

This diagram was generated with EventStudio System Designer 4.0. (<http://www.EventHelix.com/EventStudio>)  
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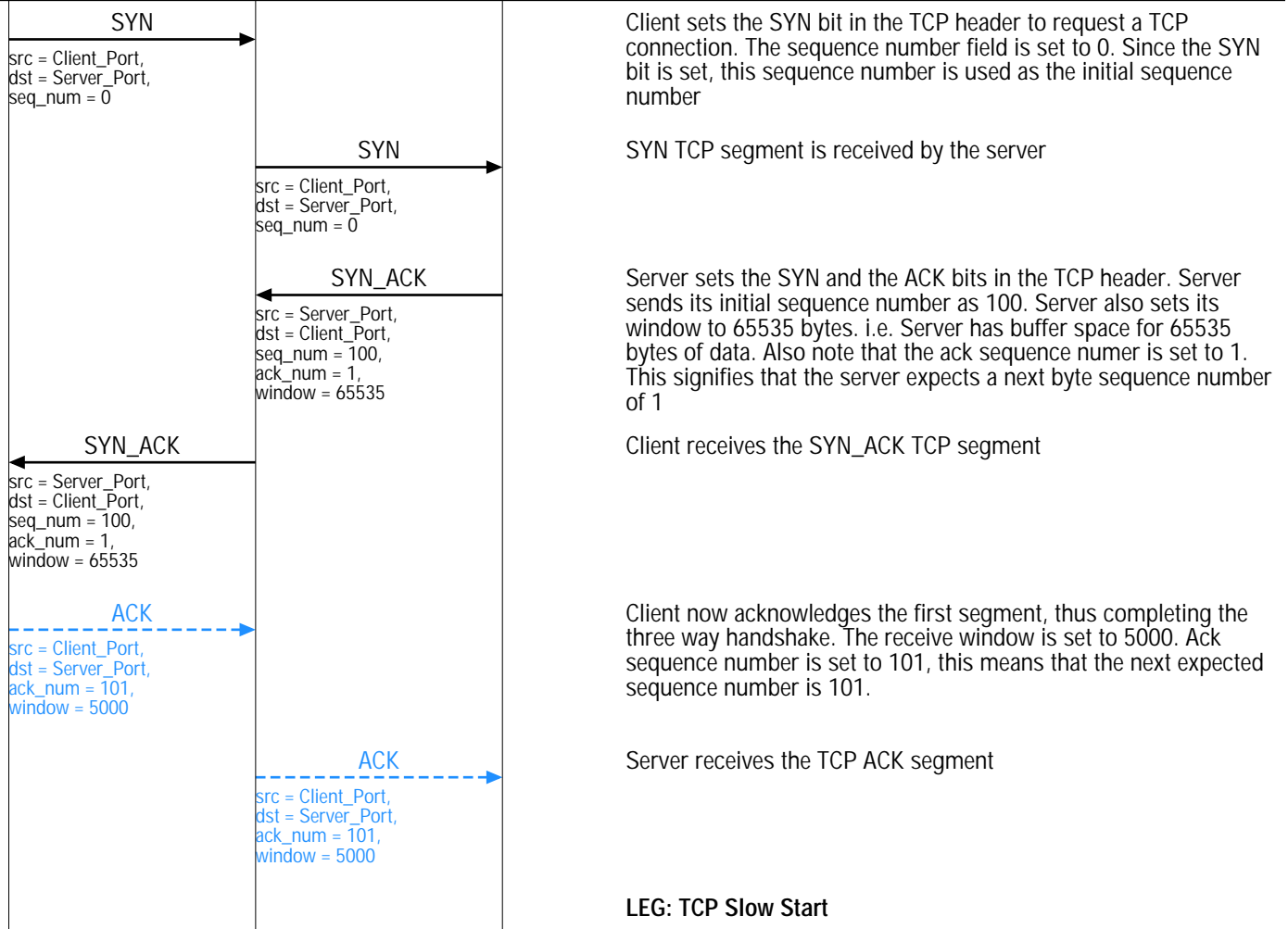
**LEG: About TCP Slow Start**

TCP is an end to end protocol which operates over the heterogeneous Internet. TCP has no advance knowledge of the network characteristics, thus it has to adjust its behavior according to the current state of the network. TCP has built in support for congestion control. Congestion control ensures that TCP does not pump data at a rate higher than what the network can handle.

In this sequence diagram we will analyse "Slow start", an important part of the congestion control mechanisms built right into TCP. As the name suggests, "Slow Start" starts slowly, increasing its window size as it gains confidence about the networks throughput.

**LEG: Client initiates TCP connection**

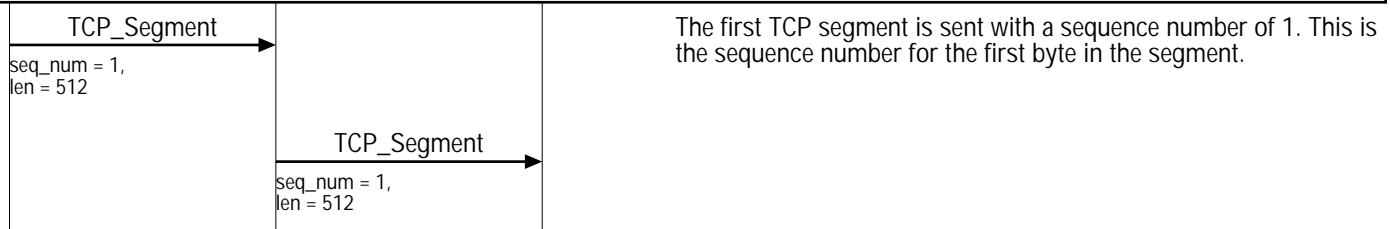
Client initiated three way handshake to establish a TCP connection



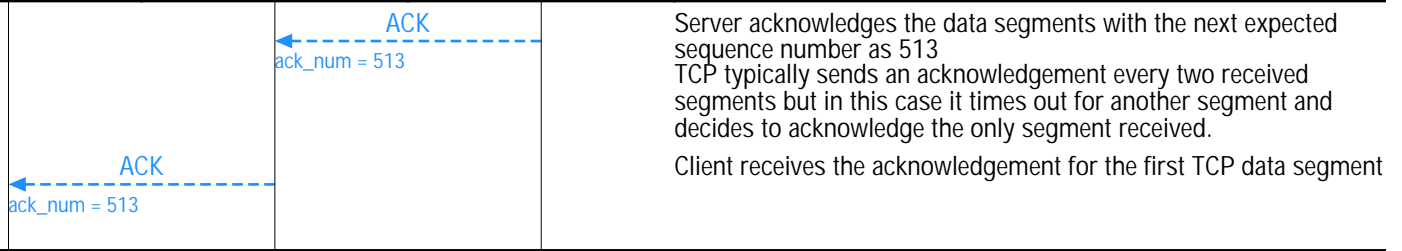
A TCP connection starts in the "Slow Start" state. In this state, TCP adjusts its transmission rate based on the rate at which the acknowledgements are received from the other end.

TCP Slow start is implemented using two variables, viz cwnd (Congestion Window) and ssthresh (Slow Start Threshold). cwnd is a self imposed transmit window restriction at the sender end. cwnd will increase as TCP gains more confidence on the networks ability to handle traffic. ssthresh is the threshold for determining the point at which TCP exits slow start. If cwnd increases beyond ssthresh, the TCP session in that direction is considered to be out of slow start phase

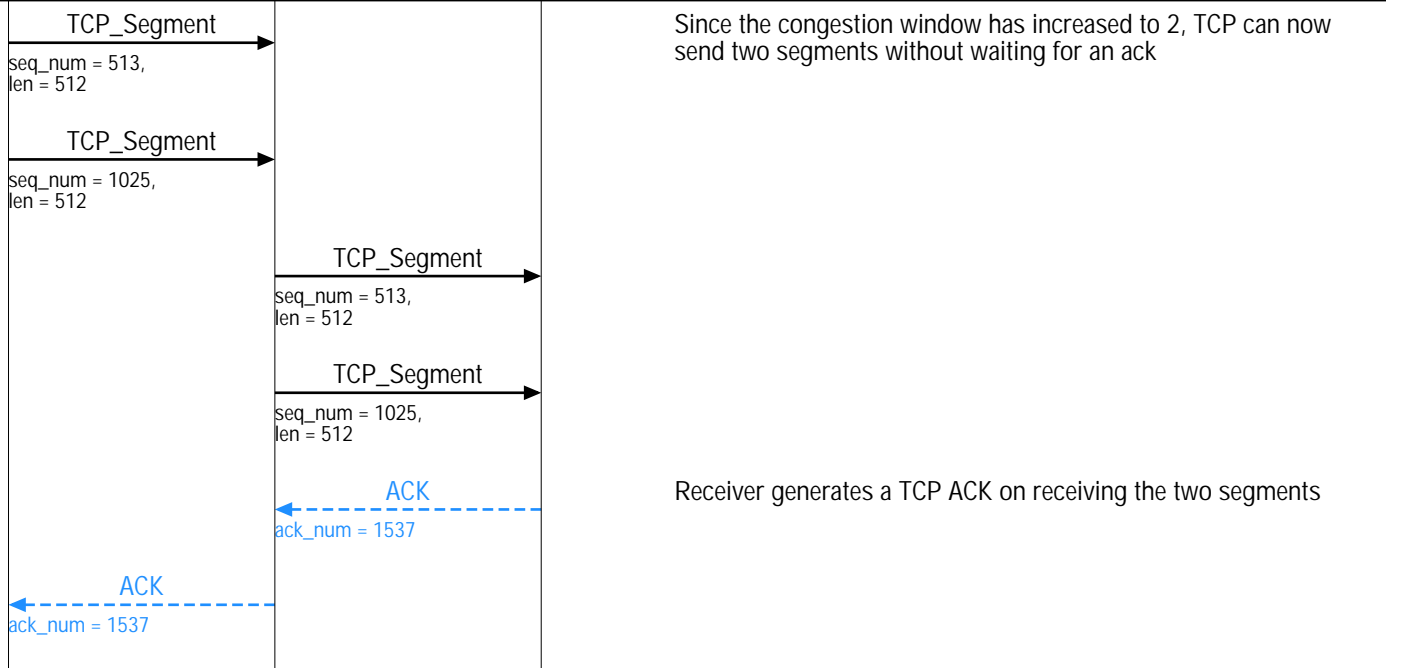
Roundtrip #1 of data transmission



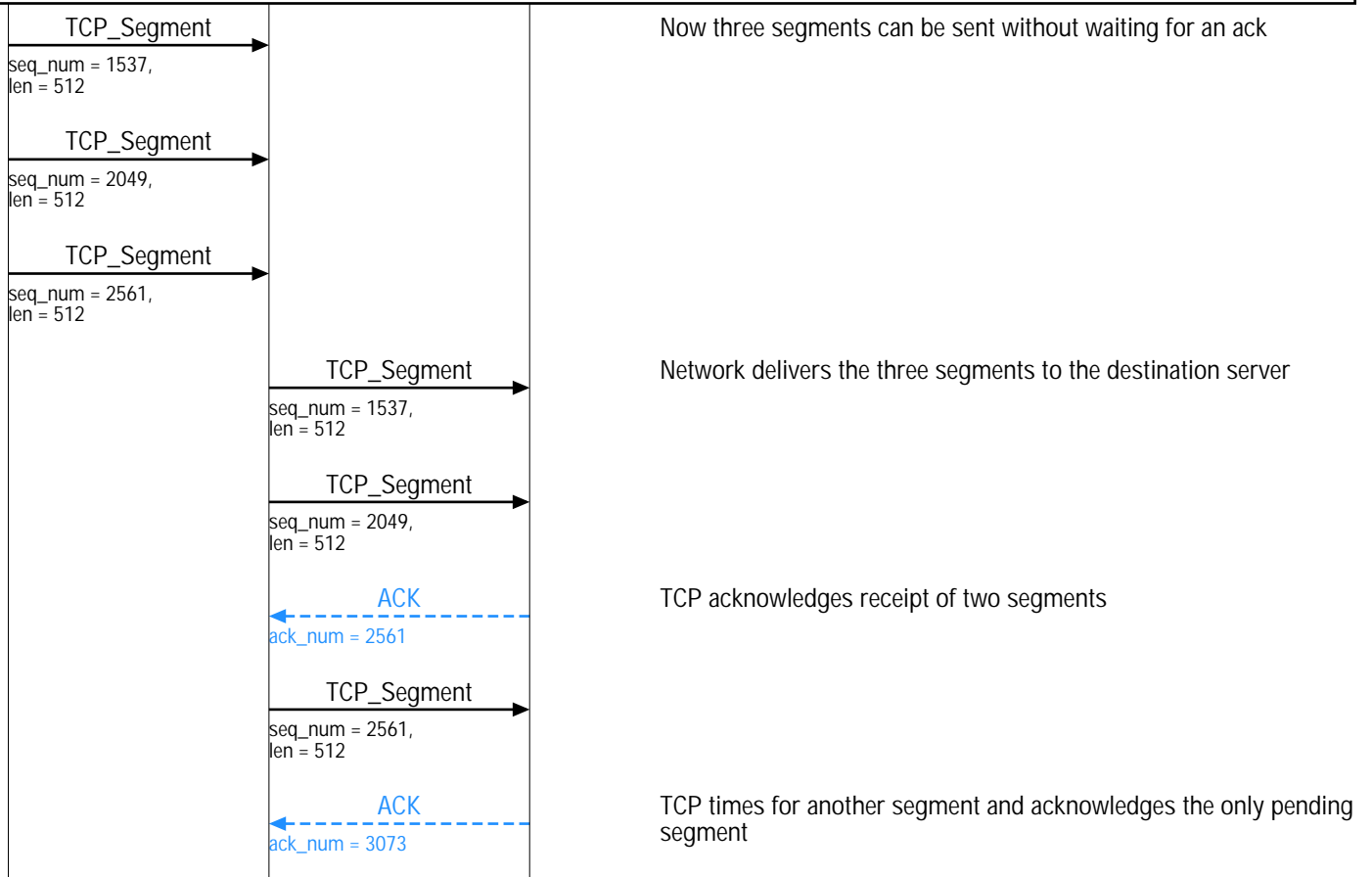
Processor Interfaces (TCP Slow Start)			
Client Node	Internet	Server Node	EventStudio System Designer 4.0
Client	Net	Server	23-Jul-07 08:19 (Page 2)



Roundtrip #2 of data transmission

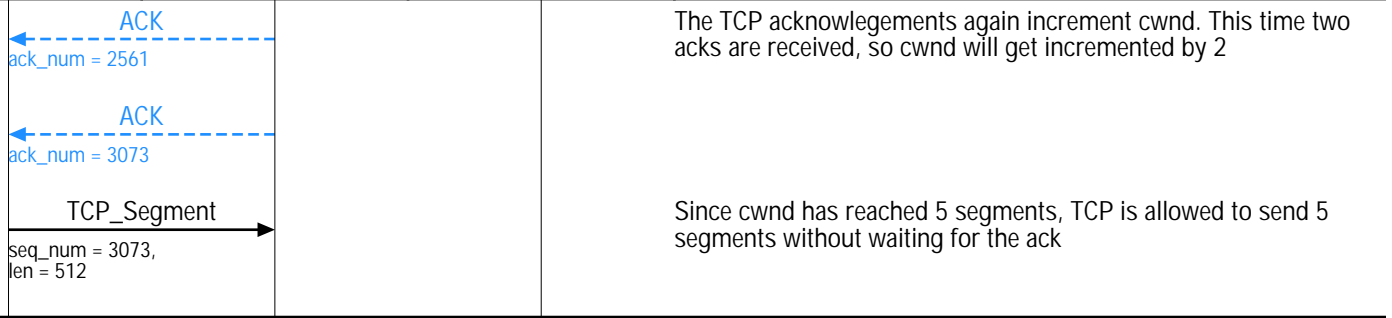


Roundtrip #3 of data transmission

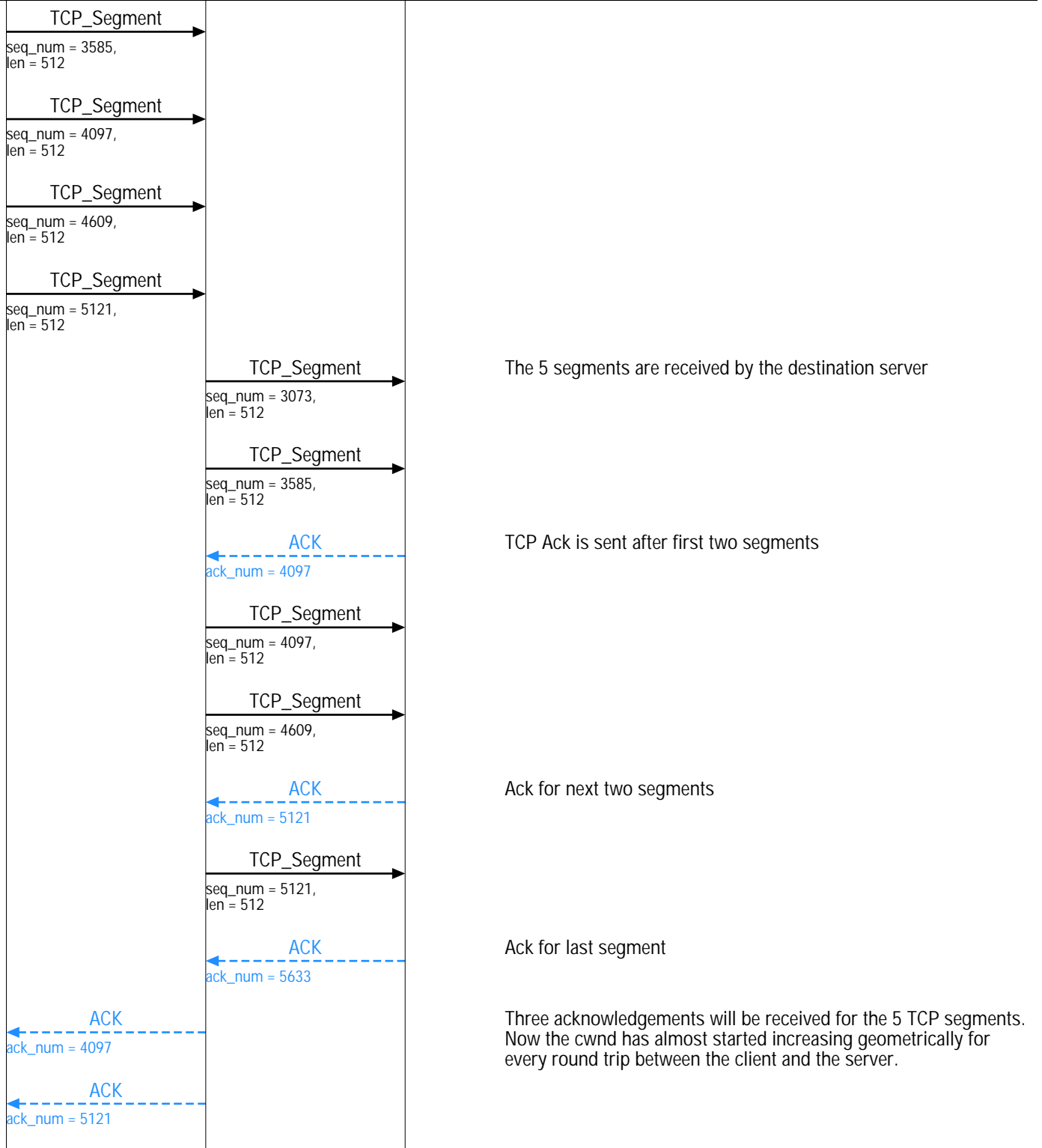


**Processor Interfaces (TCP Slow Start)**

Client Node	Internet	Server Node	EventStudio System Designer 4.0
Client	Net	Server	23-Jul-07 08:19 (Page 3)

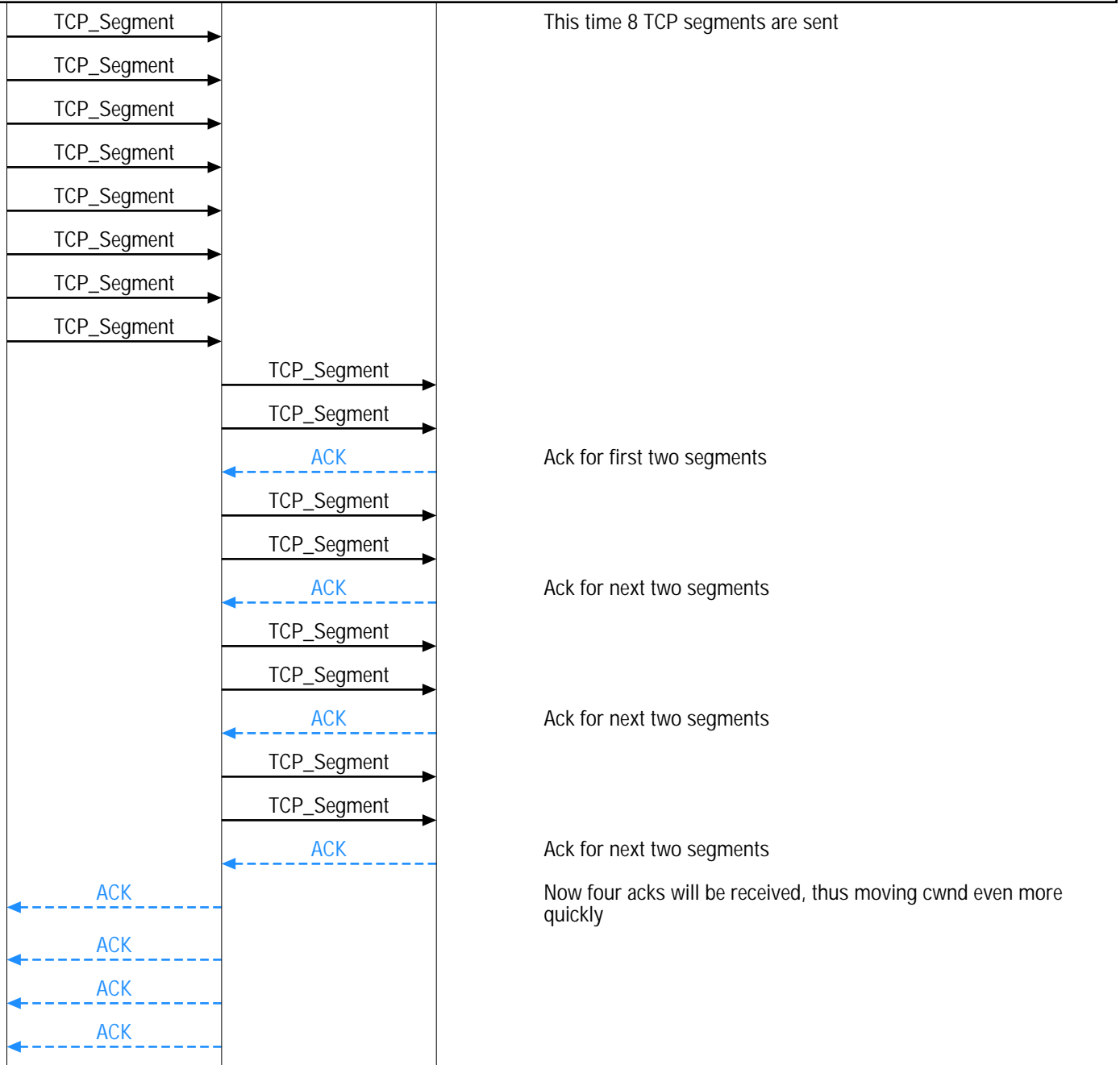


**Roundtrip #4 of data transmission**





Roundtrip #5 of data transmission

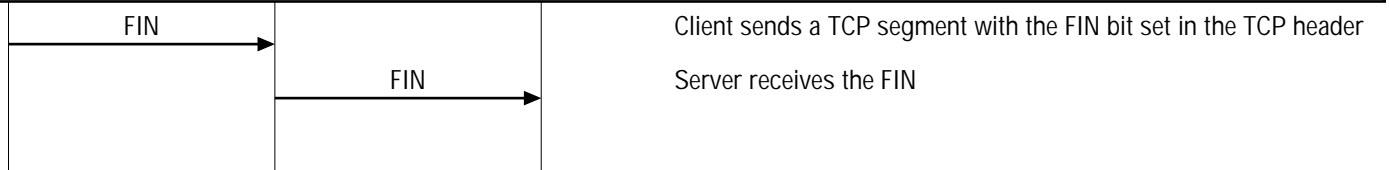


Within a few more roundtrip interactions cwnd will exceed ssthresh. At this point the session will be considered out of slow start. Note that the TCP connection from the client side is out of slow start but the server end is still in slow start as it has not sent any data to the client.

Exiting slow start signifies that the TCP connection has reached an equilibrium state where the congestion window closely matches the networks capacity. From this point on, the congestion window will not move geometrically. cwnd will move linearly once the connection is out of slow start.

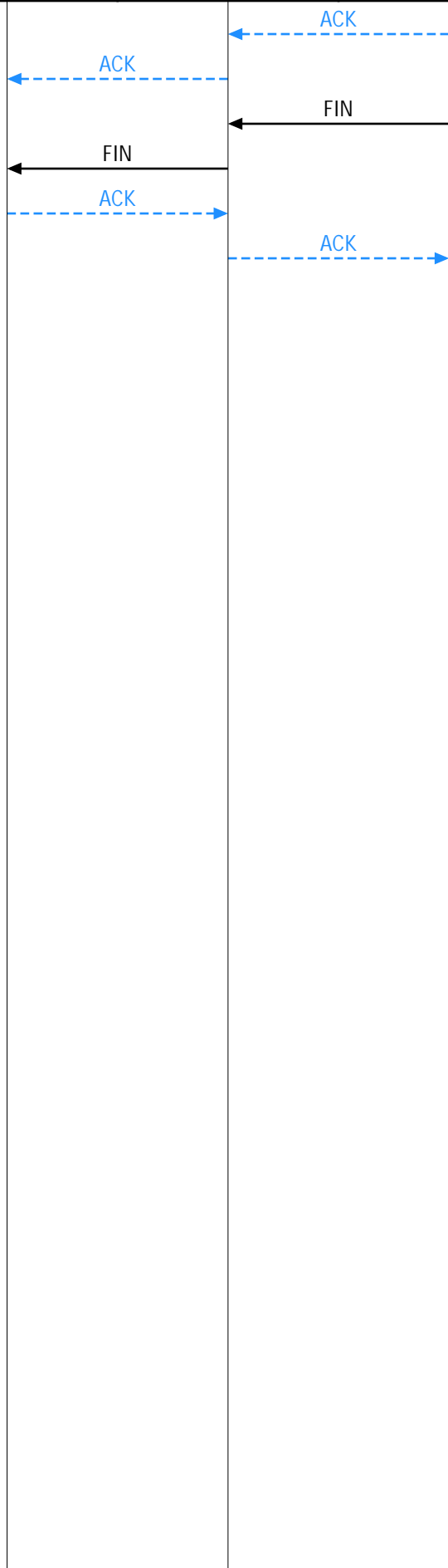
LEG: Client initiates TCP connection close

Client initiates TCP connection close



Processor Interfaces (TCP Slow Start)

Client Node	Internet	Server Node	EventStudio System Designer 4.0
Client	Net	Server	23-Jul-07 08:19 (Page 5)



Server responds back with ACK to acknowledge the FIN  
Client receives the ACK  
FIN is sent out to the client to close the connection  
Client receives FIN  
Client sends ACK  
Server receives the ACK