CS 372 Lecture #24

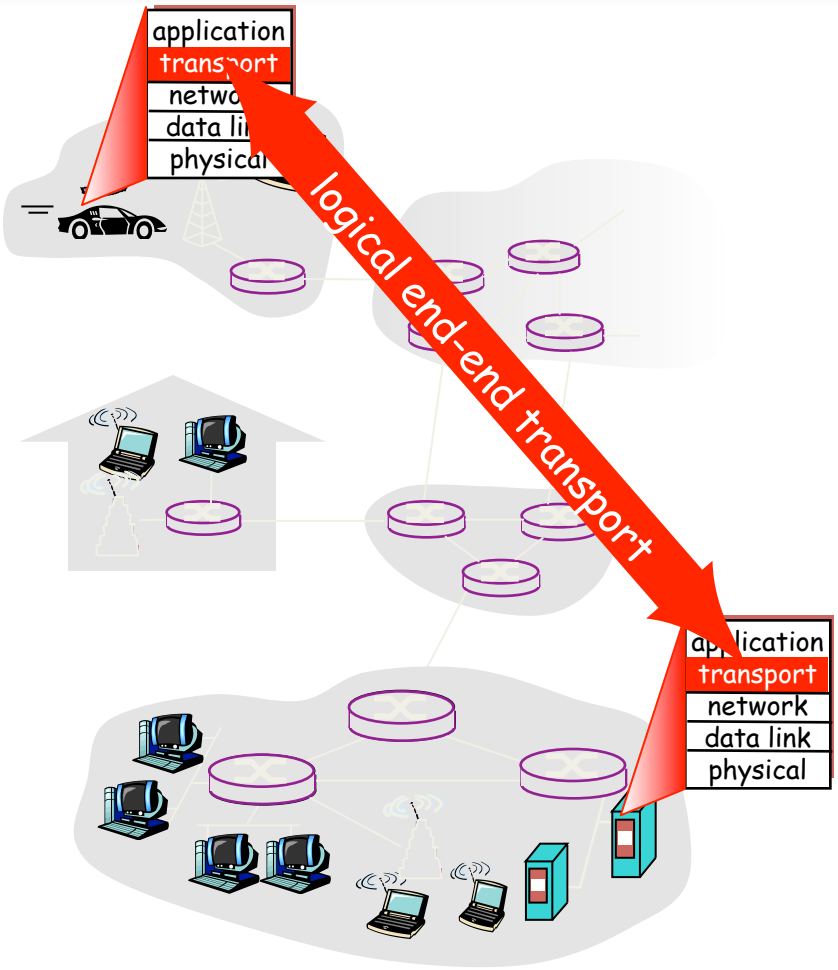
Introduction to the network layer

- routing and forwarding
  - Virtual circuit networks
  - Datagram networks

Note: Many of the lecture slides are based on presentations that accompany *Computer Networking: A Top Down Approach,* 6th edition, by Jim Kurose & Keith Ross, Addison-Wesley, 2013.

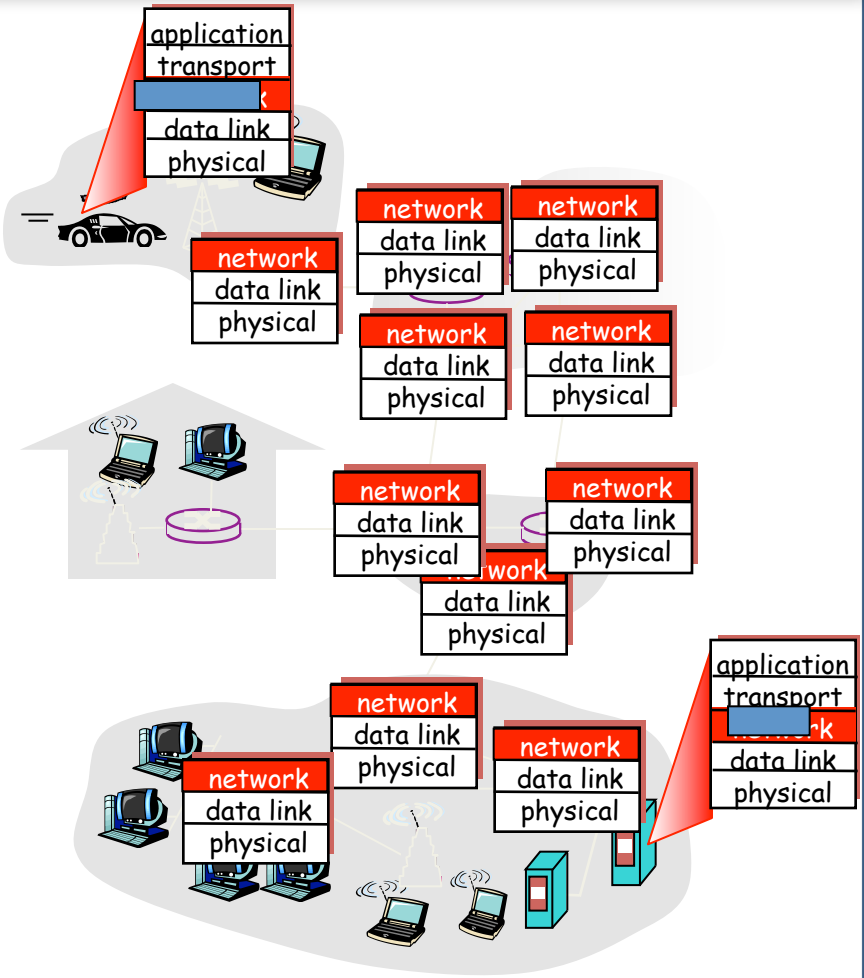
Transport layer / Network layer

- *transport layer*: logical communication between processes
  - relies on, enhances, **network** layer services
  - The transport-layer unit is called a **segment**
- *network layer*: logical communication between hosts
  - relies on, enhances, **link** layer services
  - The network-layer unit is called a **datagram**



Network layer

- Network layer protocols run at
  - end systems
  - routers
- Sender side:
  - get segments from transport layer
  - encapsulates segments into datagrams
- Routers examine header fields in all IP datagrams
- Receiver side:
  - delivers segments to transport layer

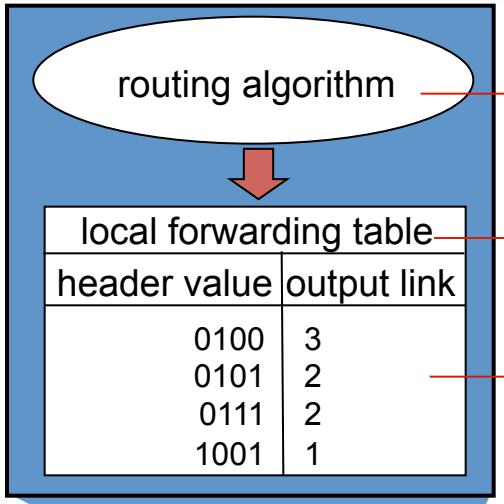


Two Major Network-Layer Functions

- *routing*: determine route taken by packets from source to destination.
  - *routing algorithms*

- *forwarding*: move packets from router's input to appropriate router output

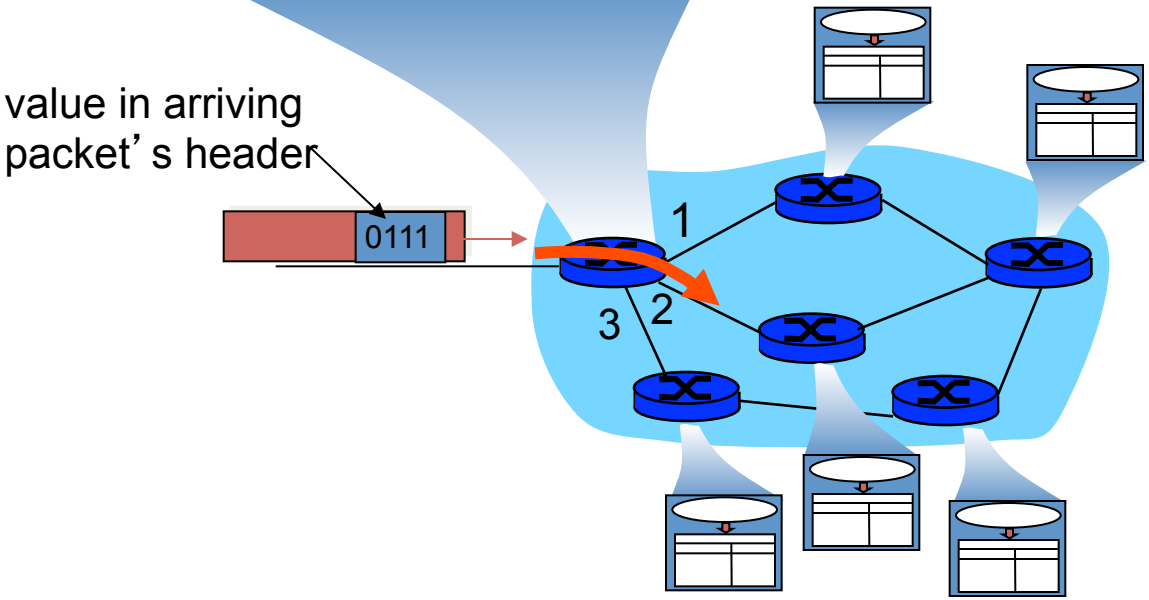
Routing and forwarding



routing algorithm determines path through network

forwarding table determines local forwarding at this router

link to "first hop" in path from this router to final destination



Connection/connectionless service

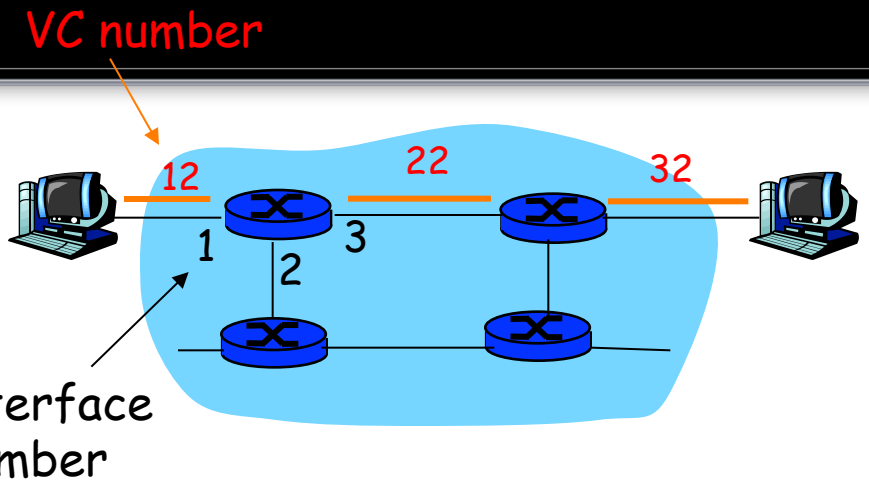
- *virtual-circuit network* provides network-layer connection service
- *datagram network* provides network-layer connectionless service
- analogous to TCP/UDP connection-oriented / connectionless transport-layer services, but …
  - *service*: host-to-host
  - *no choice*: network provides one or the other
  - *implementation*: in network core

Virtual Circuit (VC)

Source-to-destination path behaves much like a telephone circuit

- Call setup for each call *before* data can flow
- VC identifier in each packet (not destination host address)
- *Maintain state for each VC in every* router on the source-to-destination path
- Allocate resources for each VC:
  - bandwidth, buffers in links, routers involved in the VC
  - dedicated resources = predictable service

Forwarding table



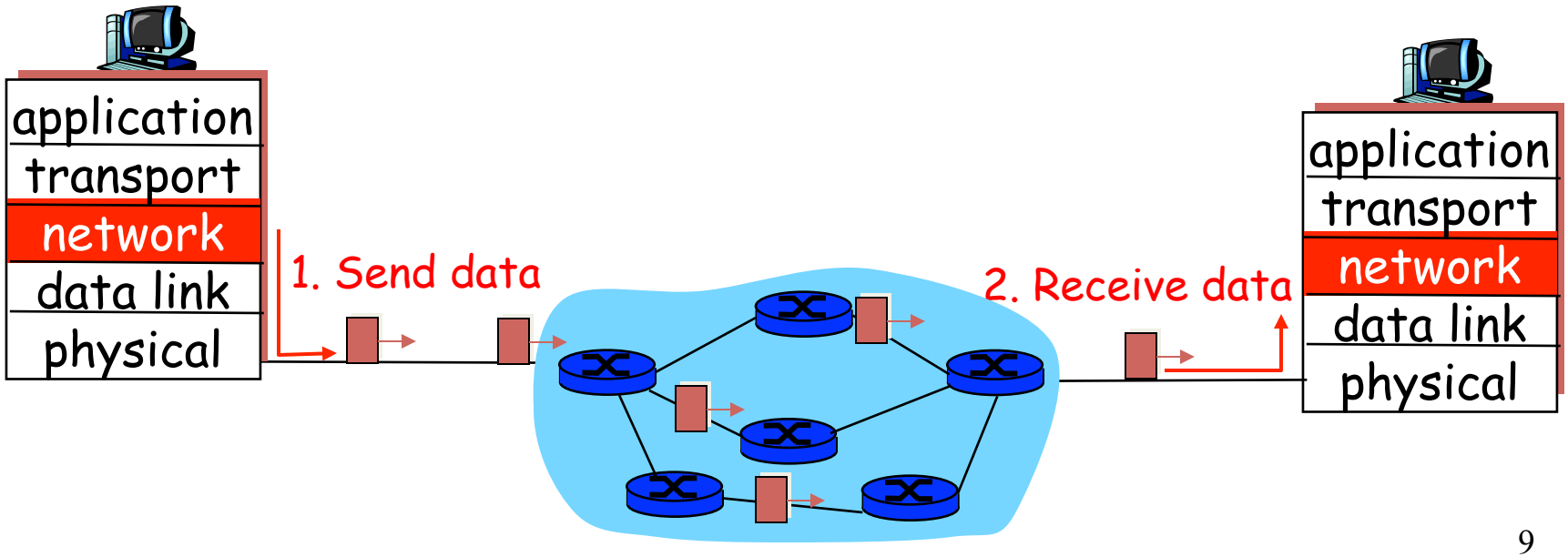
Forwarding table in northwest router:

Incoming interface	Incoming VC #	Outgoing interface	Outgoing VC #
1	12	3	22
2	63	1	18
3	7	2	17
1	97	3	87
…	…	…	…

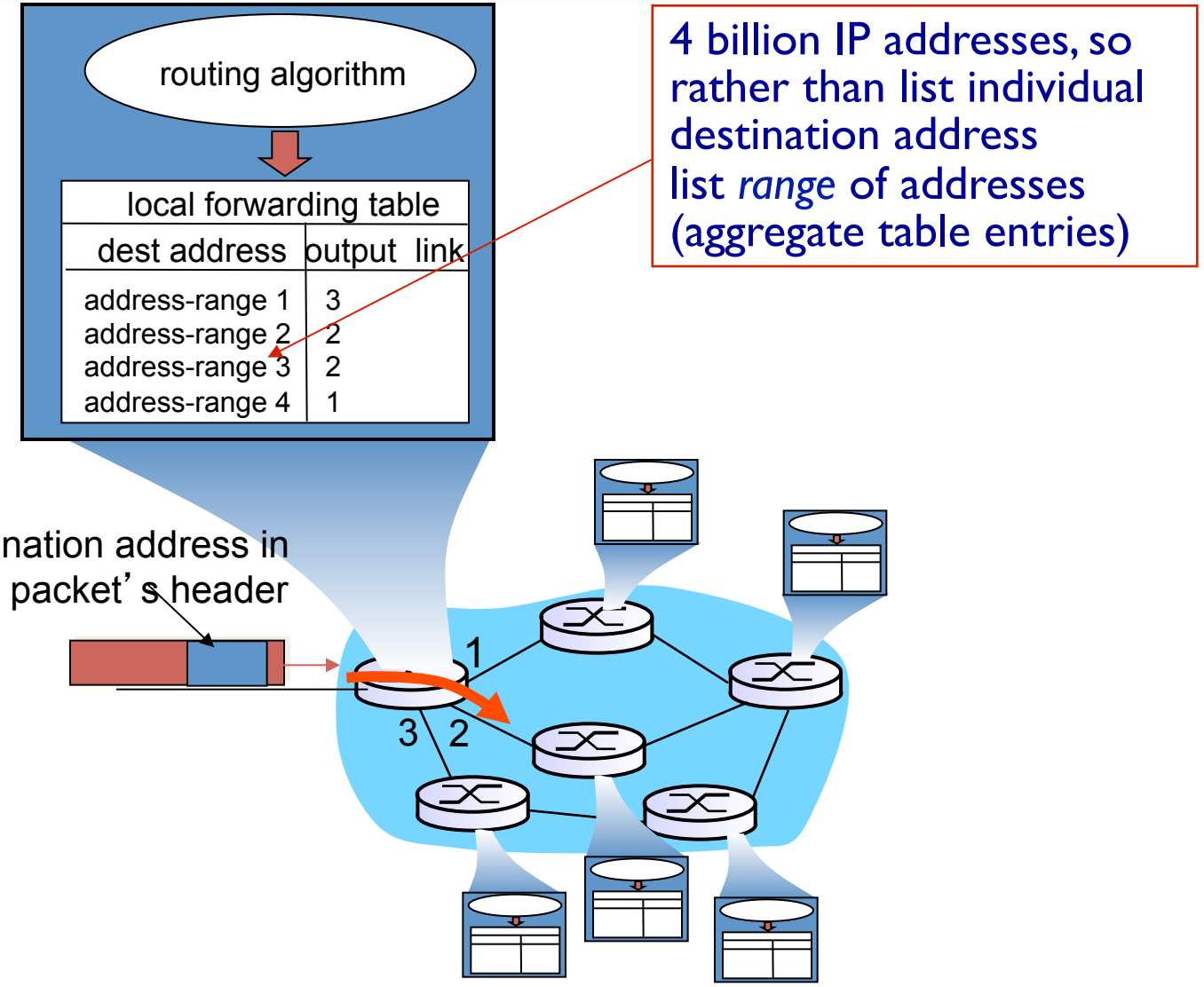
Routers maintain VC connection state information

Datagram Networks

- no call setup at network layer
- no state of end-to-end connections is kept in routers
  - no network-level concept of "connection"
- packets forwarded using destination host address
  - Note: packets with same source-destination address pair might take different paths !



Datagram forwarding table



Summary Lecture #24

- host-to-host delivery
- datagram
- routing
- forwarding
- Virtual Circuit network
- datagram network
- forwarding table