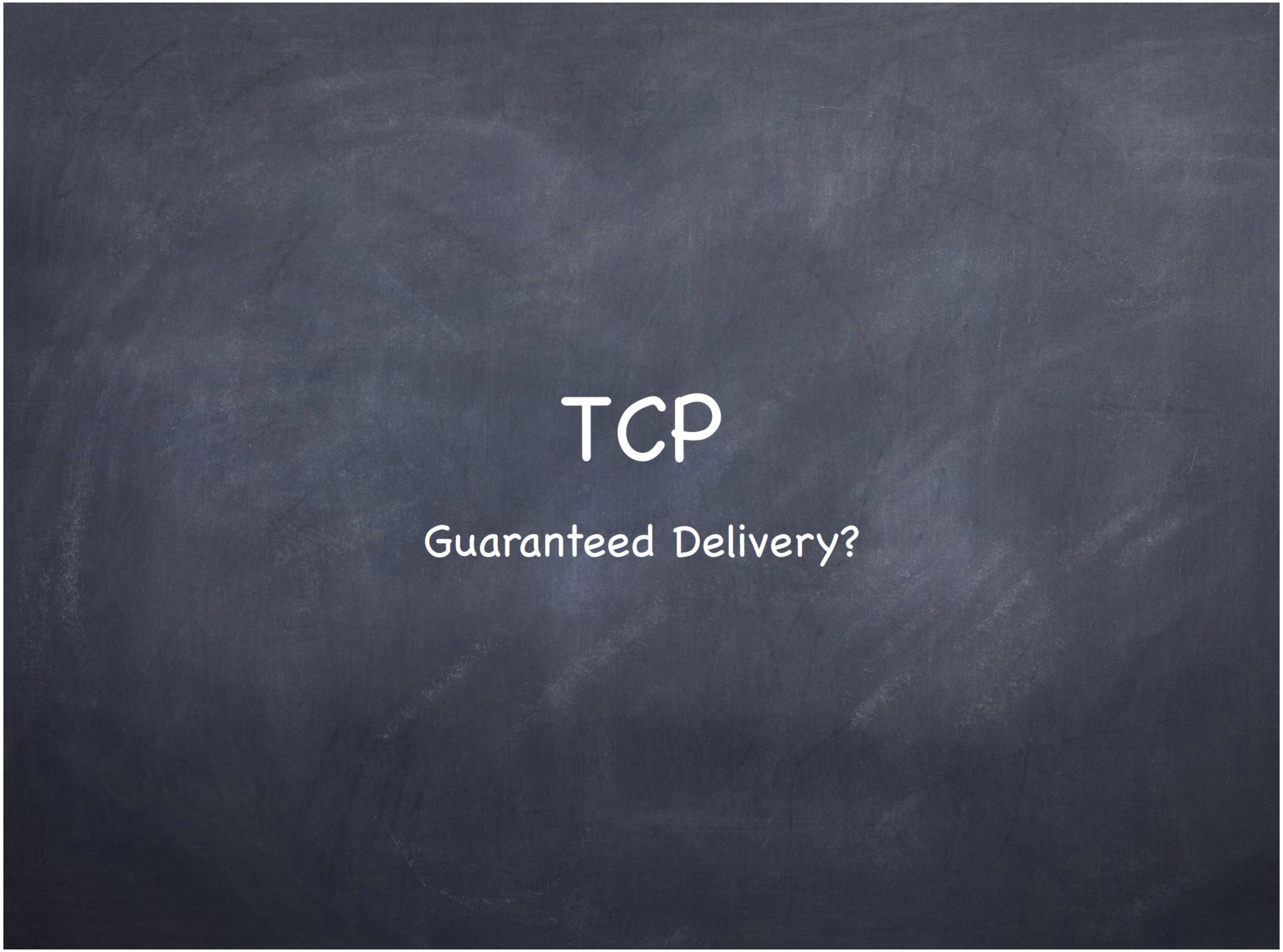
IT 609
Network and System Administration

TCP

Tuesday October 12, 2021

TCP



TCP

Guaranteed Delivery?

TCP – What’s Its Job?

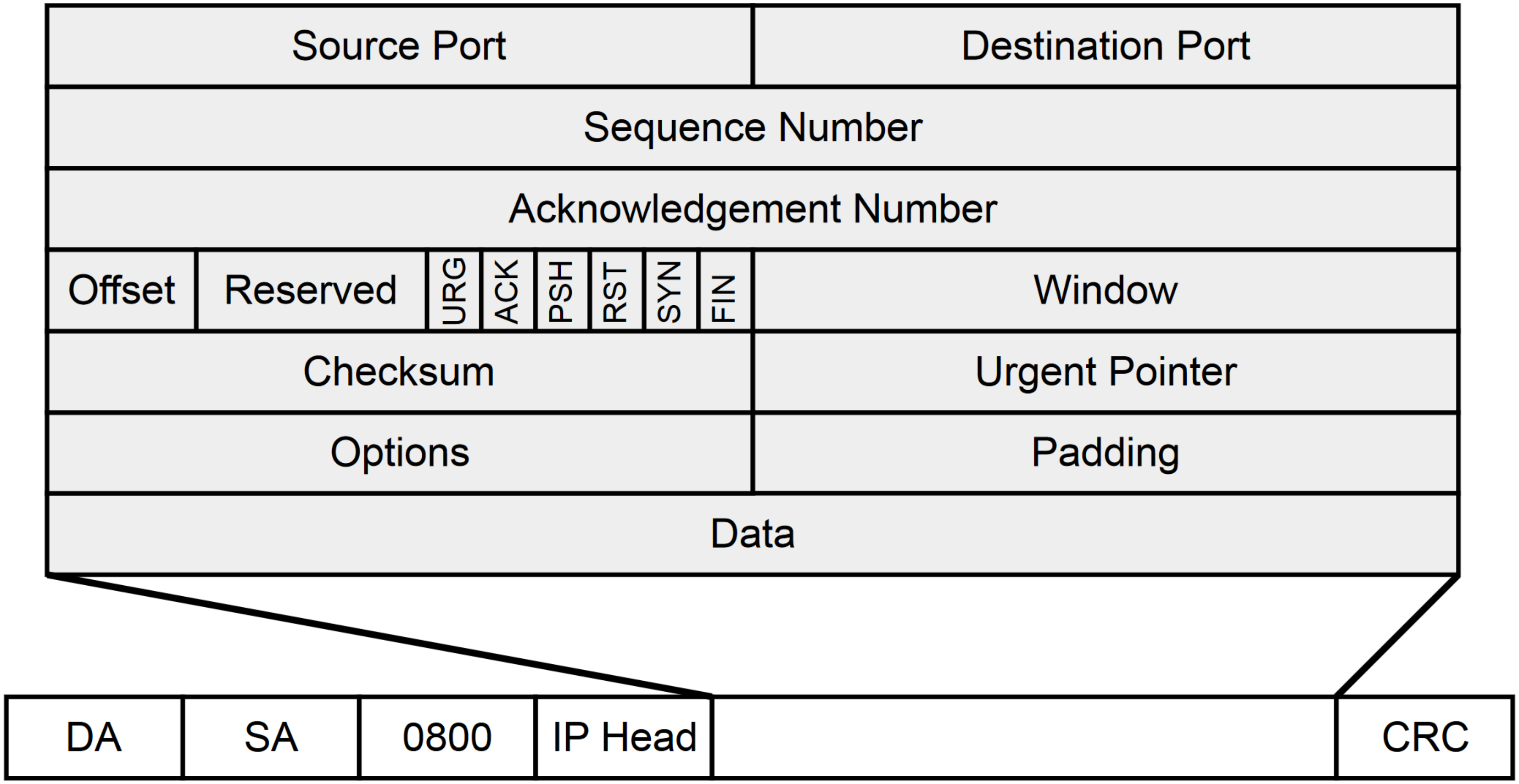
Transmission Control Protocol doesn’t actual transmit data!

It **controls** the transmission of data

The rest of the TCP/IP suite is designed to not be reliable - it can fail in many ways for many reasons

TCP works to provide a connection-oriented communication that is guaranteed (or at least tells you that it failed)

TCP Packets



Source Port

Destination Port

Sequence Number

Acknowledgement Number

Offset

Reserved

URG

ACK

PSH

RST

SYN

FIN

Window

Checksum

Urgent Pointer

Options

Padding

Data

DA

SA

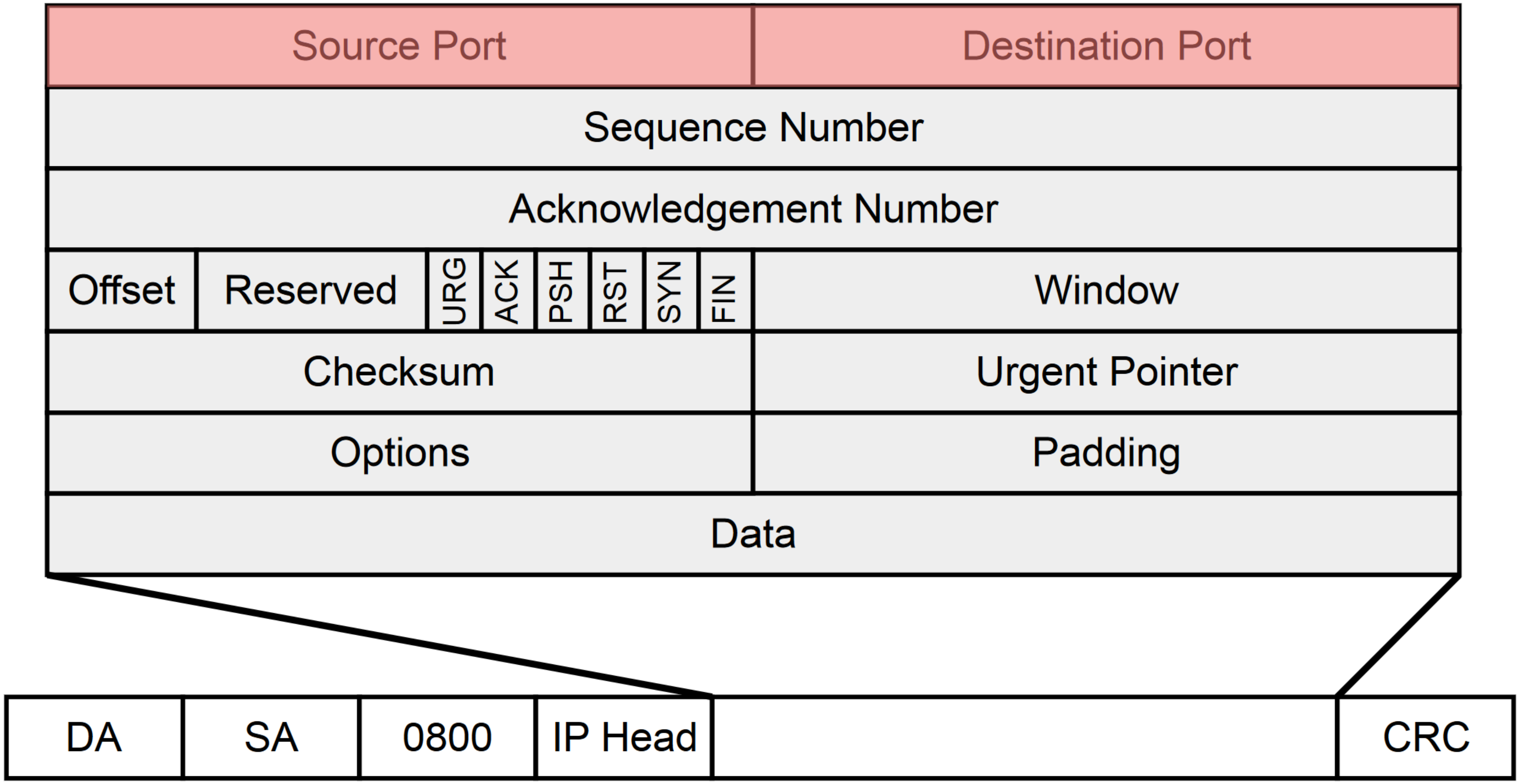
0800

IP Head

CRC

All contained in IP Datagram

TCP Packets



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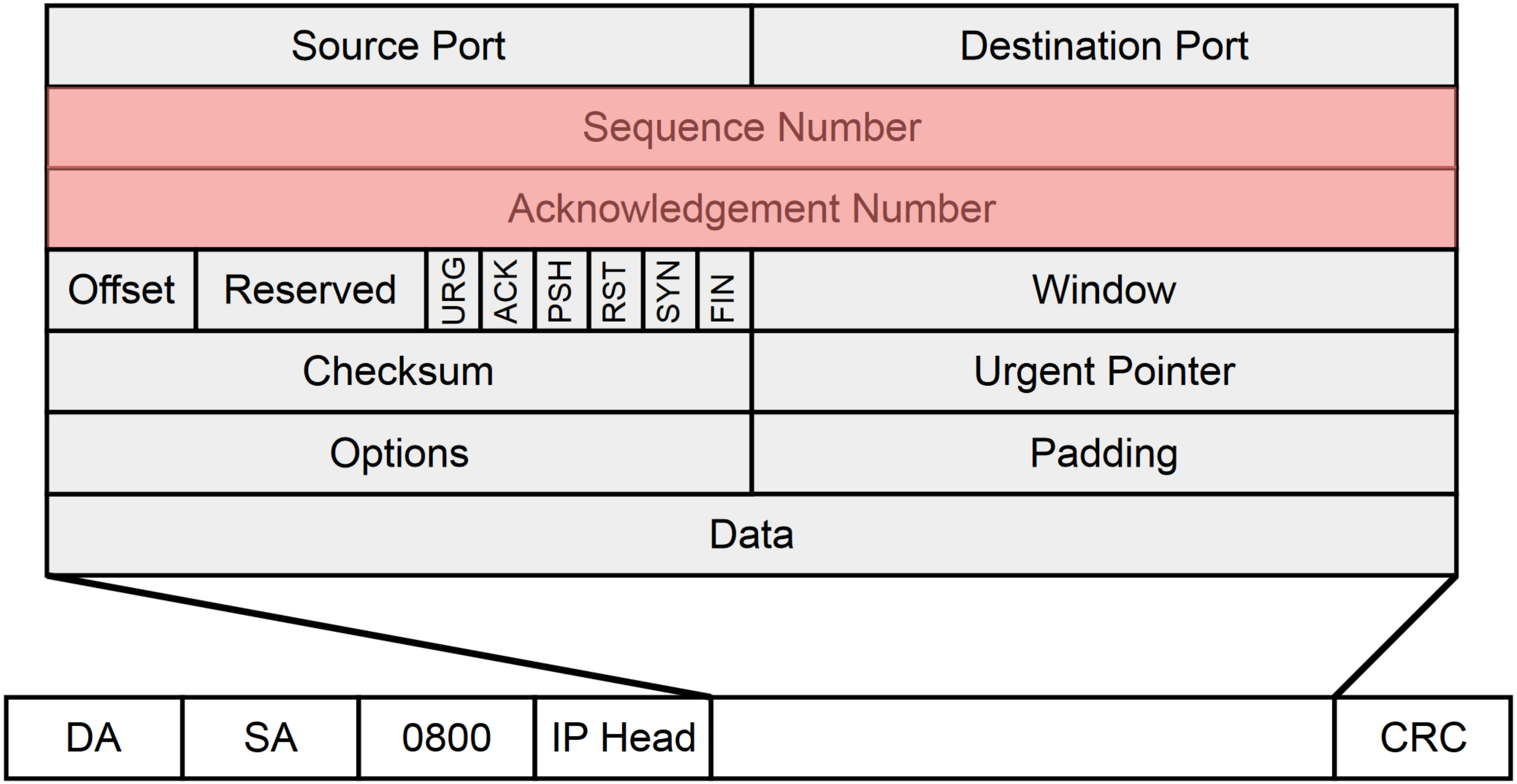

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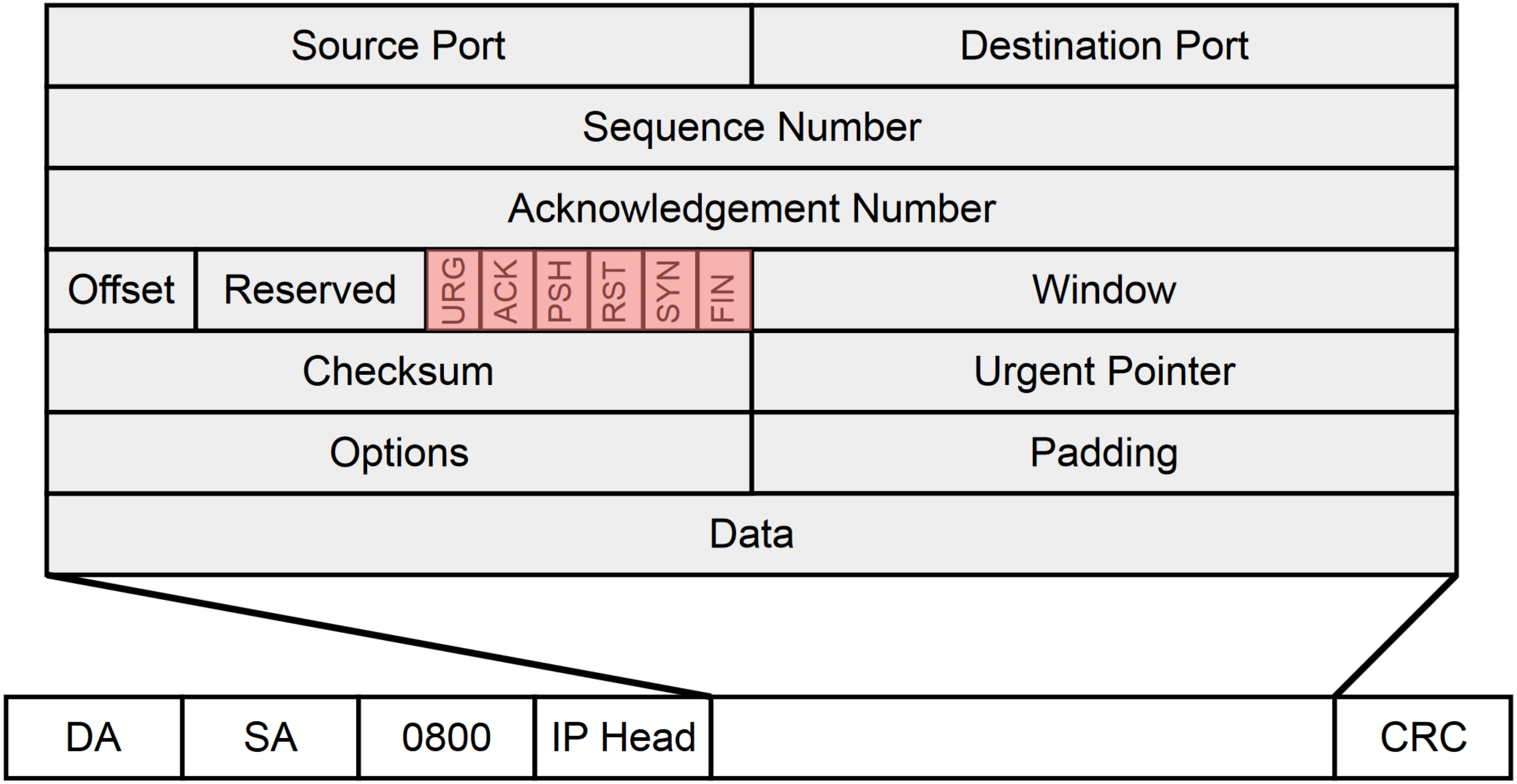

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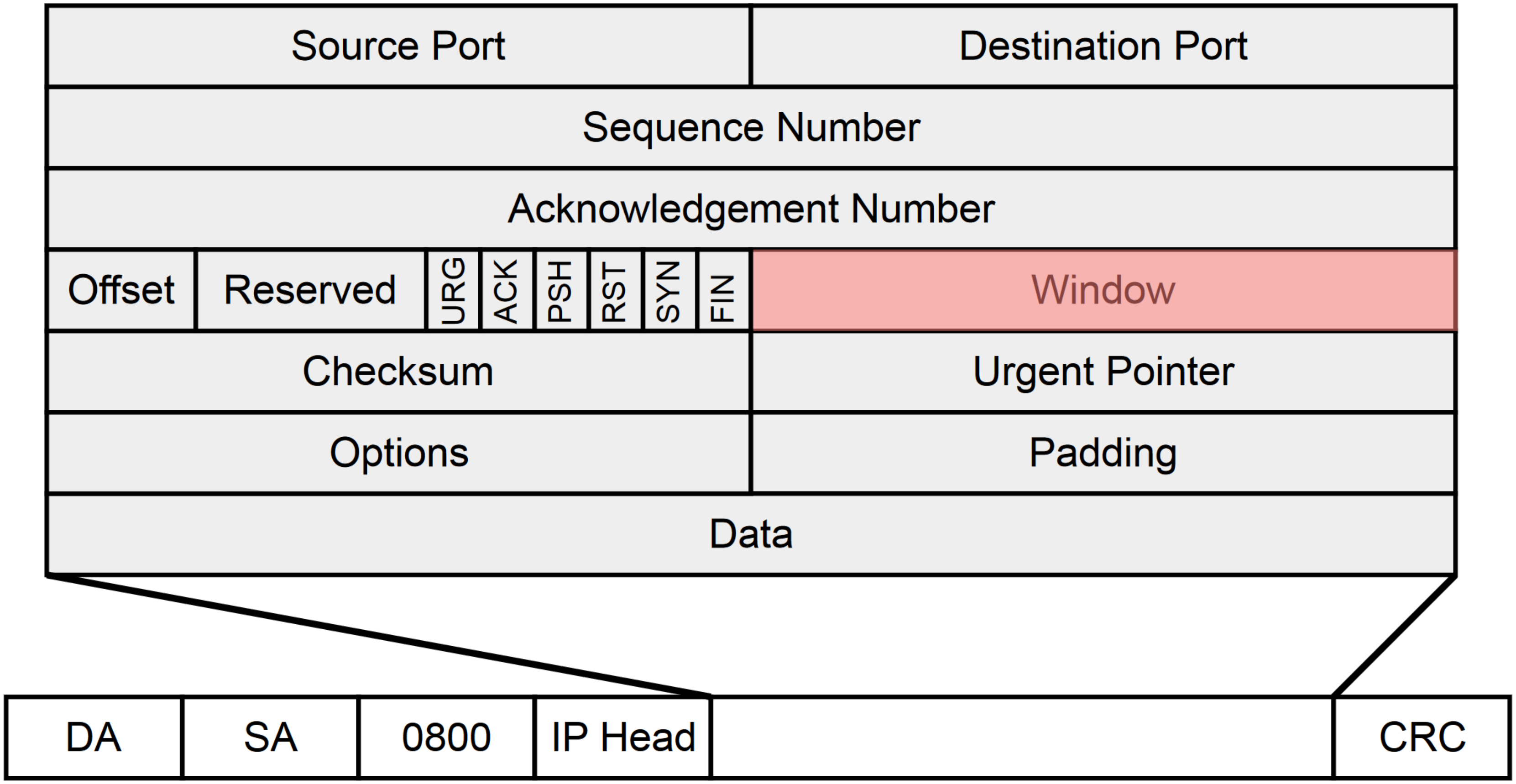

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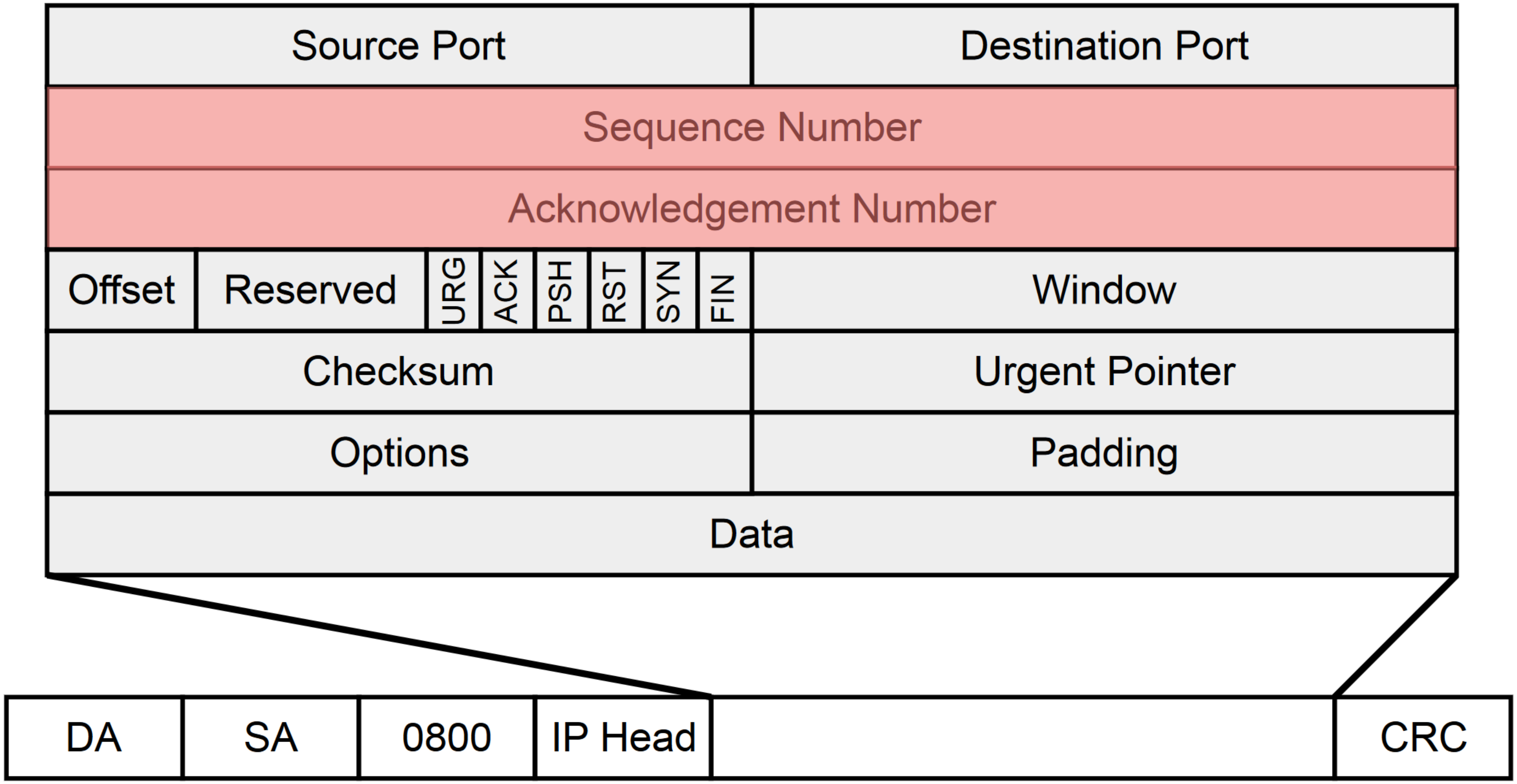


All contained in IP Datagram

Package Tracking

1Z9876543
Joe

SEQ and ACK Numbers

The Sequence and Acknowledge numbers are the key to TCP's reliability

Provide for re-sequencing of data that arrives out of order and checking for missing data

Sender's SEQ value + 1 is sent back by Receiver as the ACK number

ACK = the number of the next byte in sequence a station expects to receive

Keep in mind that each sender is also a receiver and vice versa

Retransmission

TCP calculates average round trip time

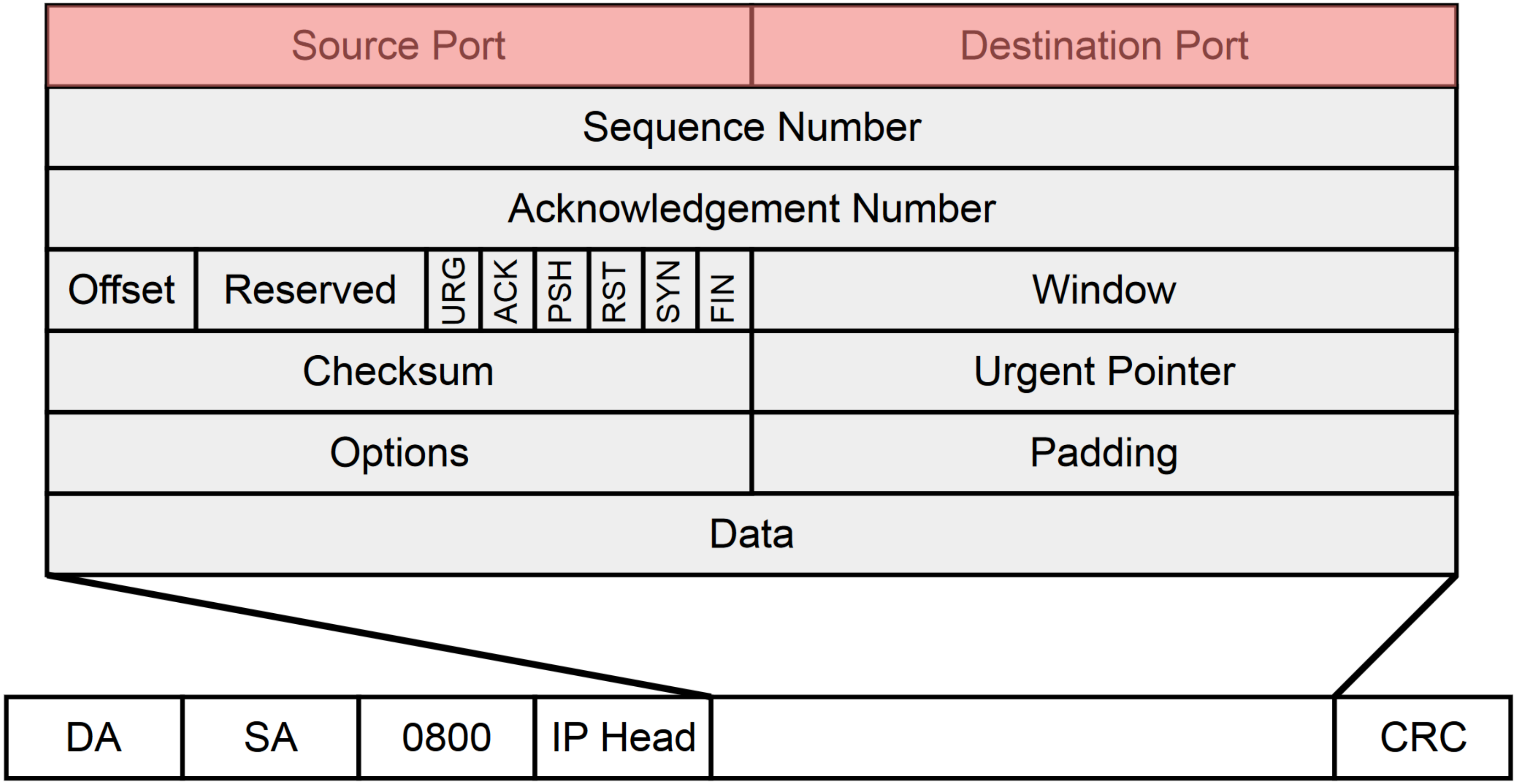
Sender caches all data

If ACK not received in an appropriate time, data is resent

If it there's no ACK again, wait longer, resend

And again…and eventually report back to the application that the connection is broken if no ACK is ever received

TCP Packets



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Options
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All contained in IP Datagram

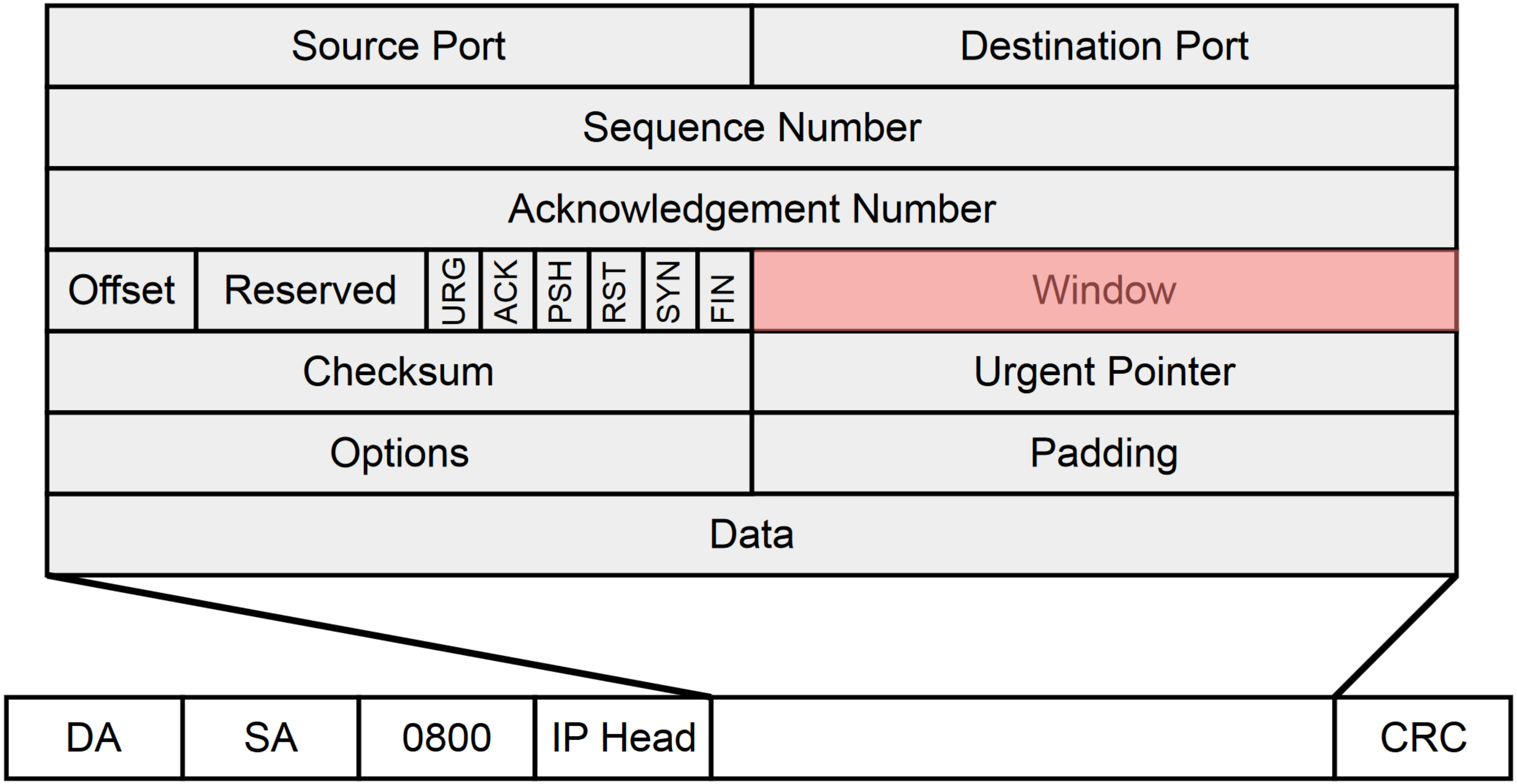
Ports

- Port numbers identify the application from/to which the Transport Layer got/should give the data
- Allows multiple applications to share one IP address and network connection
- Assigned Ports: 0 thru 1023
- Remaining Ports: 1024 to 65535
  - May be registered with IANA by a company for a specific use
  - Others selected dynamically as needed

Some Well Known Ports

Application	Type	Number
FTP	TCP	20, 21
Telnet	TCP	23
SMTP	TCP	25
HTTP	TCP	80
POP3	TCP	110
HTTPS	TCP	443
MySQL	TCP	3306

TCP Packets



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All contained in IP Datagram

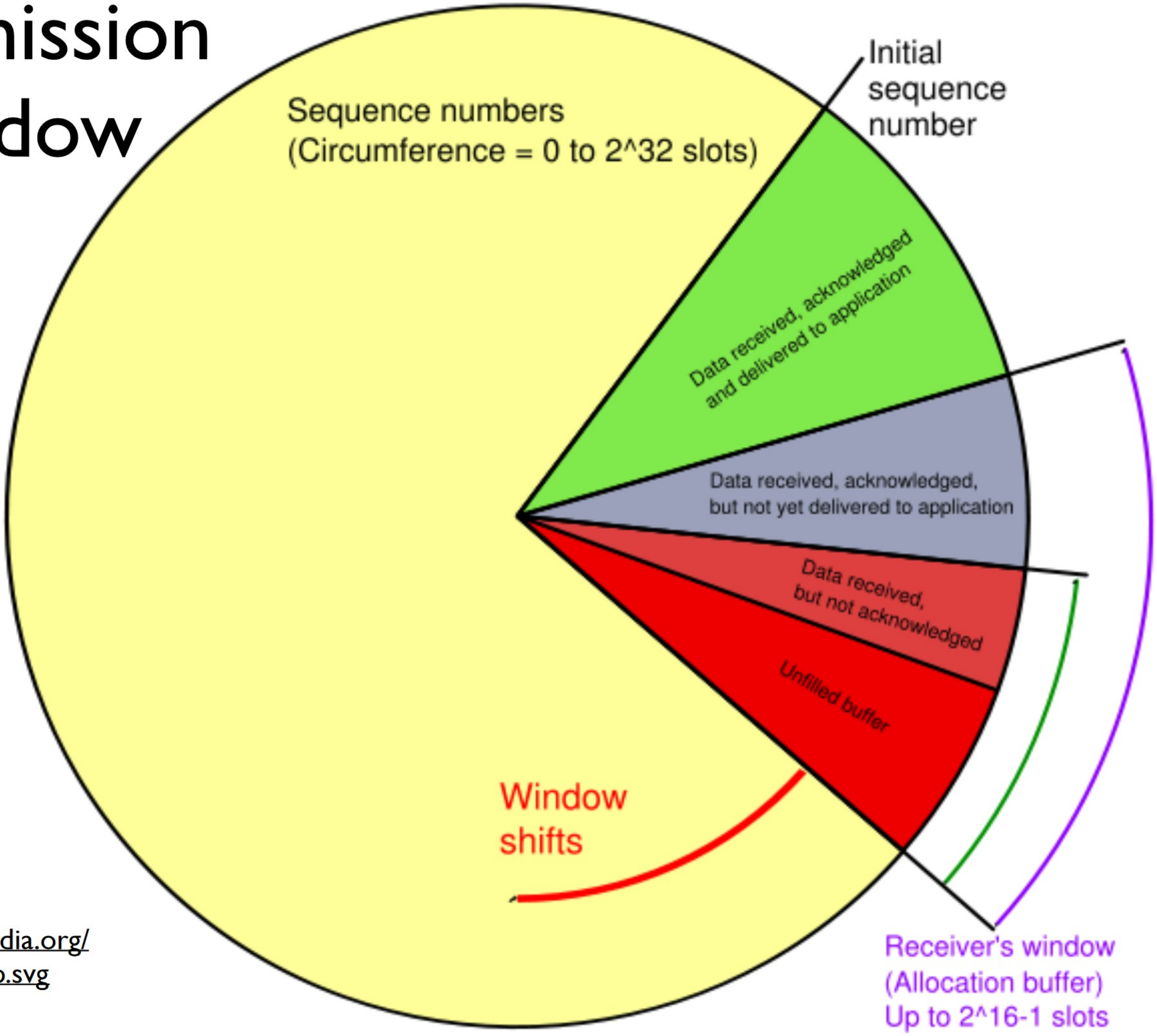
Transmission Window

Waiting for an ACK to each packet before sending the next chunk of data would be inefficient

A sliding transmission window allows TCP to send more data while waiting for ACK's

Window size is set by receiving station based on its available buffers

Transmission Window


Sequence numbers
(Circumference = 0 to 2^32 slots)
Initial sequence number
Data received, acknowledged and delivered to application
Data received, acknowledged, but not yet delivered to application
Data received, but not acknowledged
Unfilled buffer
Window shifts
Receiver's window
(Allocation buffer)
Up to 2^16-1 slots

http://commons.wikimedia.org/wiki/Image:Tcp.svg

Congestion Control

TCP can overwhelm a network with retransmissions if there isn’t a balance between waiting on ACKs and (re)-sending

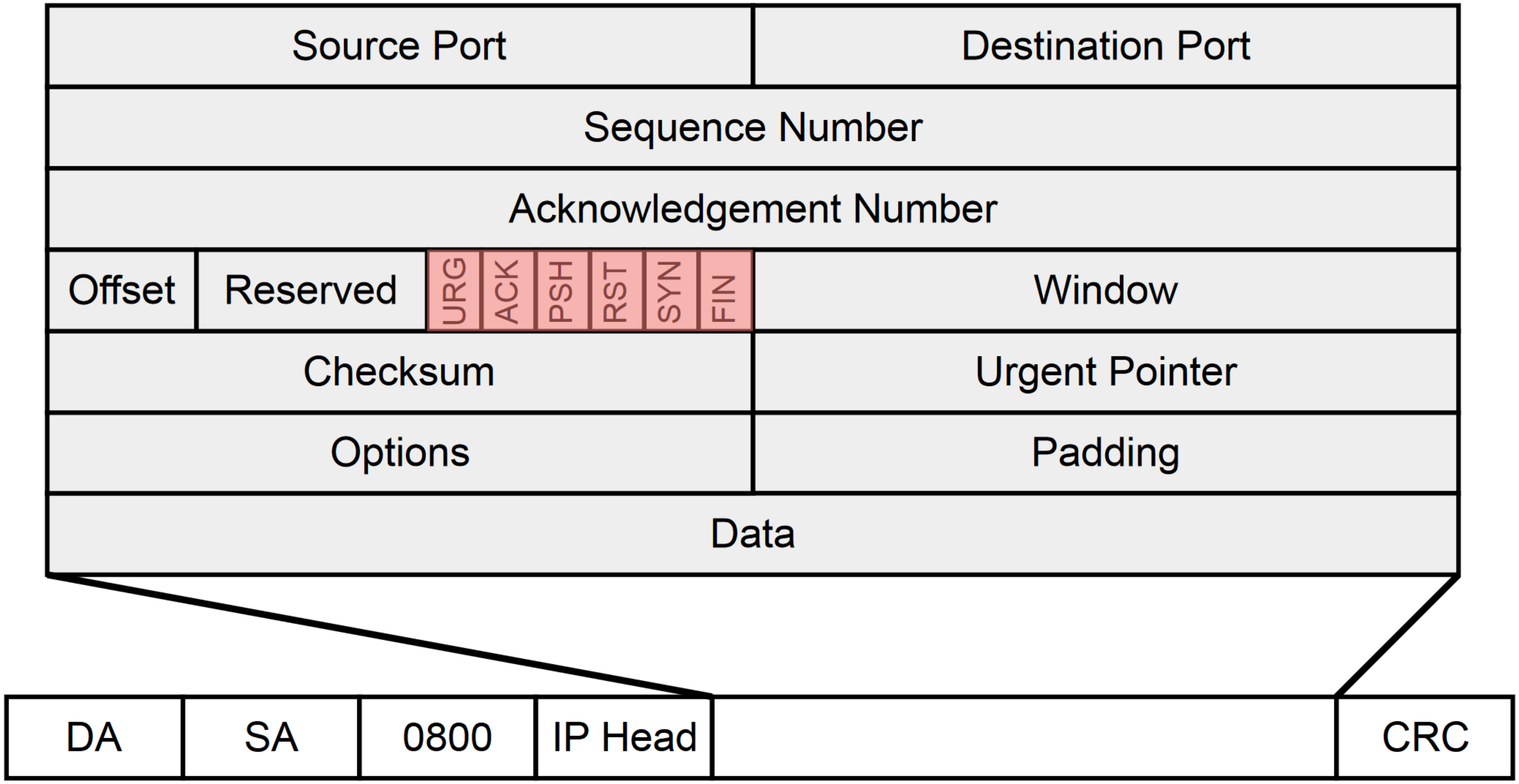
Congestion Window limits the transmission

Slow Start - Congestion Window begins at 1

Congestion leads to halving of window size

Successful transmission doubles window

TCP Packets



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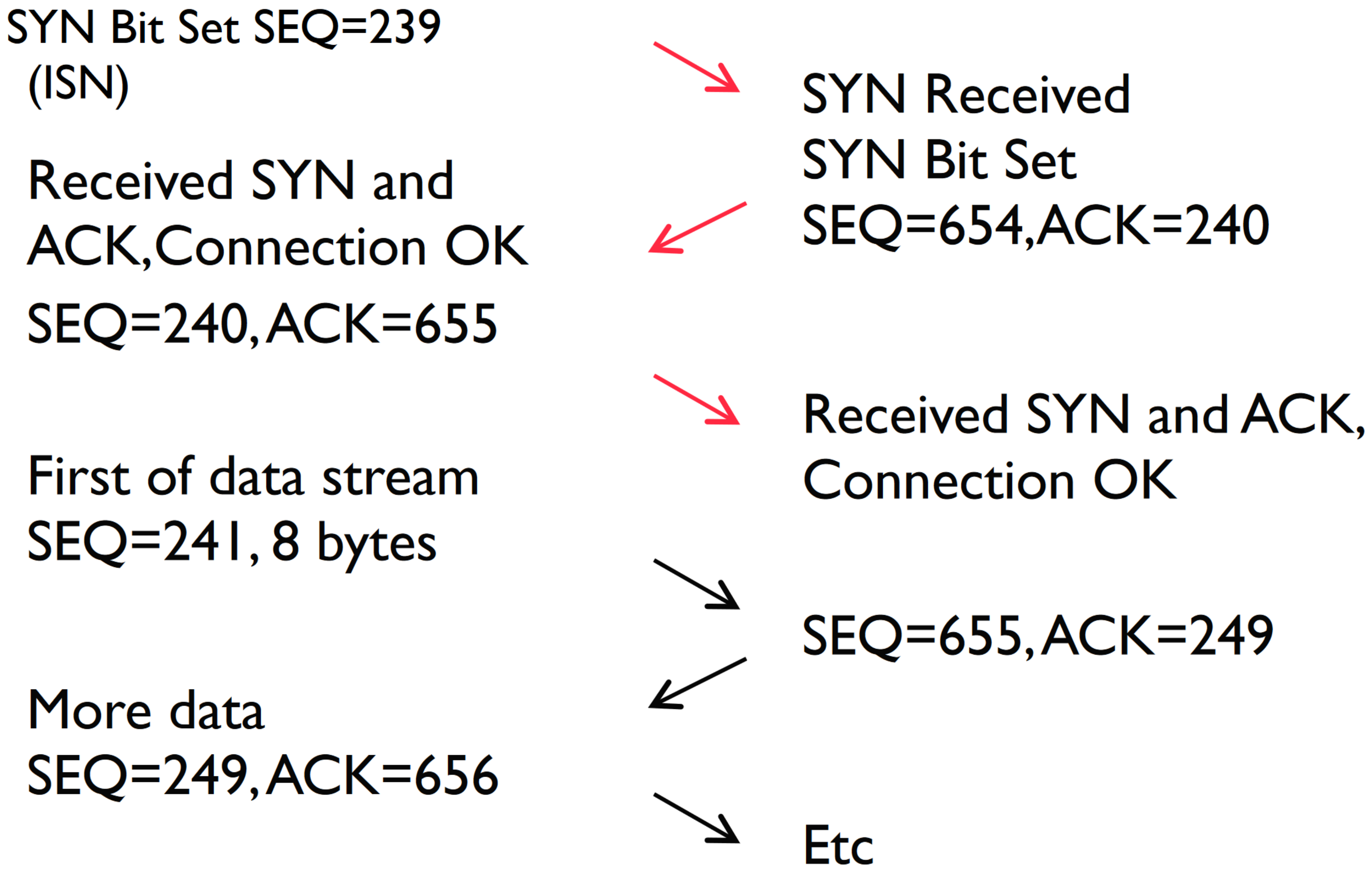
Three-Way Handshake

The handshake guarantees that each site of a connection can send and receive from each other before sending actual data

Again, avoids unnecessary network load

Also allows for setup of needed buffers and resources on both ends

Three-Way Handshake



SYN Bit Set SEQ=239 (ISN)

SYN Received
SYN Bit Set
SEQ=654,ACK=240

Received SYN and ACK,Connection OK
SEQ=240, ACK=655

Received SYN and ACK, Connection OK

First of data stream
SEQ=241, 8 bytes

SEQ=655, ACK=249

More data
SEQ=249, ACK=656

Etc

TCP Termination

TCP gives you connections. Connections must be cleanly ended.

Sender transmits last data with FIN bit set

Receiver ACK's the receipt

Receiver sends a datagram with FIN bit set

Sender ACK's the receipt

Connection is now closed