Transport Layer Contd

Internet Technologies
COMP90007

TCP and Congestion Control

- When networks are overloaded, congestion occurs, affecting all layers
- Although lower layers (data and network) attempt to ameliorate congestion, in reality **TCP impacts congestion most significantly** because TCP offers best methods to reduce the data rate, and hence reduce congestion itself

Congestion Control: The Design

- Two different problems exist
  - network capacity and receiver capacity
  - these should be dealt with separately, **but compatibly**
- The sender maintains two windows actually
  - Window described by the receiver
  - + Congestion window
- Each regulates the number of bytes the sender can transmit – the maximum transmission rate is the **minimum of the two windows**

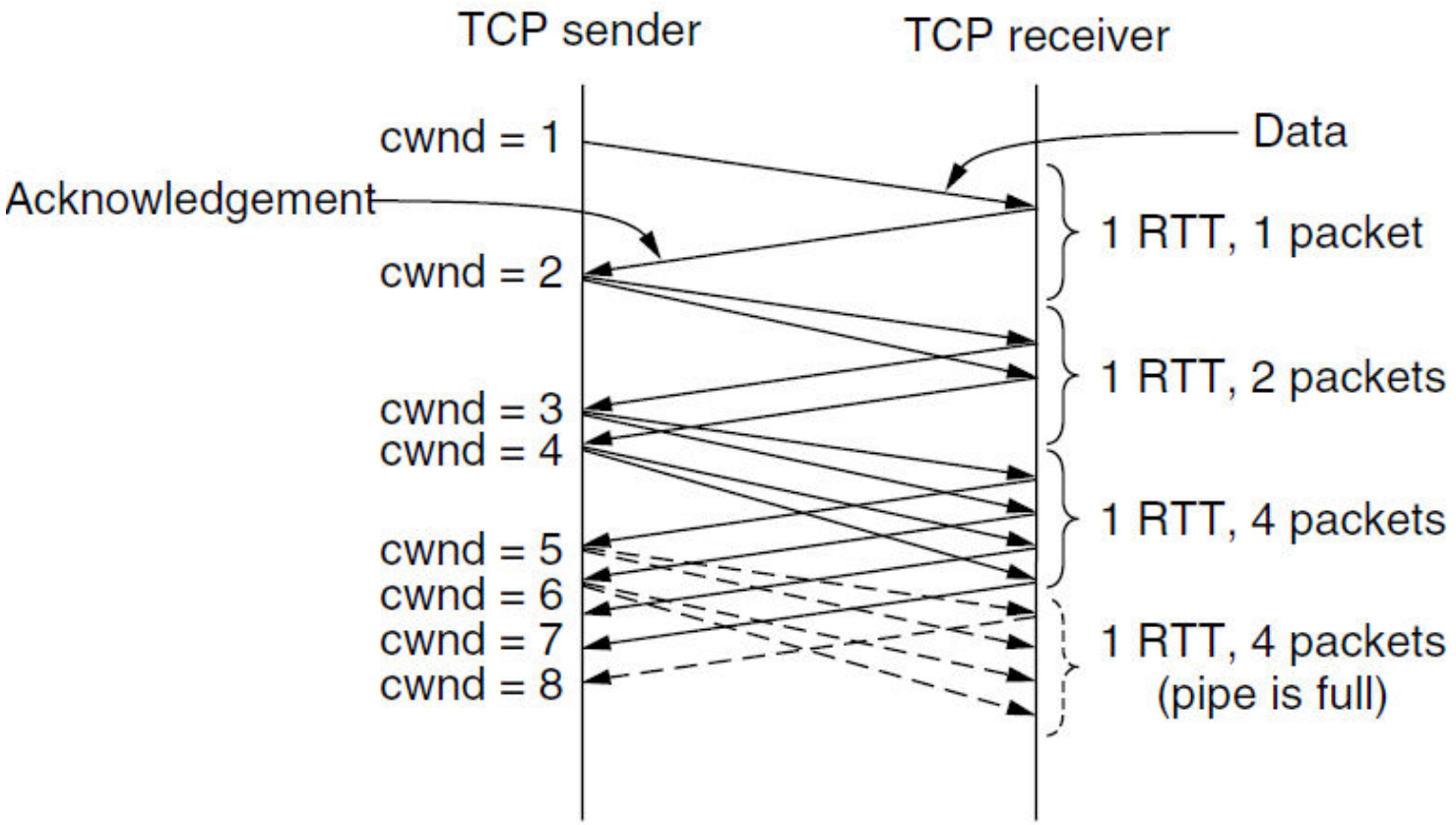
TCP and Congestion Control Contd.

- TCP basically adopts a defensive stance:
  - At connection establishment, a **suitable window size is chosen by the receiver based on its buffer** size
  - If the sender is constrained to this size, then **problems will not occur due to buffer overflow** at the receiver itself, but may still **occur due to congestion within the network**, TCP addresses this as follows

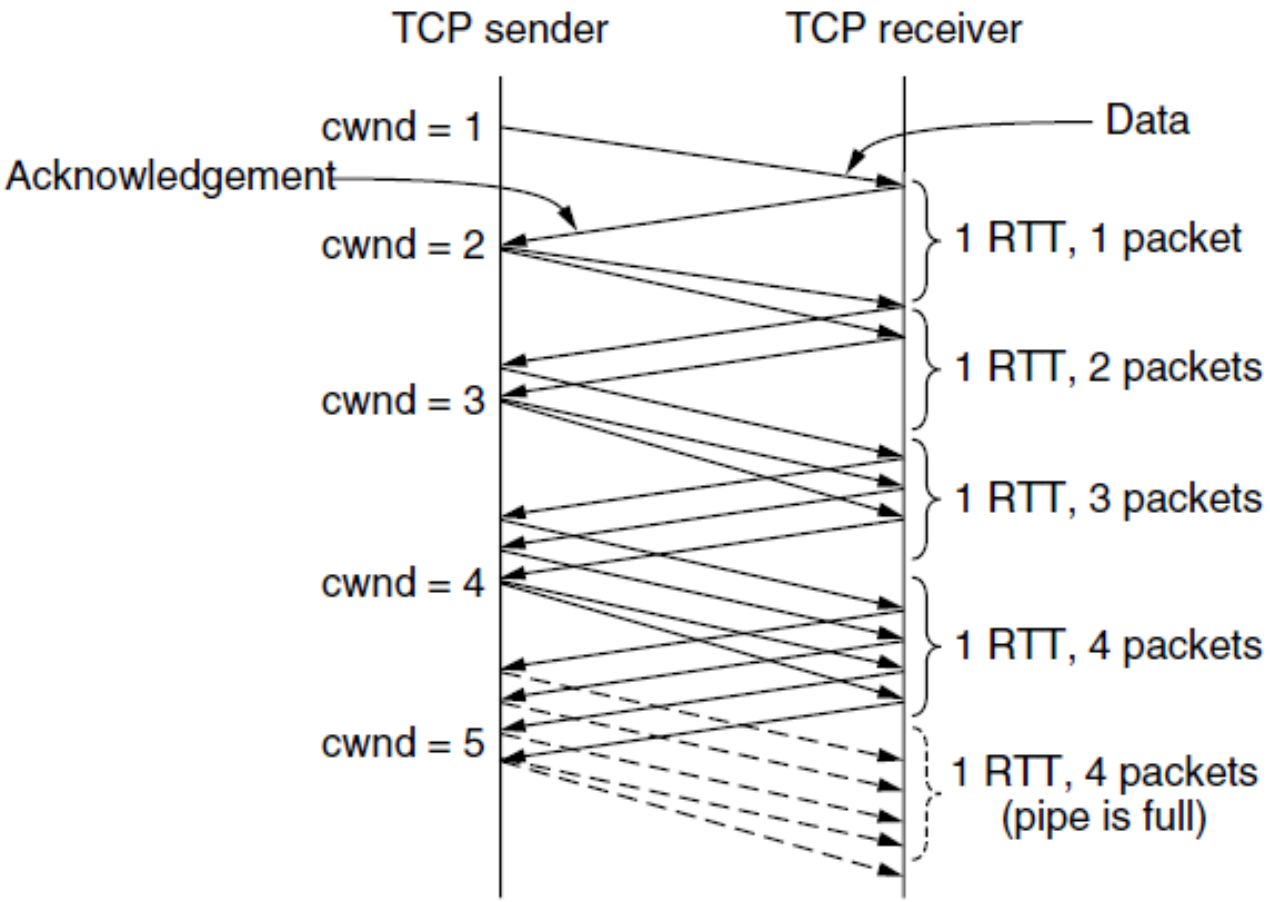
Incremental Congestion Control: Slow Start

- On connection establishment, the **sender initializes the congestion window to a size**, and transmits one segment
- If this segment is acknowledged before the timer expires, **the sender adds another segment's worth of bytes to the congestion window**, and transmits two segments
- As **each new segment is acknowledged**, the congestion window is increased by **one more segment**
- In effect, each set of acknowledgements doubles the congestion window - which **grows until either a timeout occurs or the receiver's specified window is reached**

Slow Start

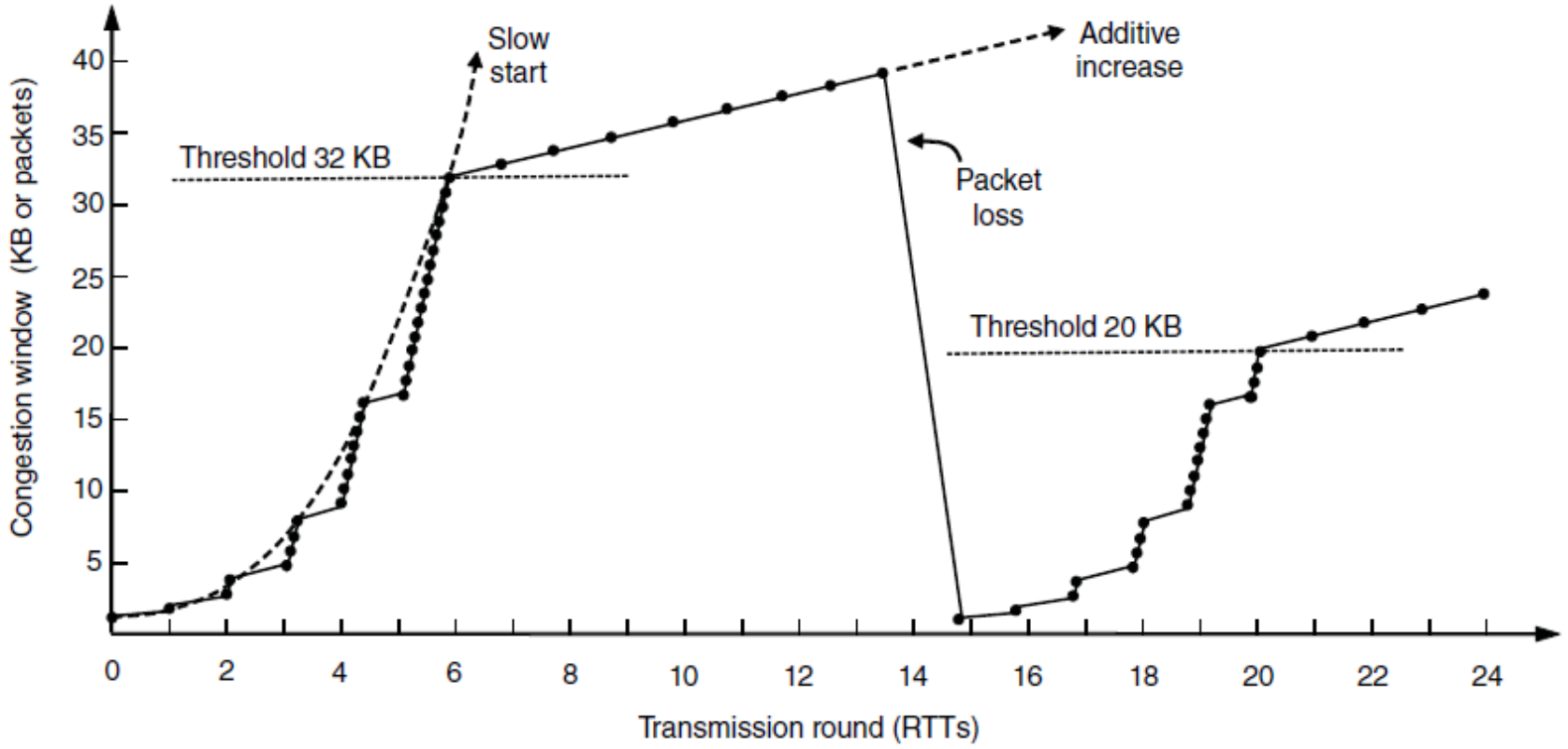

TCP sender
TCP receiver
cwnd = 1
Data
Acknowledgement
1 RTT, 1 packet
cwnd = 2
1 RTT, 2 packets
cwnd = 3
cwnd = 4
1 RTT, 4 packets
cwnd = 5
cwnd = 6
cwnd = 7
cwnd = 8
1 RTT, 4 packets
(pipe is full)

Then Additive increase



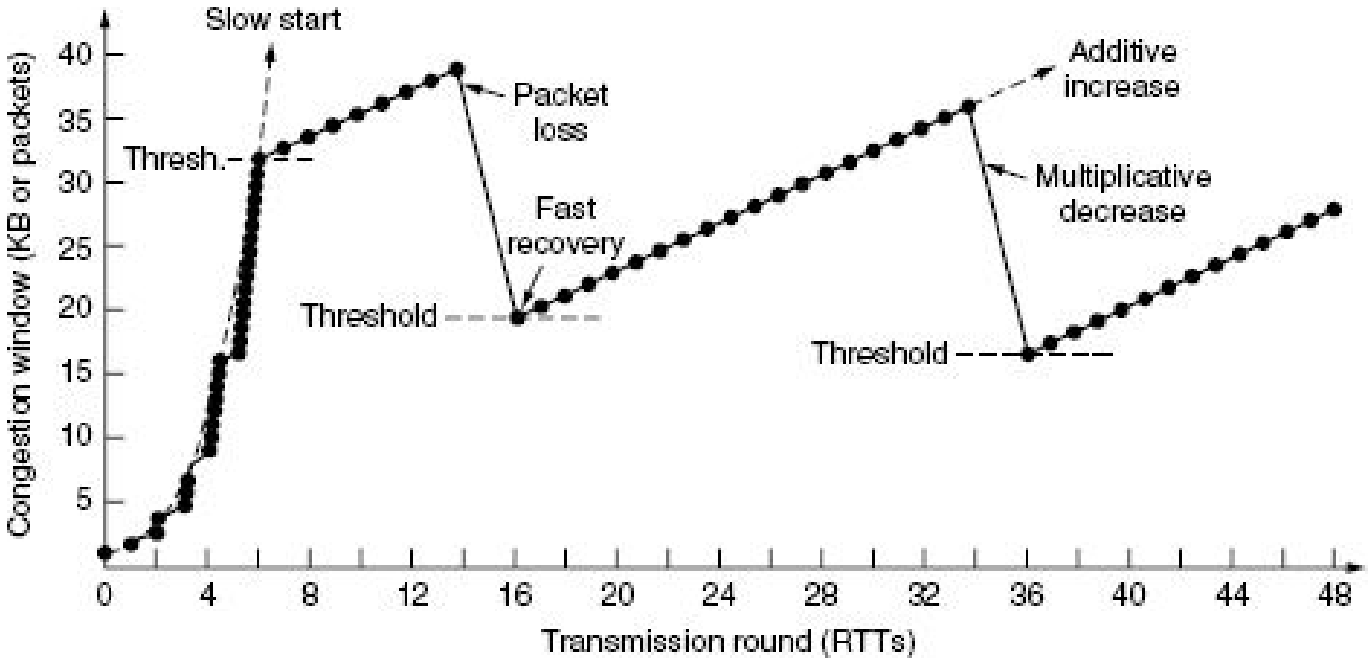
Internet Congestion Control

Slow start followed by additive increase (**TCP Tahoe**) --
Threshold is half of previous when ack is not received and we restart process



Internet Congestion Control Contd

An extension: TCP Reno



Congestion Control And Wireless

- Things are increasingly wireless
- Wireless settings are much harder to deal with
  - E.g., SNR varies when people move around
  - Not everything is wireless, but parts of a path which complicates matters even more
  - So how does one know where wireless is and what to do when we know where it is
  - Larger variety on wireless types as well
    - Delay is different if it is Wifi vs Satellite
  - This is a hot area of research

A Key Worry in TCP is with Timers

- A key worry is when timers should go out
- Too early means too many resends
- Too late means reliability comes with other additional cost
- Solutions rely on dynamicity as network conditions change
- Thus one needs to measure network performance and adapt timers

Application Layer

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The Last Layer in Our Stack

- Things are done in an Application specific manner
- We will look at key implementations to study this layer: **Domain Name System** first and then some others