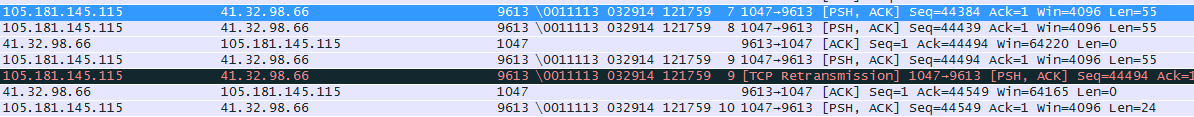
* **Retransmission:** this packet is sent when packets sent by FDR are not acknowledged by server within a certain amount time called retransmission timeout (RTO) for example



Here FDR sent packets with sequence numbers from 44384 to44494 then server sent ACK packet to acknowledge the reception of packets sent by FDR when FDR sent packet with sequence numbers from 44494 to 44549 FDRs retransmission timeout (RTO) timer is up without receiving ACK packet so FDR sent TCP retransmission packet asking for ACK packet for packets with sequence numbers from 44384 to44494 and eventually server sends ACK packet for FDR to acknowledge the reception of packets from 44384 to 44549

Retransmit Ack on 44984-44494

Ack on 44984-44494

Seq no 44494-44549 Len=55

Seq no 44439-44494 Len==55

Seq no 44384-44439 Len=55

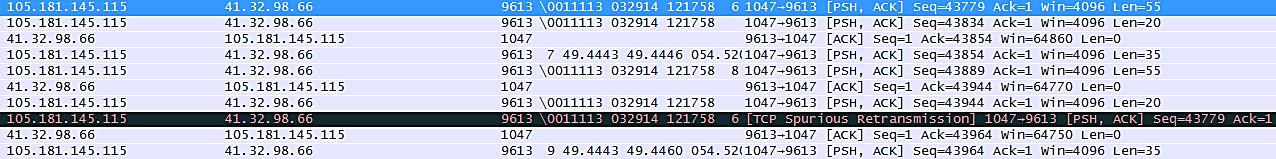
Ack on 44384-44494

ACK

FDR

Data concentrator

* **Spurious retransmission :** also called (unwanted retransmission) because its retransmission packet sent from FDR asking for ACK packet for data already server sent ACK packet acknowledging there reception for example

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Here FDR sent packets with sequence numbers from 43779 to 43854 and server sent ACK packet to acknowledge the reception of packets sent by FDR then FDR sent another packets with sequence number from 43854 to 43944 and also server sent ACK packet to acknowledge the reception of packets sent by FDR but when FDR started sending new packets because the first ACK packet didn’t reach FDR sent a spurious retransmission packet eventually server sends ACK packet for from 43779 to 43964

Ack on 43779-43854

Spurious retransmission on 43779-43854

Seq no 43944-43964 Len=20

Seq no 43889-43944 Len=35

Seq no 43854-43889 Len=35

Ack on 44384-44494

Ack on 43854-43944

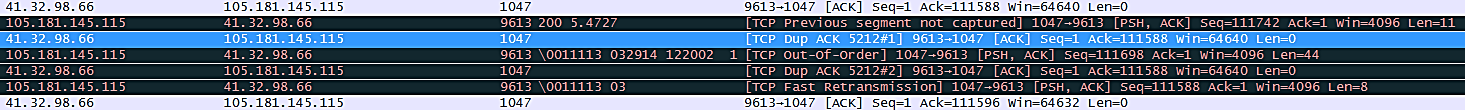
Seq no 43834-43854 Len=20

Seq no 43779-43834 Len=55

FDR

Data concentrator

* **Duplicate ACK and fast retransmission :** duplicate ACK happens when receiver receives a TCP segment with a sequence number higher than the expected one (out of order segments). The receiver then sends an immediate ACK with the Acknowledgement field set to the Sequence number the receiver was expecting. This ACK is a duplicate of an ACK (DupACK) which was sent previously. This is basically done to update the sender with regards to the dropped/missing TCP segments. After receiving 2 DUPACKs, TCP performs a retransmission of that segment without waiting for the retransmission timer to expire .This is called a Fast Retransmit this what happened in the following example



Here packets with sequence number from 111588 to 111742 are lost and FDR send packet with sequence number start from 111742 to 111753 which is higher than expected sequence number so server sent a duplicate ACK asking for packet with right sequence number but FDR tried to recover packets with sequence numbers from 111698 to 111742 but this is not the right sequence number so FDR sent another duplicate ACK and FDR is forced to send the right sequence numbers from 111588 to 111596 in form of fast retransmission packet

Fast retransmission Seq no 111588-111596 Len=8

Ack on 111588-111596

Seq no 111588-111742

Dup ACK Seq=1, Ack=111588

Seq no 111698-111742 Len=44

Dup ACK Seq=1 ,Ack=111588

Seq no 111742-111753 Len=11

Ack on 111588

FDR

Data concentrator

* **Zero window:** sent from server to FDR because server is busy with something else and has not been fetching the received data and Zero-size window effectively stops FDR from transmitting data until server send ACK packet with non-zero window to notify FDR than buffer is empty again