شبکه های کامپیوتری ۲

درس ۵ فصل ۵

Routing Protocols

دانشگاه صنعتی اصفهان

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Chapter 5: outline

The Internet

Making routing scalable

our routing study thus far - idealized
- all routers identical
- network "flat"

… *not* true in practice

scale: with billions of destinations:
- can't store all destinations in routing tables!
- routing table exchange would swamp links!

administrative autonomy
- internet = network of networks
- each network admin may want to control routing in its own network

Internet approach to scalable routing

aggregate routers into regions known as "autonomous systems" (AS) (a.k.a. "domains")

intra-AS routing

- routing among hosts, routers in same AS ("network")
- all routers in AS must run *same* intra-domain protocol
- routers in *different* AS can run *different* intra-domain routing protocol
- gateway router: at "edge" of its own AS, has link(s) to router(s) in other AS'es

inter-AS routing

- routing among AS'es
- gateways perform inter-domain routing (as well as intra-domain routing)

Interconnected ASes
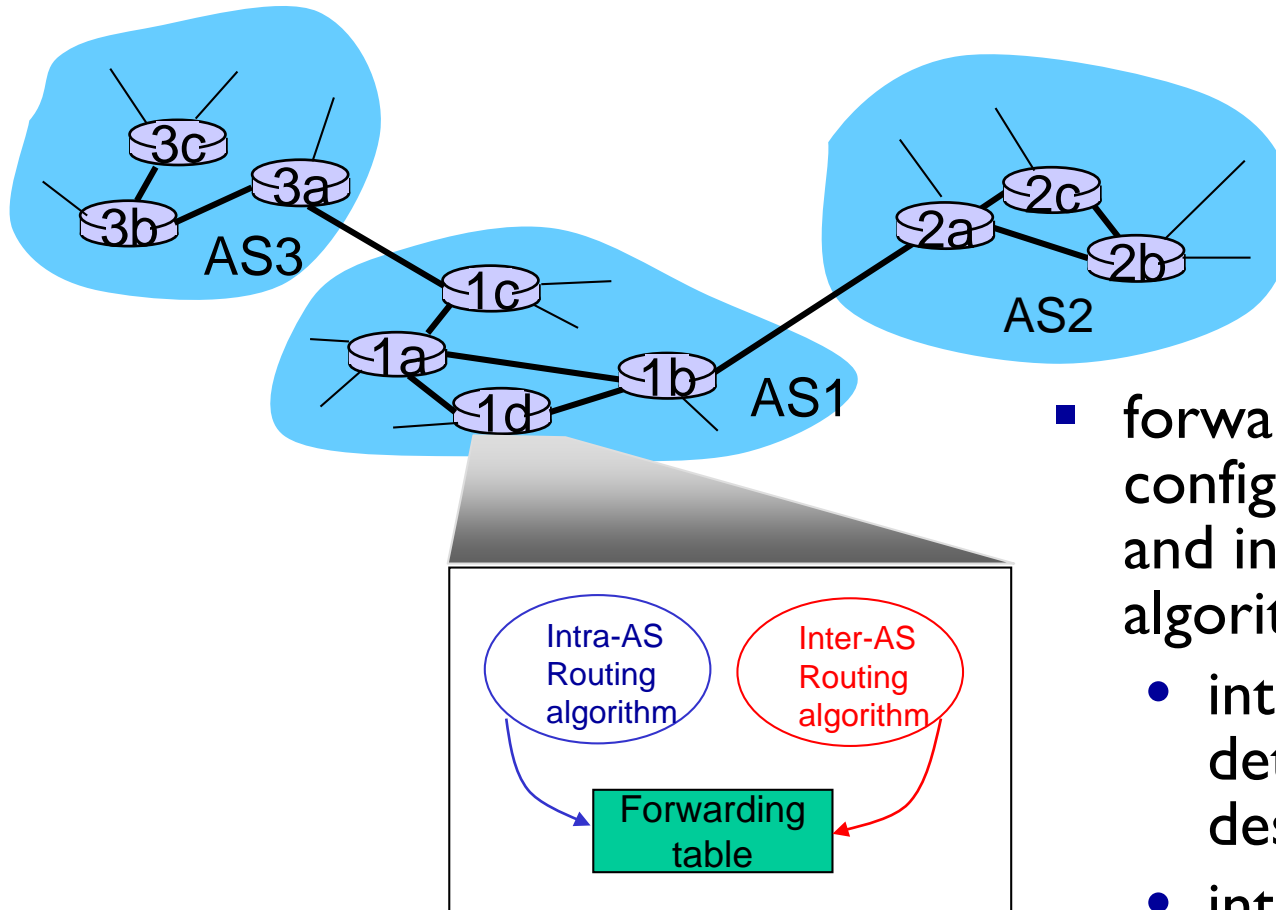
- forwarding table configured by both intra- and inter-AS routing algorithm
  - intra-AS routing determine entries for destinations within AS
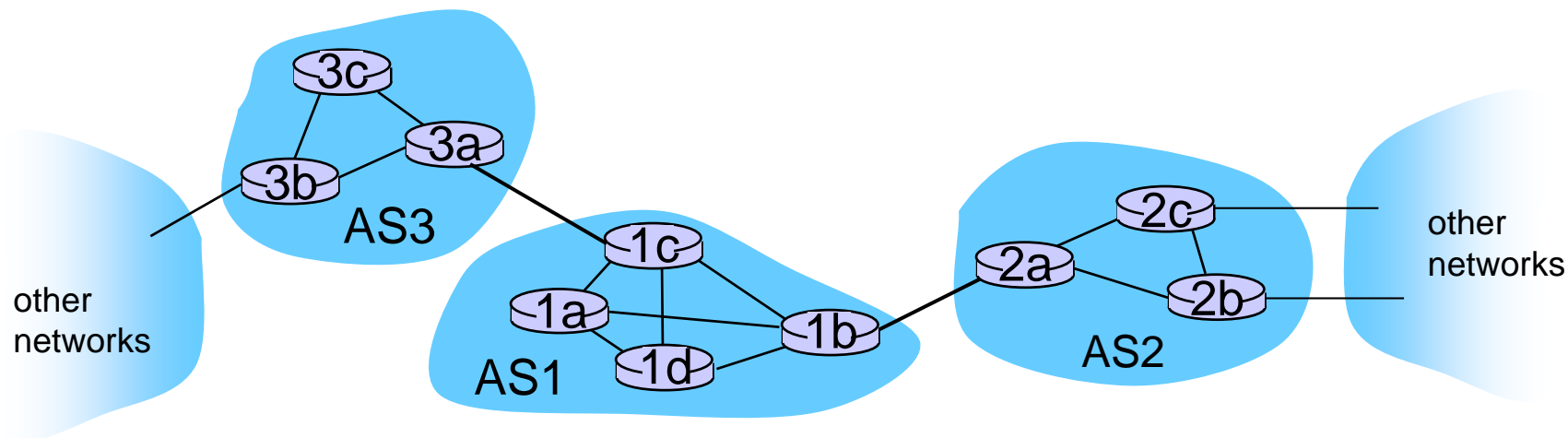 - inter-AS & intra-AS determine entries for external destinations

Inter-AS tasks

- suppose router in AS1 receives datagram destined outside of AS1:
  - router should forward packet to gateway router, but which one?

AS1 must:

1. learn which dests are reachable through AS2, which through AS3
2. propagate this reachability info to all routers in AS1

job of inter-AS routing!

Intra-AS Routing

- also known as *interior gateway protocols (IGP)*
- most common intra-AS routing protocols:
    - RIP: Routing Information Protocol
    - OSPF: Open Shortest Path First (IS-IS protocol essentially same as OSPF)
    - IGRP: Interior Gateway Routing Protocol (Cisco proprietary for decades, until 2016)
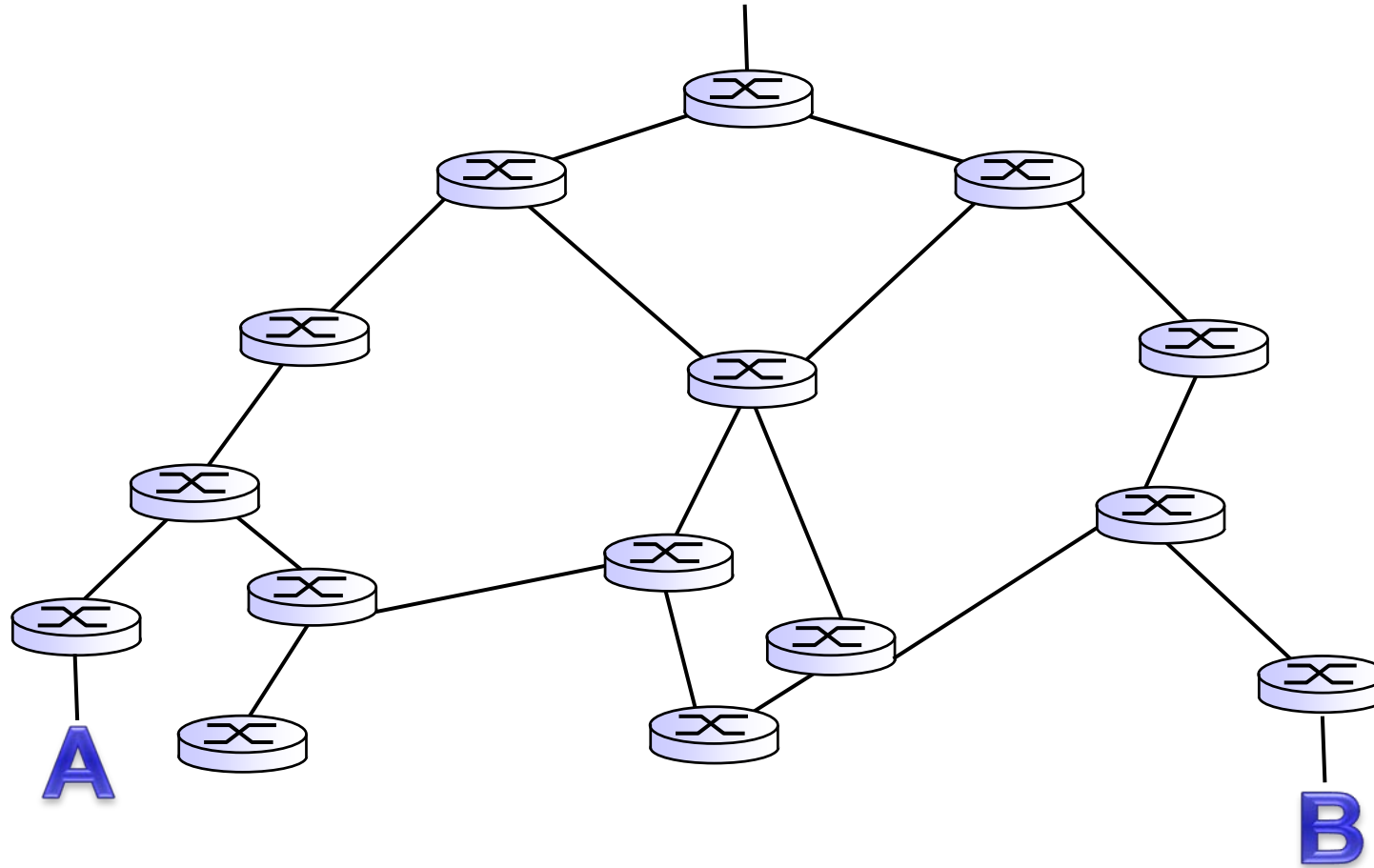
OSPF (Open Shortest Path First)

- "open": publicly available
- uses link-state algorithm
  - link state packet dissemination
  - topology map at each node
  - route computation using Dijkstra's algorithm
- router floods OSPF link-state advertisements to all other routers in *entire* AS
  - carried in OSPF messages directly over IP (rather than TCP or UDP
  - link state: for each attached link
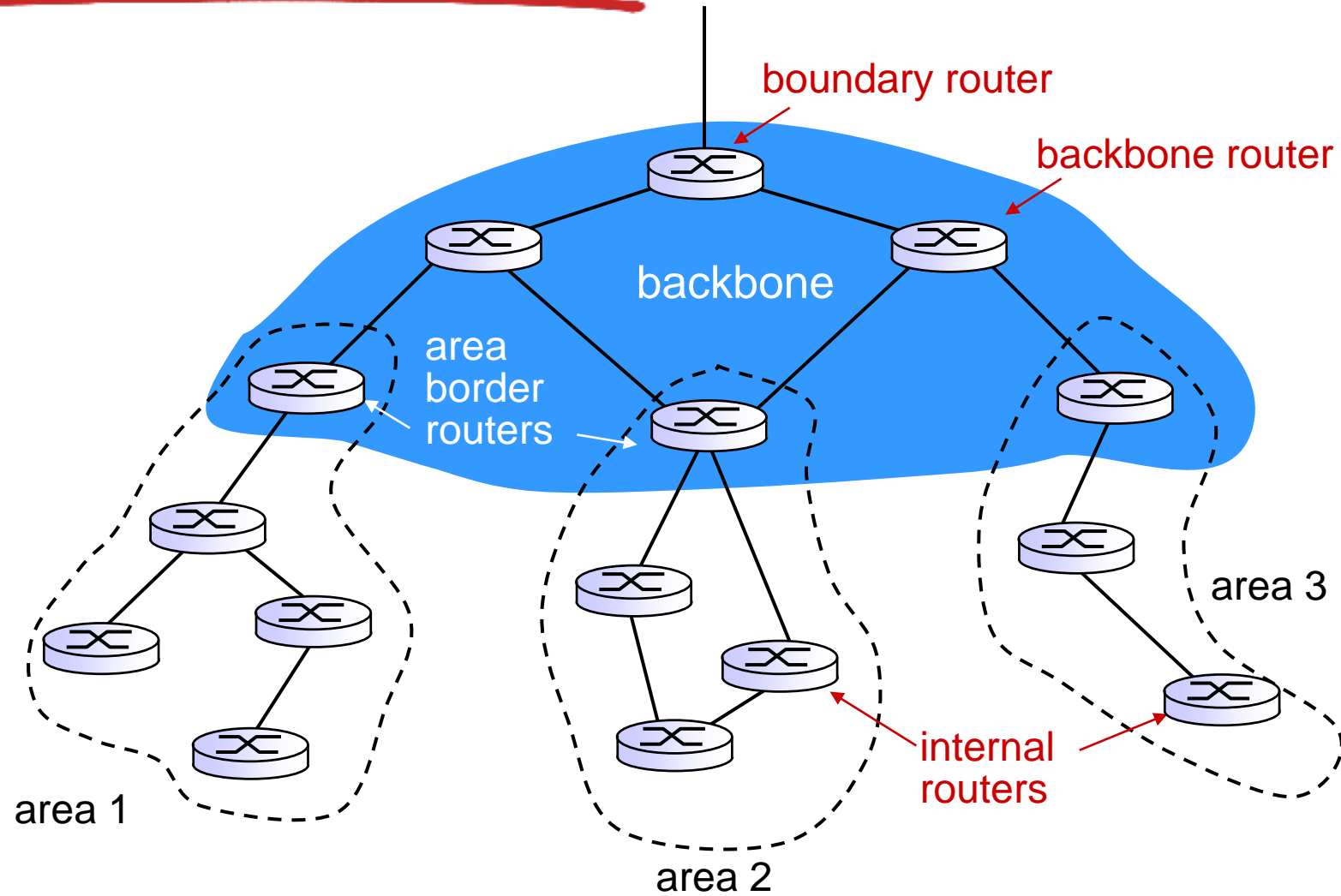- *IS-IS routing* protocol: nearly identical to OSPF

OSPF "advanced" features

- *security:* all OSPF messages authenticated (to prevent malicious intrusion)
- multiple same-cost paths allowed (only one path in RIP)
- for each link, multiple cost metrics for different TOS (e.g., satellite link cost set low for best effort ToS; high for real-time ToS)
- integrated uni- and multi-cast support:
  - Multicast OSPF (MOSPF) uses same topology data base as OSPF
- hierarchical OSPF in large domains.

Enterprise Network

Hierarchical OSPF

boundary router

backbone router

backbone

area border routers

internal routers

area 1

area 2

area 3

Hierarchical OSPF

- *two-level hierarchy:* local area, backbone.
  - link-state advertisements only in area
  - each nodes has detailed area topology; only know direction (shortest path) to nets in other areas.
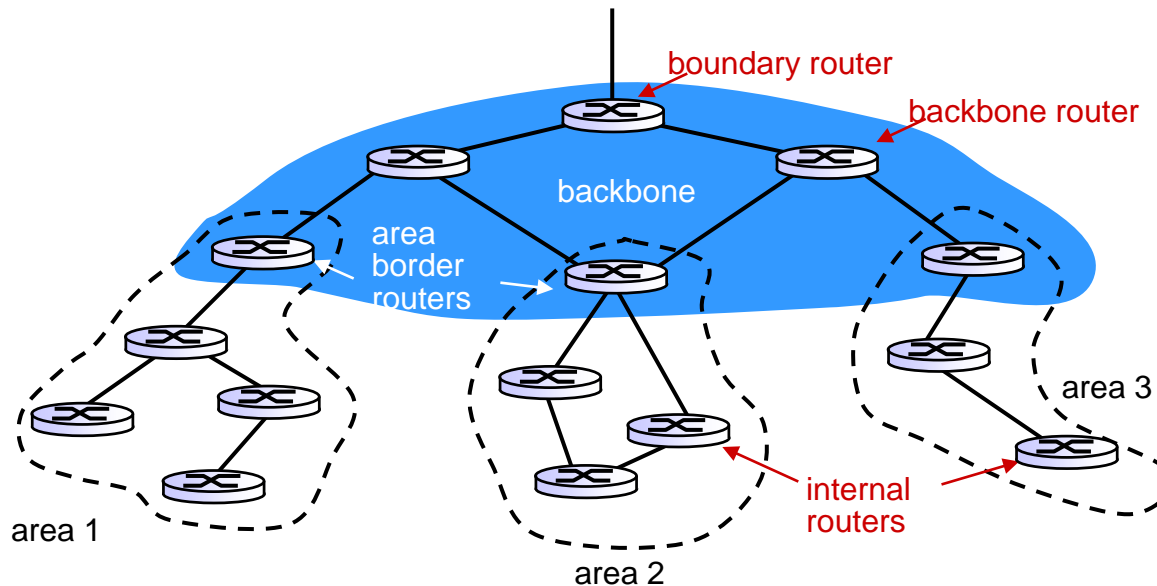
Hierarchical OSPF

- *area border routers:* "summarize" distances to nets in own area, advertise to other Area Border routers.

- *backbone routers:* run OSPF routing limited to backbone.

- *boundary routers:* connect to other AS'es.