IIT KHARAGPUR

NPTEL ONLINE
CERTIFICATION COURSES

COMPUTER NETWORKS AND INTERNET PROTOCOLS

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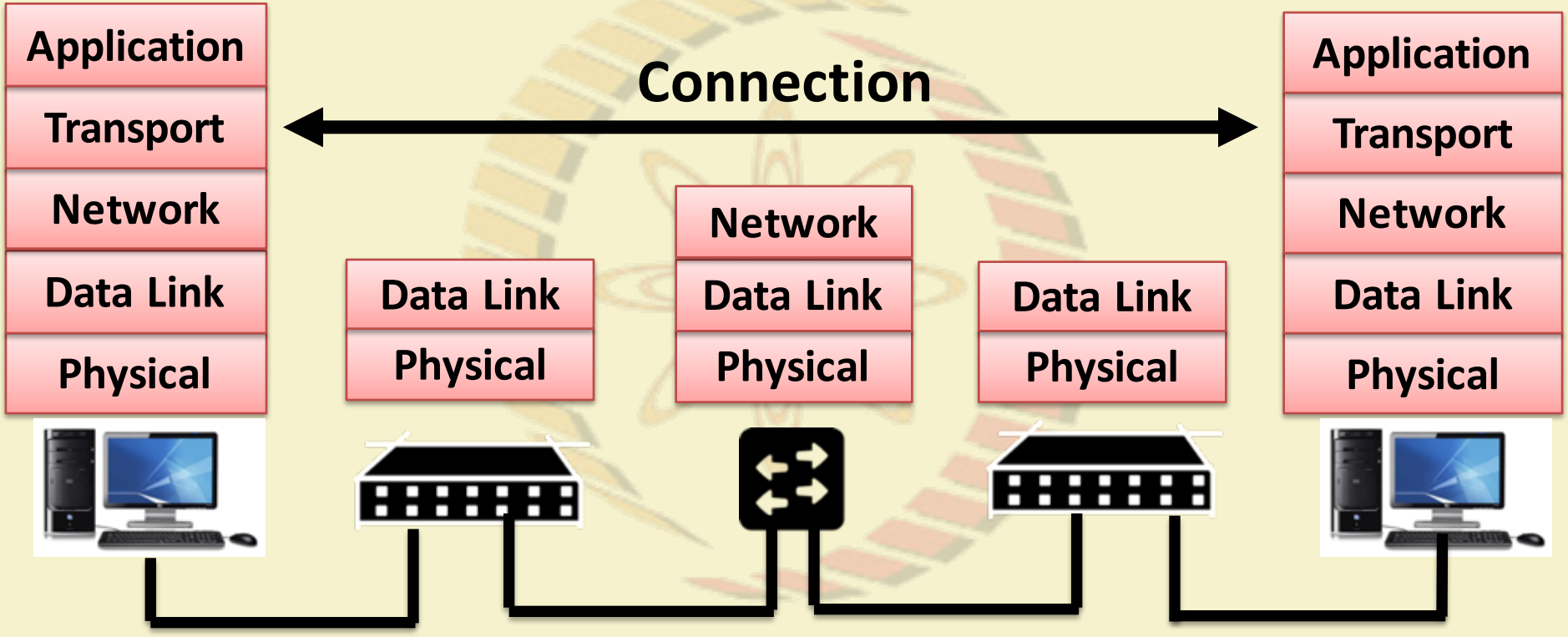
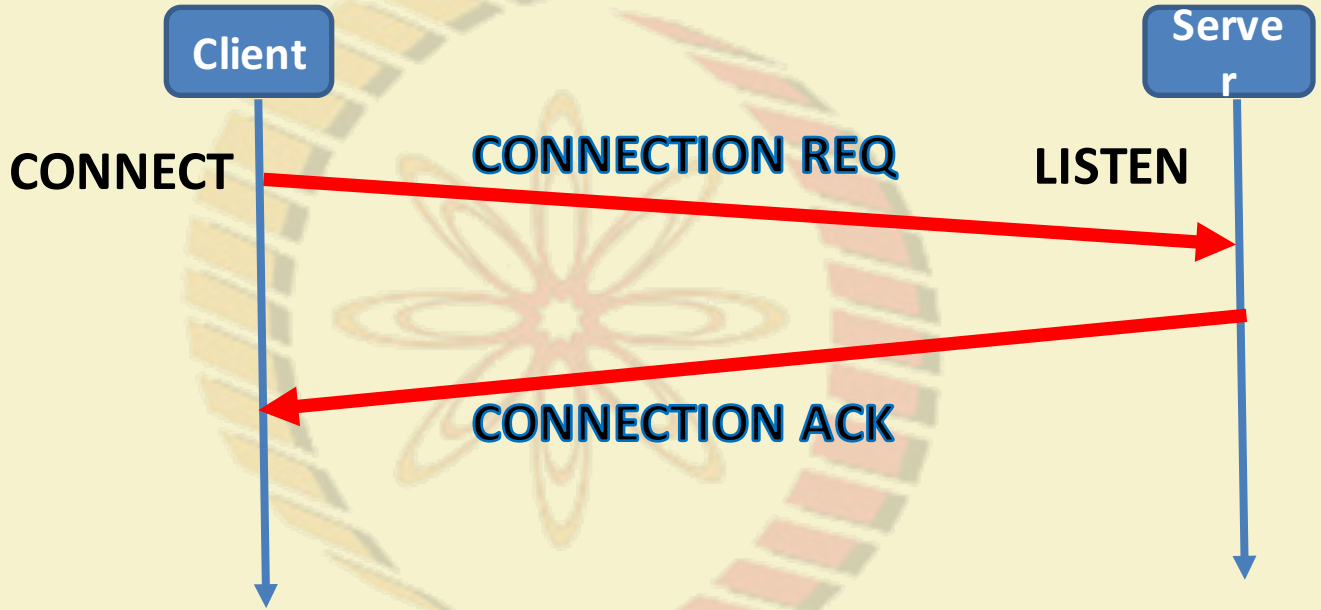
Transport Layer - II (Connection I)



Connection Establishment



- This is a simple primitive for connection establishment – but does this work good?

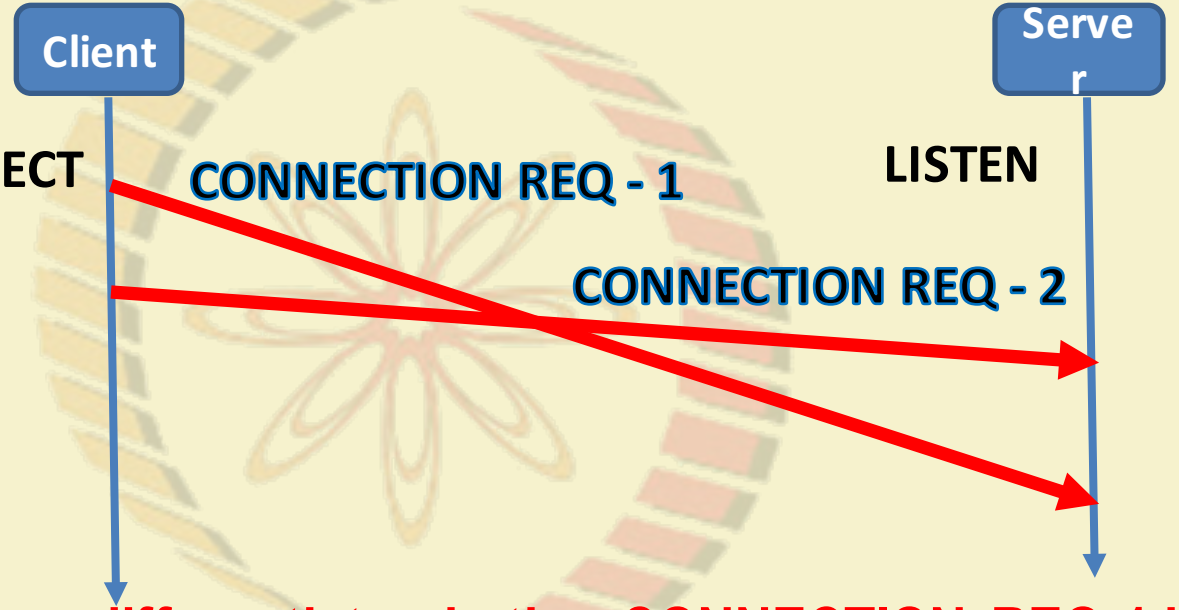
Connection Establishment

- Consider a scenario when the network can lose, delay, corrupt and duplicate packets (the underline network layer uses unreliable data delivery)

- Consider retransmission for ensuring reliability – every packet uses different paths to reach the destination

- Packets may be delayed and got struck in the network congestion, after the timeout, the sender assumes that the packets have been dropped, and retransmits the packets

Connection Establishment



It may happen that the server has crashed and reinitiated the connection. So distinguishing between these two is essential

- How will the server differentiate whether CONNECTION REQ-1 is a new connection request or a duplicate of the CONNECTION REQ-2?

Connection Establishment

- **Protocol correctness versus Protocol performance – an eternal debate in computer networks …**

- Delayed duplicates create a huge confusion in the packet switching network. A major challenge in packet switching network is to develop **correct** or **at least acceptable** protocols for handling delayed duplicates

Connection Establishment – Handling Delayed Duplicates

- **Solution 1: Use Throwaway Transport Address (Port Numbers)**
  - Do not use a port number if it has been used once already – Delayed duplicate packets will never find their way to a transport process
  - Is this solution feasible?

- **Solution 2: Give each connection a unique identifier chosen by the initiating party and put in each segment**
  - Can you see any problem in this approach?

Connection Establishment – Handling Delayed Duplicates

- **Solution 3:** Devise a mechanism to kill off aged packets that are still hobbling about (Restrict the packet lifetime)
  - Makes it possible to design a feasible solution

Connection Establishment – Handling Delayed Duplicates

- Three ways to restrict packet lifetime
  - **Restricted Network Design** – Prevents packets from looping (bound the maximum delay including congestion)
  - **Putting a hop count in each packet** – **initialize to a maximum value and decrement each time the packet traverses a single hop (most feasible implementation)**
  - **Timestamping each packet** – define the lifetime of a packet in the network, need time synchronization across each router.

Connection Establishment – Handling Delayed Duplicates

- Design Challenge: We need to guarantee not only that a packet is dead, but also that all acknowledgements to it are also dead

Connection Establishment – Handling Delayed Duplicates

- Let us define a maximum packet lifetime T – If we wait a time T secs after a packet has been sent, we can be sure that all traces of it (packet and its acknowledgement) are now gone

- Rather than a physical clock (clock synchronization in the Internet is difficult to achieve), let us use a virtual clock – **sequence number generated based on the clock ticks**

Connection Establishment – Handling Delayed Duplicates

- **Label segments with sequence numbers that will not be reused within T secs.**

- The period T and the rate of packets per second determine the size of the sequence number – **at most one packet with a given sequence number may be outstanding at any given time**

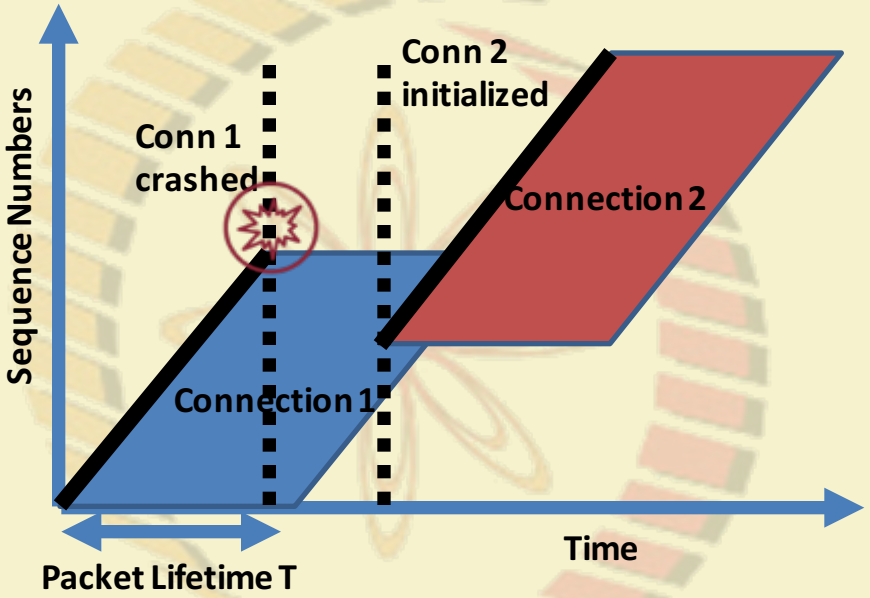
Sequence Number Adjustment

- **Two important requirements (*Tomlinson 1975, Selecting Sequence Numbers*)**
  - **R1.** Sequence numbers must be chosen such that a particular sequence number never refers to more than one byte (for byte sequence numbers) at any one time
  - **How to choose the initial sequence number**

Sequence Number Adjustment

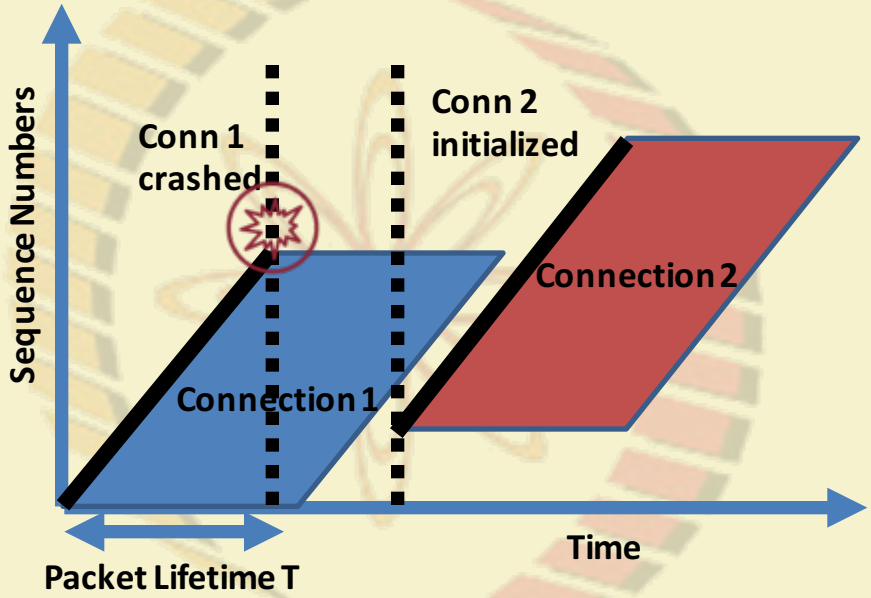
- **Two important requirements (*Tomlinson 1975, Selecting Sequence Numbers*)**
  - **R2:** The valid range of sequence numbers must be positively synchronized between the sender and the receiver, whenever a connection is used
  - **Three way handshaking followed by the flow control mechanism – once connection is established, only send the data with expected sequence numbers**

Initial Sequence Number during Connection Establishment

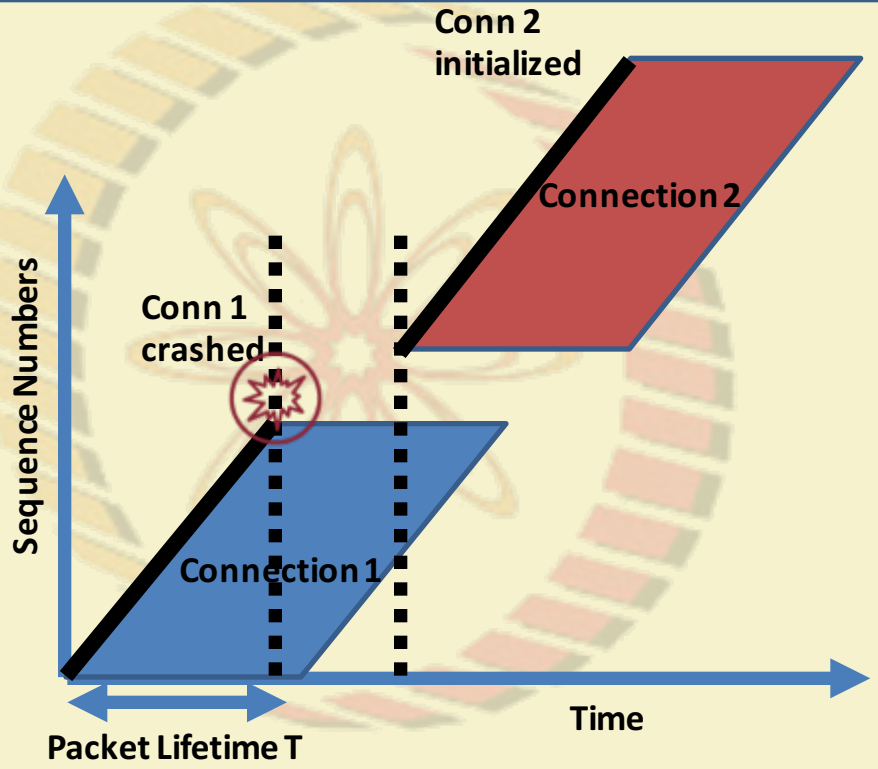


- A Delayed duplicate packet of connection 1 can create a confusion for connection 2

What We Ideally Want? Either …



What We Ideally Want? Or …




thank you!