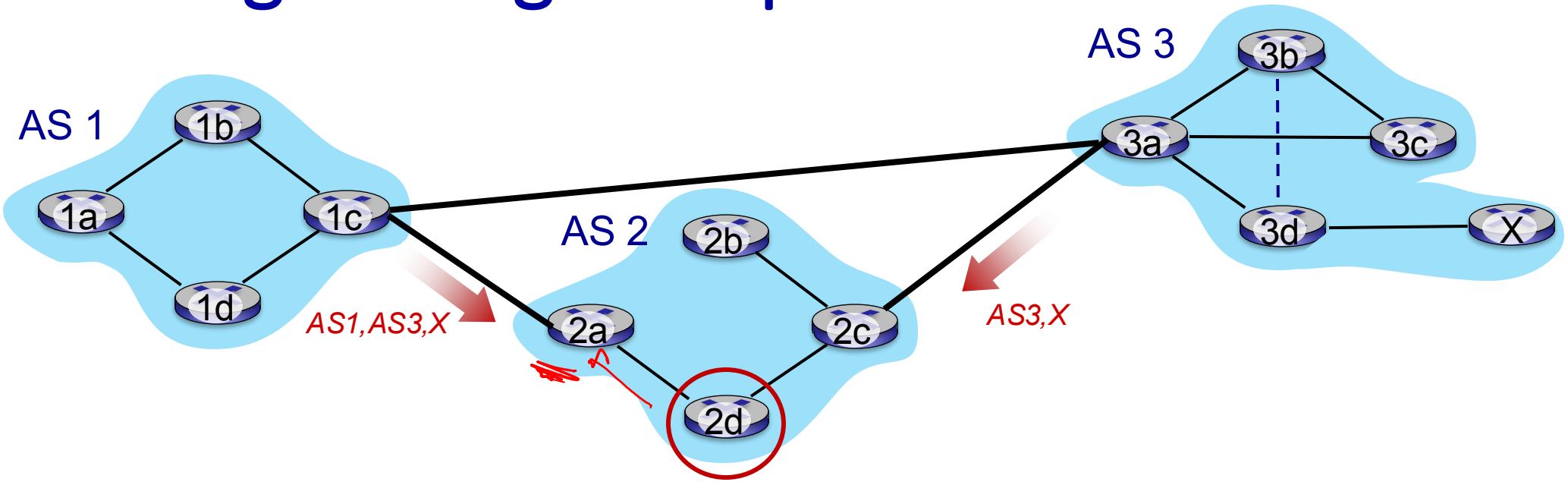


Border Gateway Router (BGP) is the de facto inter-domain routing protocol

- Consists of eBGP and iBGP connections [TCP Connections]
- ASes announce BGP advertisements to neighboring AS
- The advertisement consists of path attributes and IP prefix
- Path attributes include AS path and next hop

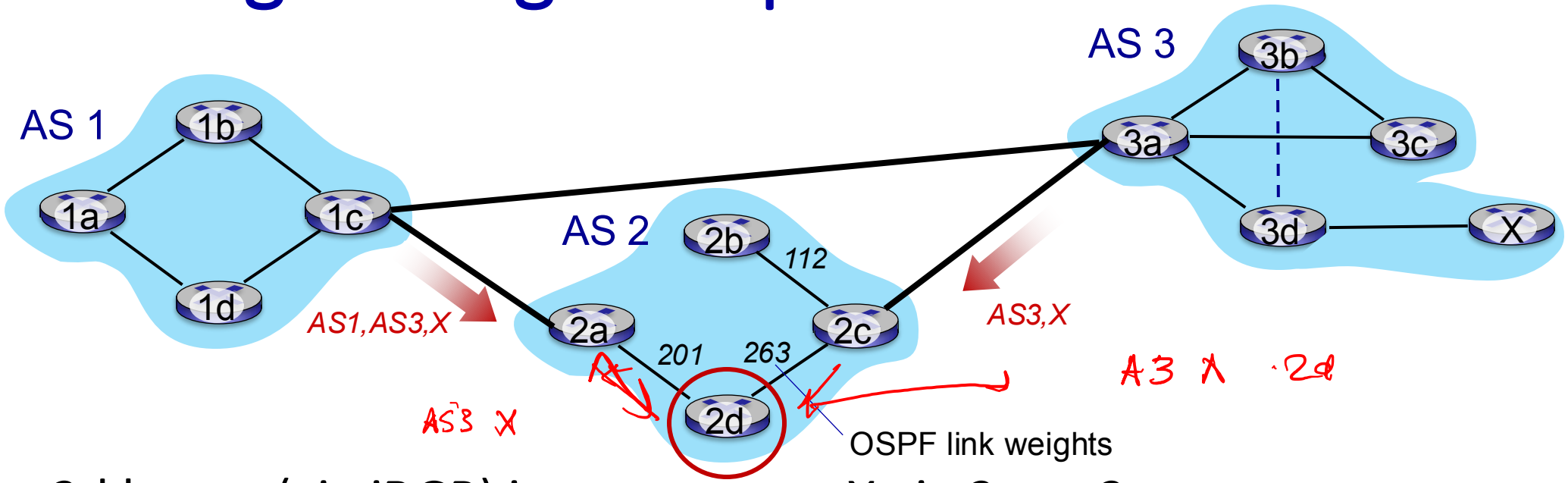
How does a BGP router select among the multiple announcements?

Selecting Among Multiple Announcements



- 2d learns (via iBGP) it can route to X via 2a or 2c
- shortest AS path: choose local gateway that has fewest number of AS hops to the destination

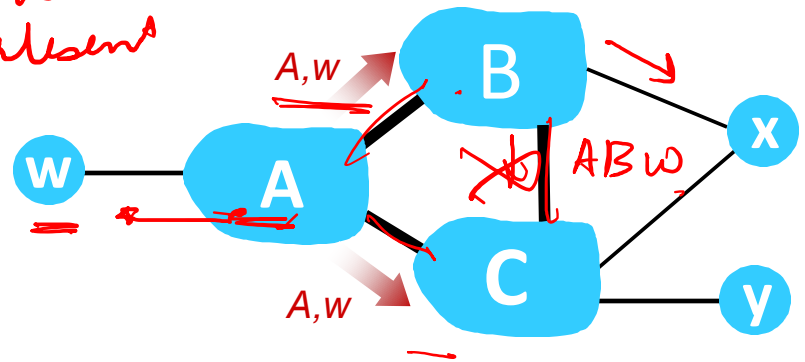
Selecting Among Multiple Announcements

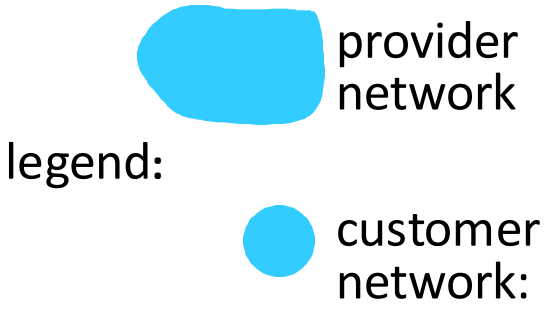


- 2d learns (via iBGP) it can route to X via 2a or 2c
- shortest AS path: choose local gateway that has fewest number of AS hops to the destination
- hot potato routing: choose local gateway that has least *intra-domain* cost (e.g., 2d chooses 2a, even though more AS hops to *X*): don't worry about inter-domain cost!
- network policy: for both path selection and announcements!

BGP: achieving policy via advertisements

Policy
① Route selection
② Route advertisement





ISP only wants to route traffic to/from its customer networks (does not want to carry transit traffic between other ISPs – a typical "real world" policy)

- A advertises path Aw to B and to C
- B *chooses not to advertise* BAw to C!
  - B gets no "revenue" for routing CBAw, since none of C, A, w are B's customers
  - C does *not* learn about CBAw path
- C will route CAw (not using B) to get to w

Inter-AS Routing: Policies

- *No transit traffic through certain ASes*
- *Never put China on a route starting from Ministry of Defence*
- *Do not use Singapore to get from India to Maldives*
- *Traffic starting or ending at Google should not transit through Microsoft*
- *Don't share information about this peering link to other routers*

1. local pref
2. AS path
3. hot potato routing

What is the mechanism in BGP?

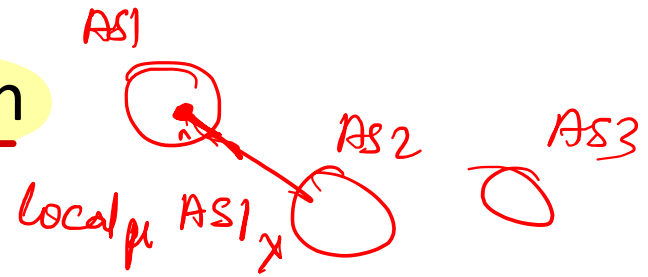
Set local preference on inbound routes

BGP route selection

NOC: Network Operation Center

AS2 ↓ 200 AS3 ↑ 100

- router may learn about more than one route to destination AS, selects route based on:
  1. local preference value attribute: policy decision
  2. shortest AS-PATH
  3. closest NEXT-HOP router: hot potato routing
  4. additional criteria ..



cold potato routing

Summary

- Routing Algorithms: Finding "shortest" path from sending host to receiving host
- Intra-domain routing and inter-domain routing
  - Intra: focus more on performance
  - Inter: focus more on policy
- Intra-domain routing
  - Distance vector (e.g., RIP, EIGRF)
  - Link state (e.g., OSPF)
- Inter-domain routing
  - Path vector routing
  - Border Gateway Protocol (BGP)
- All examples of per-router control plane or a distributed control plane

Centralize control plane → SDN
Software Defined Network

Two key network-layer functions

network-layer functions:

- *forwarding:* move packets from a router's input link to appropriate router output link
- *routing:* determine route taken by packets from source to destination
  - *routing algorithms*

analogy: taking a trip

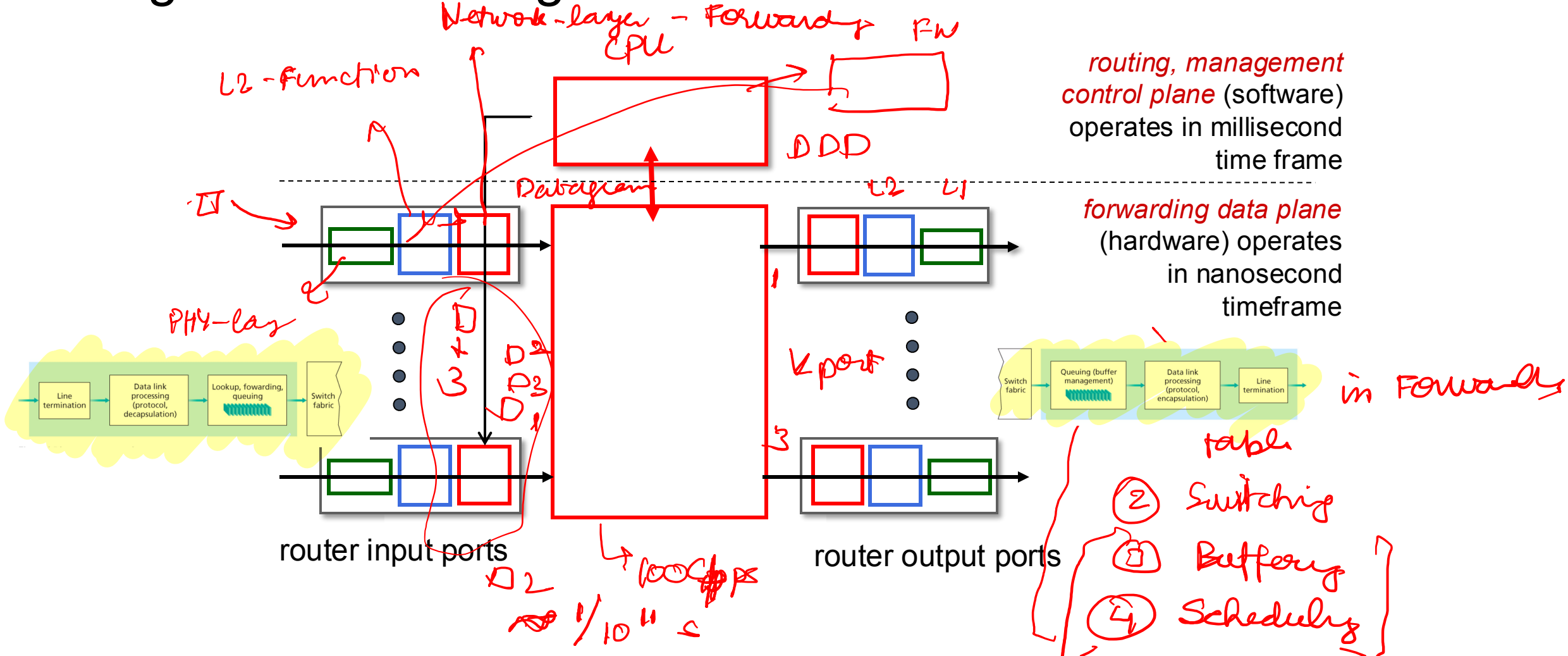
- *forwarding:* process of getting through single interchange
- *routing:* process of planning trip from source to destination

forwarding

routing

Router architecture overview

high-level view of generic router architecture:



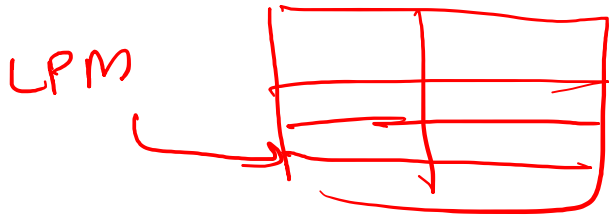
Lookup

forwarding table

Destination Address Range	Link Interface
11001000 00010111 00010000 00000000 through 11001000 00010111 00010000 00000100	0
11001000 00010111 00010000 00000101 through 11001000 00010111 00010000 00000111	3
11001000 00010111 00011000 11111111	
11001000 00010111 00011001 00000000 through 11001000 00010111 00011111 11111111	2
otherwise	3

Q: but what happens if ranges don't divide up so nicely?

Longest prefix matching



longest prefix match

when looking for forwarding table entry for given destination address, use *longest* address prefix that matches destination address.

Destination Address Range	Link interface
11001000 00010111 00010*** ********	0
11001000 00010111 00011000 ********	1
11001000 00010111 00011*** ********	2
otherwise	3

match!

examples:

11001000 00010111 00010110 10100001 which interface?

11001000 00010111 00011000 10101010 which interface?

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