COMP 3331/9331: Computer Networks and Applications

Week 6

Network Layer – Introduction

Reading Guide:

Chapter 4: Section 4.1

Network Layer: outline

Our goals:

NETWORK LAYER IS ON EVERYTHING, END SYSTEMS, ROUTER ETC.

- understand principles behind network layer services, focusing on data plane:
  - network layer service models

    what does it provide to the layer above this? (transport layer)
    what does it ask from the layer below it (data link layer)
  - forwarding versus routing
- instantiation, implementation in the Internet

Network Layer, data plane: outline

4.1 Overview of Network layer
- data plane
- control plane

4.2 What's inside a router
-- **Not Covered**

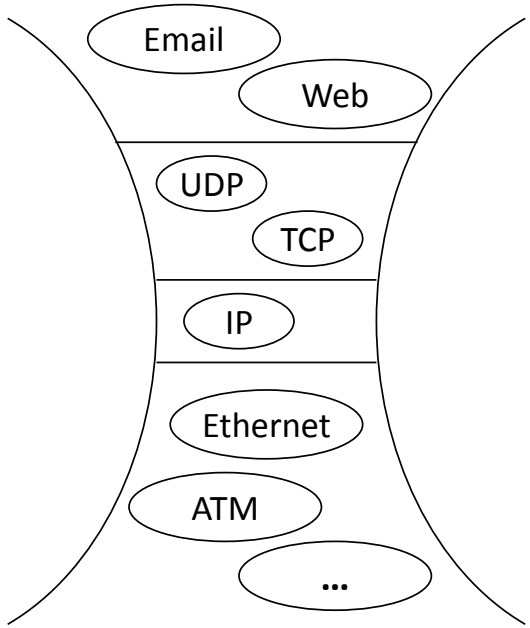
4.3 IP: Internet Protocol
- datagram format
- fragmentation
- IPv4 addressing
- network address translation
- IPv6

4.4 Generalized forwarding and Software Defined Networking (SDN)
- Not Covered

Some Background

- 1968: DARPAnet/ARPAnet (precursor to Internet)
  - (Defense) Advanced Research Projects Agency Network
- Mid 1970's: new networks emerge
  - SATNet, Packet Radio, Ethernet
  - All "islands" to themselves – didn't work together
- Big question: How to connect these networks?

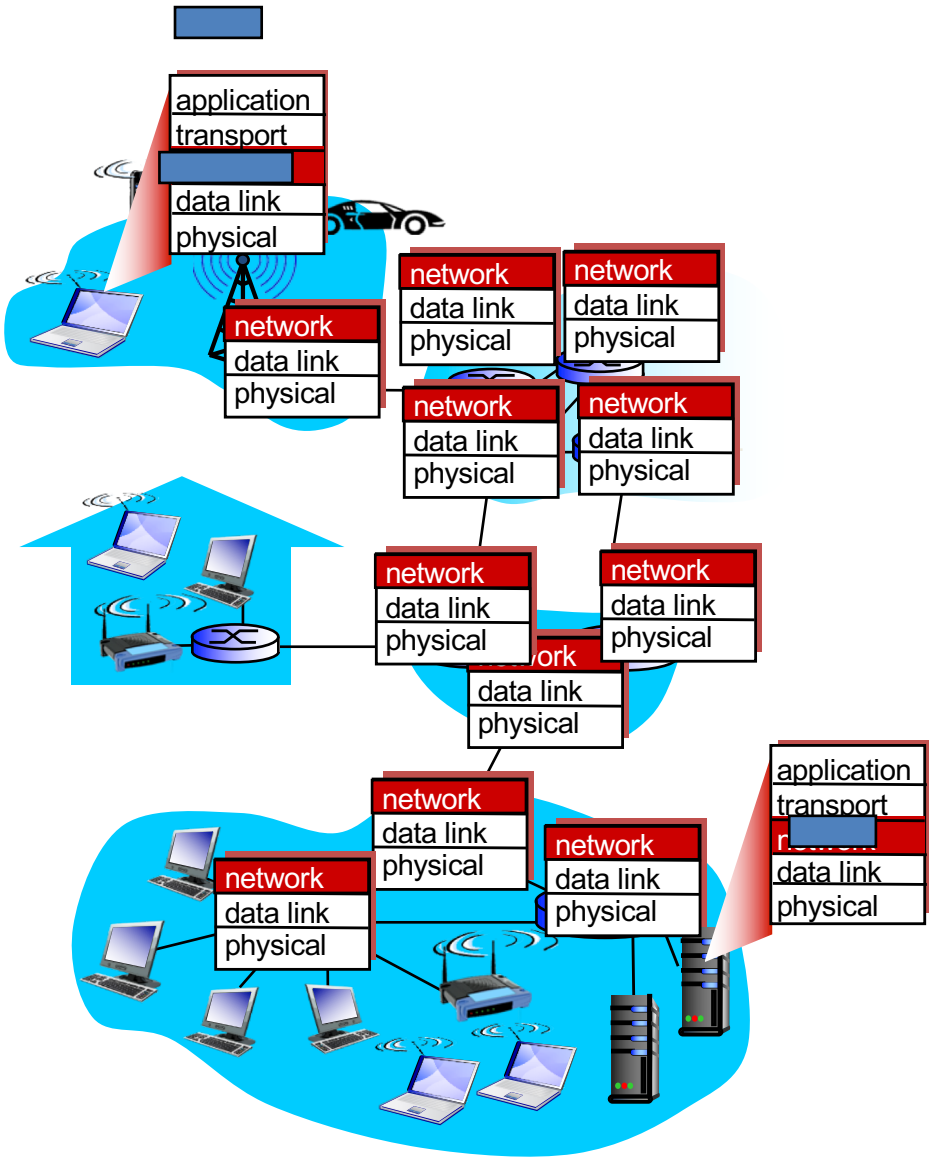
Internetworking



- Cerf & Kahn in 1974,
  - "A Protocol for Packet Network Intercommunication"
  - Foundation for the modern Internet
- **Routers** forward **packets** from source to destination
  - May cross many separate networks along the way
- All packets use a common **Internet Protocol**
  - Any underlying data link protocol i.e. what network hands off too
  - Any higher layer transport protocol i.e. what transport layer protocols is handing network layer segments (could be TCP, UDP, etc)

Network Layer

- transport segment from sending to receiving host
- on sending side encapsulates segments into datagrams
- on receiving side, delivers segments to transport layer
- network layer protocols in *every* host, router
- router examines header fields in all IP datagrams passing through it



Two key nework-layer functions

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

analogy:

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

When should a router perform routing? And forwarding ?

A: Do both when a packet arrives

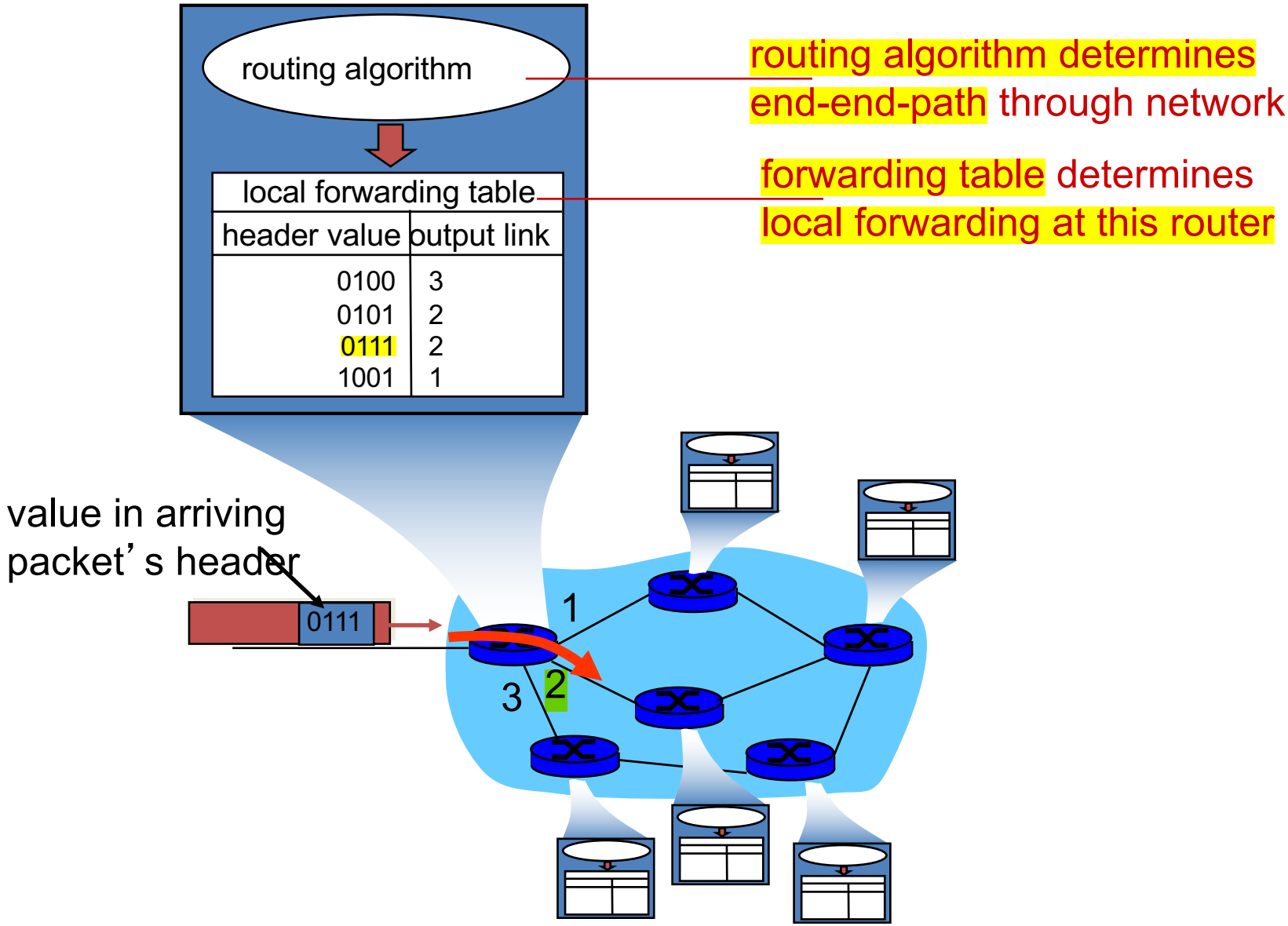
B: Route in advance, forward when a packet arrives

C: Forward in advance, route when a packet arrives

D: Do both in advance

E: Some other combination

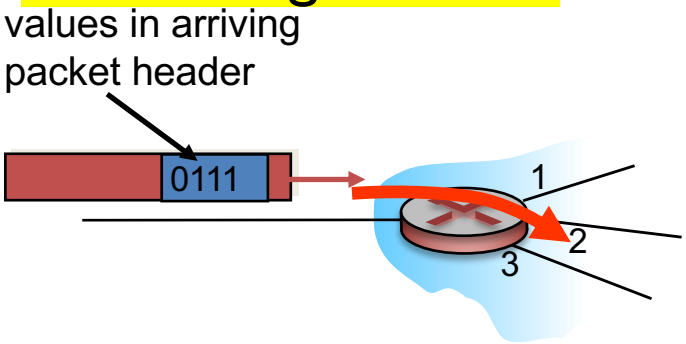
Interplay between routing and forwarding



Network Layer: data vs control plane

Data plane

- local, per-router function
- determines how datagram arriving on router input port is forwarded to router output port
- forwarding function

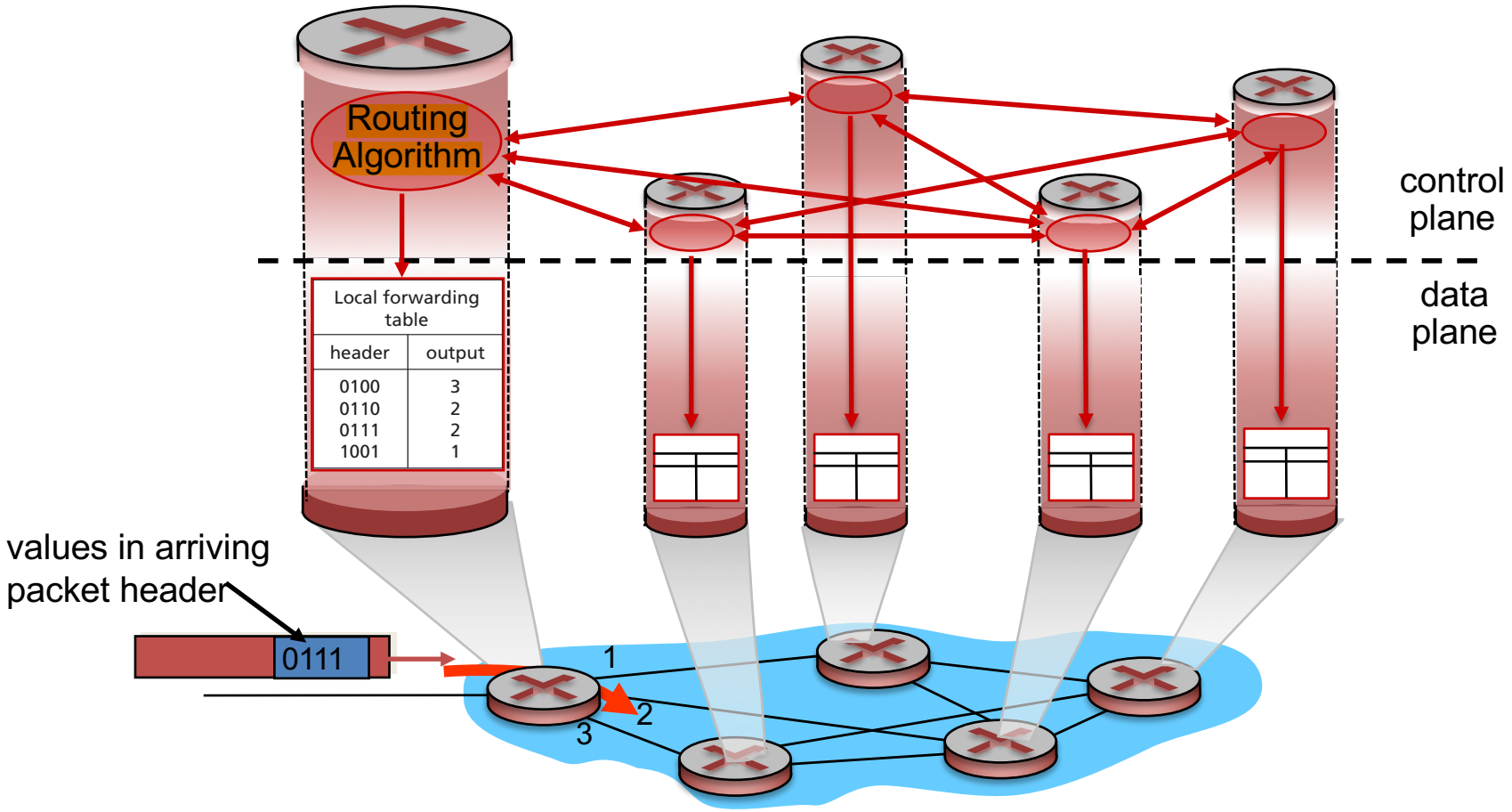


Control plane

- network-wide logic
- determines how datagram is routed among routers along end-end path from source host to destination host
- two control-plane approaches:
  - *traditional routing algorithms:* implemented in routers
  - *software-defined networking (SDN):* centralised (remote) servers

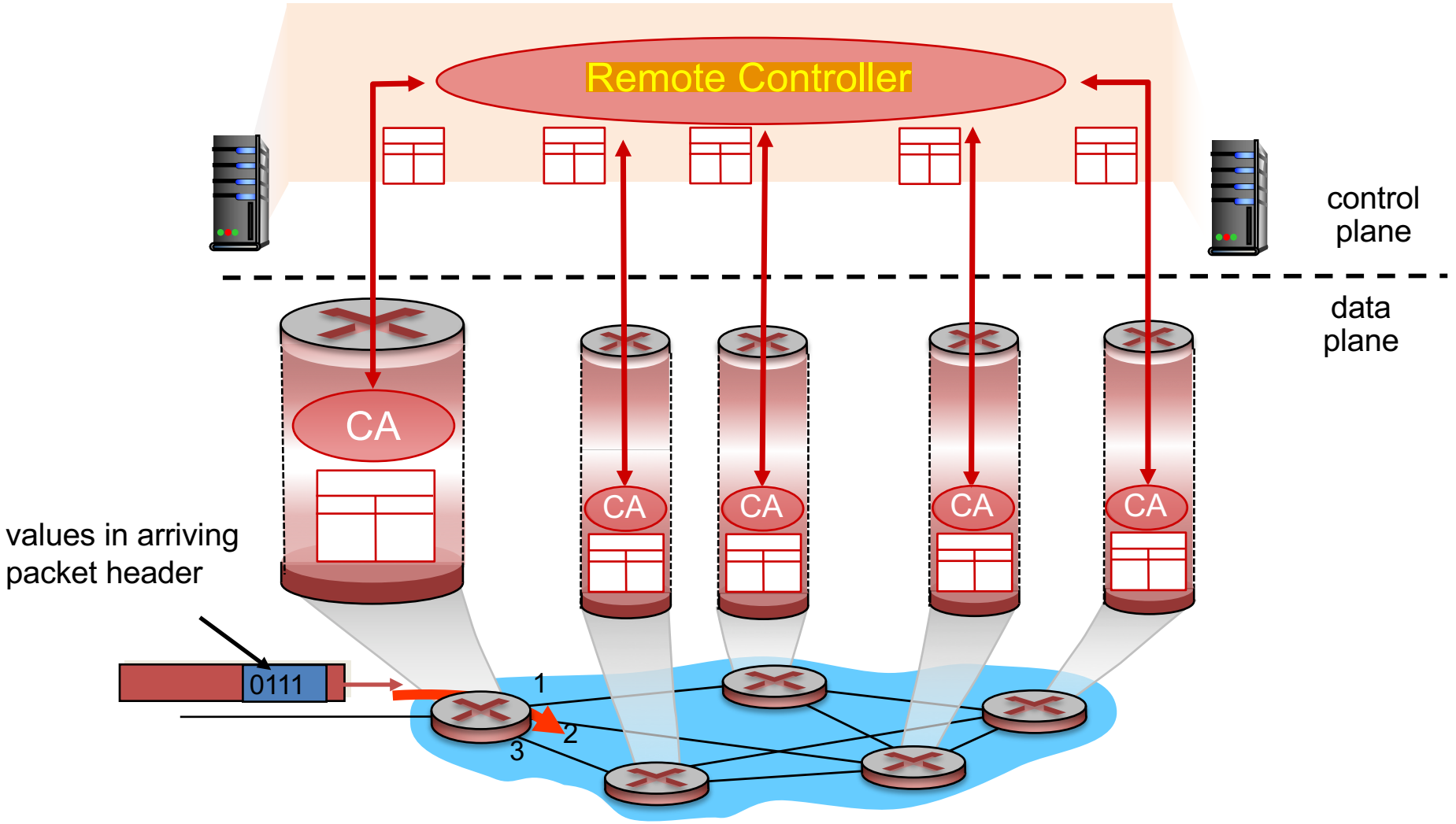
Per-router control plane

Individual routing algorithm components *in each and every router* interact in the control plane



Logically centralized control plane (SDN)

A distinct (typically remote) controller interacts with local control agents (CAs)



Network Layer: service model

Q: What *service model* for "channel" transporting datagrams from sender to receiver?

A. No guarantee whatsoever is provided by IP layer in TCP/IP protocol stack. It's "best effort service".