

## Transport Layer Overview

Kai Shen

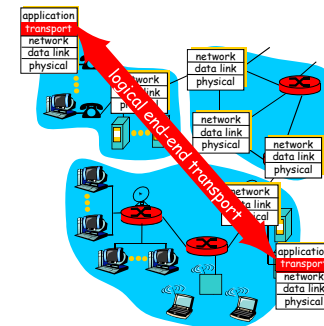
10/6/2014

CSC 257/457 - Fall 2014

1

## Transport-layer Overview

- **Network layer:** host-to-host logical communication between *hosts*.
- **Transport layer:** logical communication between *applications*.
  - multiple comm. applications can reside in one host.
  - comm. applications can be a Web browser/server, an FTP client/server, etc.

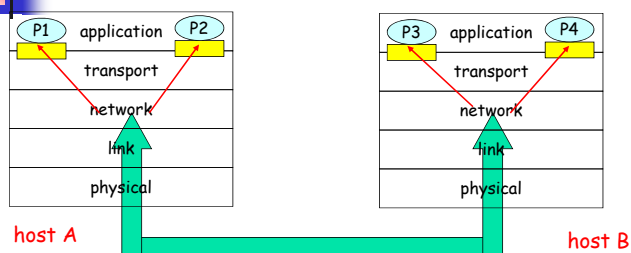


10/6/2014

CSC 257/457 - Fall 2014

2

## Multiplexing/demultiplexing



○ = comm. application

□ = socket

P1 on host A is communicating with P3 on host B; while at the same time, P2 on host A is communicating with P4 on host B.

10/6/2014

CSC 257/457 - Fall 2014

3

## Transport-layer Service Model

- **Transport layer:** logical communication between *applications*.
  - multiplexing/demultiplexing
- Possible additional services:
  - reliable data transfer (guaranteed arrival, no error, in-order)
  - flow control (keep sender from overrunning receiver): good for myself
  - congestion control (keep sender from overrunning network): good for the community
  - delay/bandwidth guarantee
  - ...

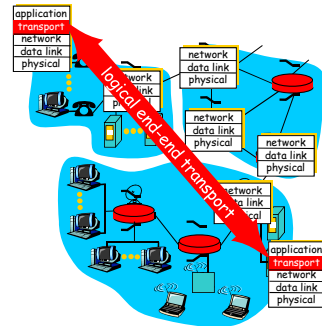
10/6/2014

CSC 257/457 - Fall 2014

4

## Transport-layer in the Internet Architecture

- End-host only transport implementation
- Simple network layer, complex transport
- Benefits:
  - Flexible transport layer
  - Fast, stable network core
- Challenge:
  - Transport functions without router assistance



10/6/2014

CSC 257/457 - Fall 2014

5

## Internet Transport-layer Protocols

- UDP: minimum service transport
  - multiplexing/demultiplexing
  - error detection
- TCP: full service transport
  - multiplexing/demultiplexing
  - error detection
  - reliable data transfer
  - flow control
  - congestion control
- Services not available:
  - delay guarantees
  - bandwidth guarantees
  - why?

10/6/2014

CSC 257/457 - Fall 2014

6

## Connection-oriented /Connectionless Transport

- What is a **connection**?
  - logical grouping/sequencing of data segments for a comm. session between the same pair of end-points
  - state maintained for such session
- Why is a connection useful?
  - conn. state-based reliable communication
  - resource differentiation
  - track network performance using a history of performance measurement
  - ... ..
- UDP is connectionless
- TCP is connection-oriented

10/6/2014

CSC 257/457 - Fall 2014

7

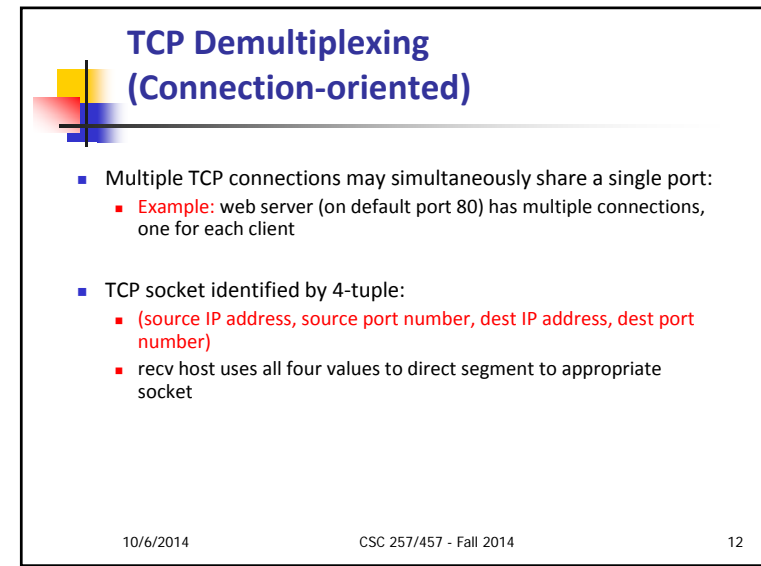
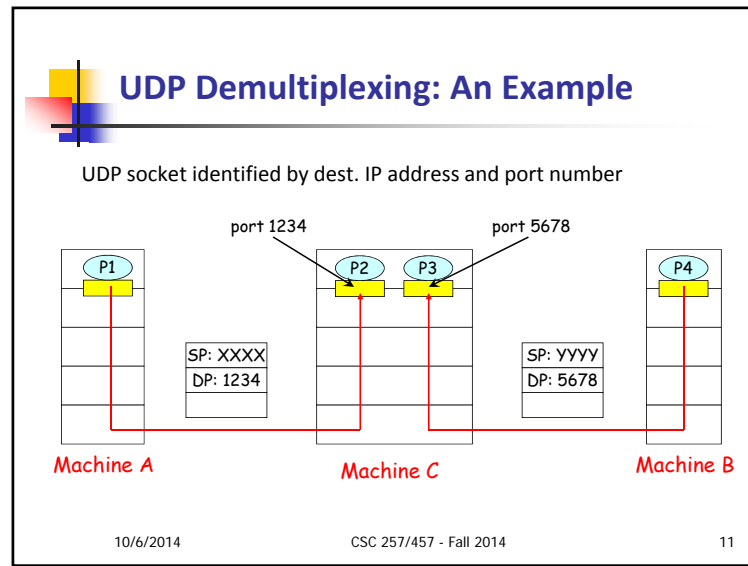
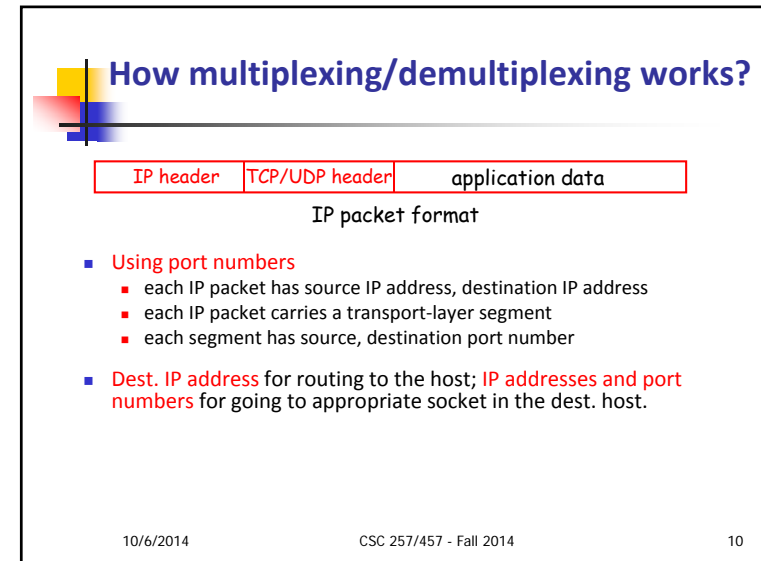
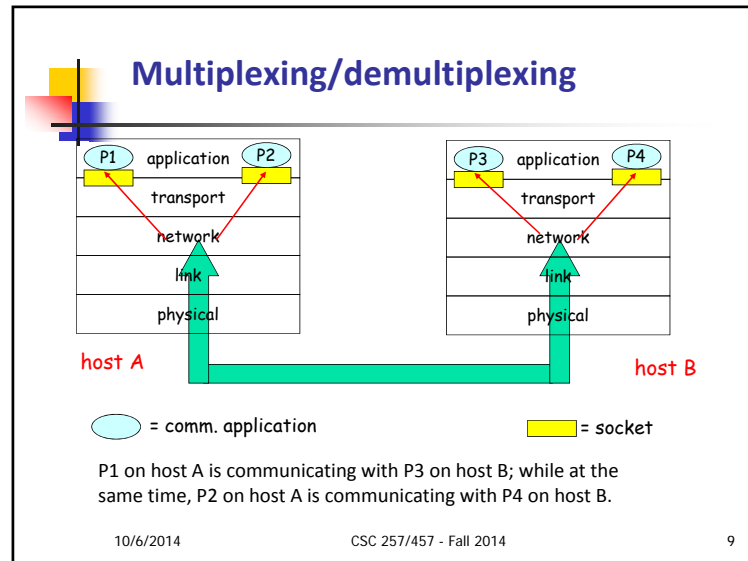
## Outline

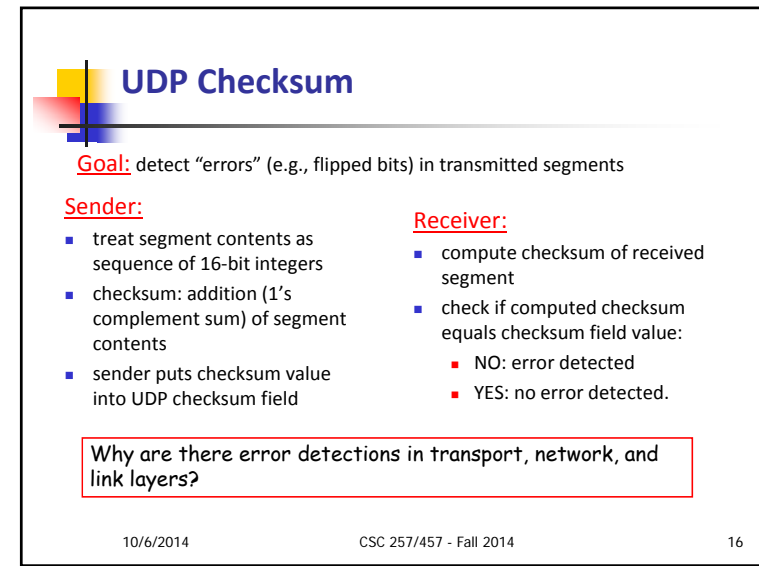
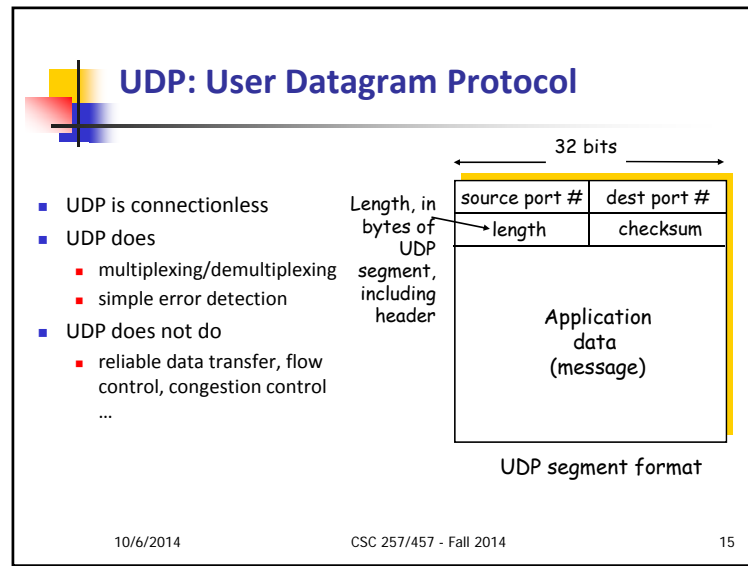
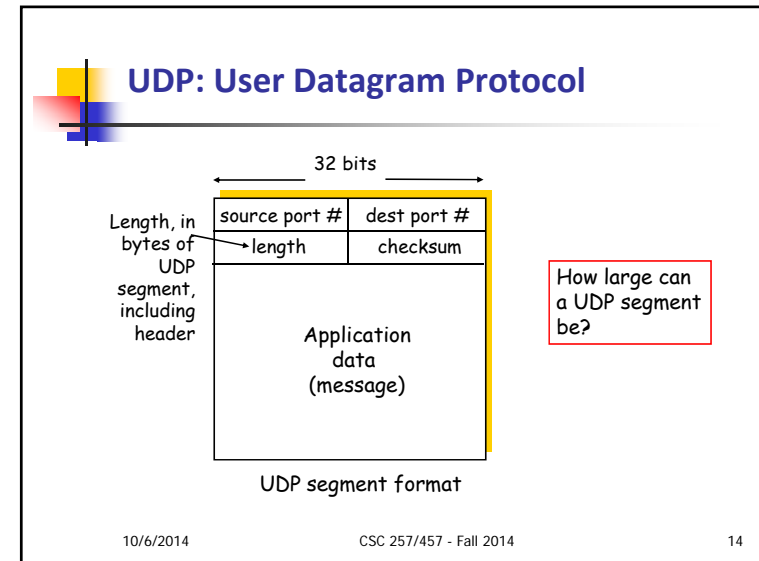
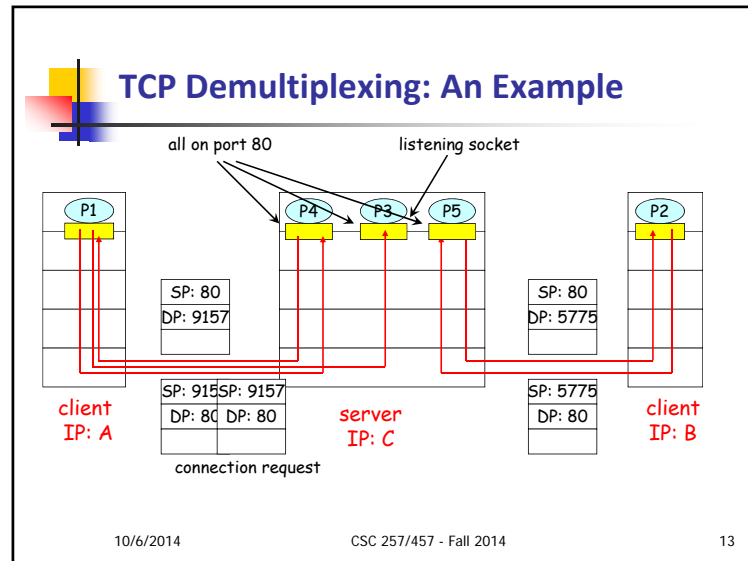
- Overview of transport-layer services/protocols
- Multiplexing and demultiplexing
- Connectionless transport: UDP
- Principles of reliable data transfer
- Connection-oriented transport: TCP
  - reliable data transfer
  - flow control
  - connection management
- Principles of congestion control
- Congestion control in TCP

10/6/2014

CSC 257/457 - Fall 2014

8







## What is good about UDP?

- Less overhead:
  - no running cost for connection management
  - no space cost for connection state
  - small segment header
- Flexibility in doing things your own way
  - no congestion control: UDP can blast away as fast as desired (may not be good for others, but not bad for my own connection 😊)
- Simple ⇒ more robust, less security vulnerability
  - less susceptible to denial-of-service attacks

10/6/2014

CSC 257/457 - Fall 2014

17



## UDP In Practice

- When to use UDP?
  - TCP services are not useful, or even hurtful
  - TCP services are useful, but not worth the cost
  - TCP services are useful in concept, but need to be customized
- Used for:
  - routing exchanges between routers
  - network performance measurements
  - streaming multimedia apps
    - loss tolerant, rate sensitive
    - flow control and loss recovery sometimes implemented at the application level

10/6/2014

CSC 257/457 - Fall 2014

18



## Disclaimer

- Parts of the lecture slides contain original work of James Kurose, Larry Peterson, and Keith Ross. The slides are intended for the sole purpose of instruction of computer networks at the University of Rochester. All copyrighted materials belong to their original owner(s).

10/6/2014

CSC 257/457 - Fall 2014

19