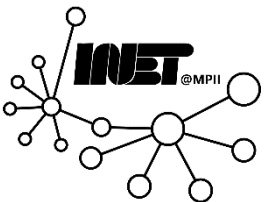




TCP

Prof. Anja Feldmann, Ph.D.

(Based on slide deck of Computer Networking, 7th ed., Jim Kurose and Keith Ross.)



TCP: Overview



- **Reliable, in-order byte stream**
 - No “message boundaries”
- **Connection-oriented**
 - Handshaking *prior* to data exchange
- **Flow controlled**
 - Sender *will not* overwhelm receiver
- **Point-to-Point**
 - One sender, one receiver
- **Full-duplex data channel**
 - *Bi-directional* data flow in same connection

RFCs

- 793, 1122, 1323, 2018, 2581



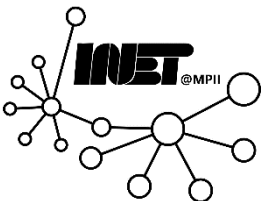
TCP Segments



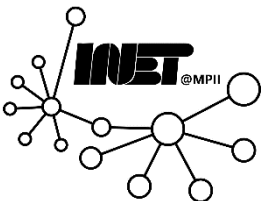
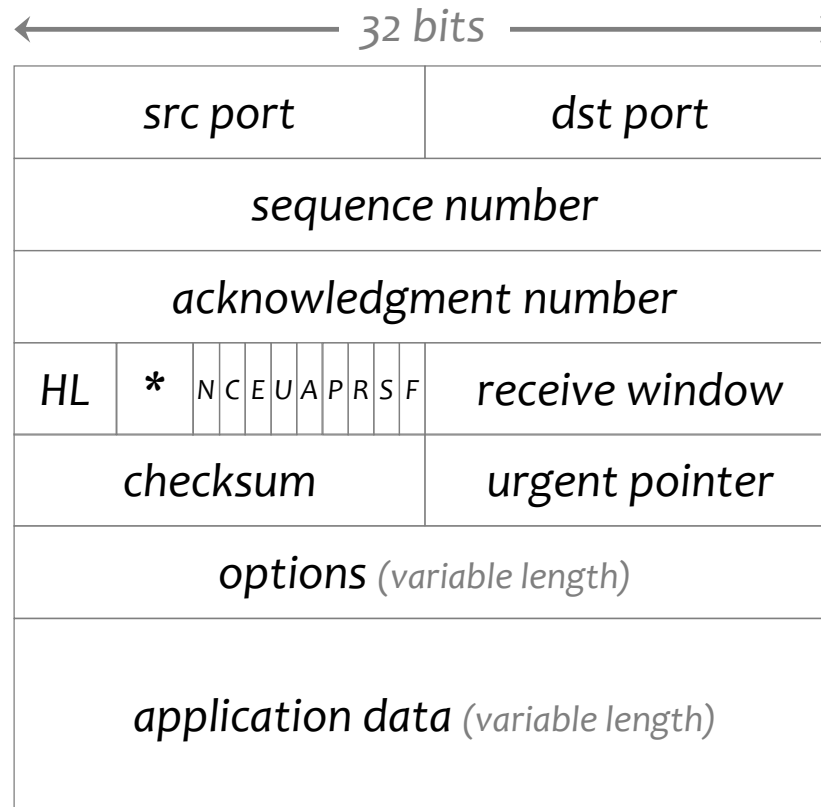
Segment?

- *Protocol data unit (PDU)*

PDU of transport layer is a **segment**; PDU of network layer is a **packet**



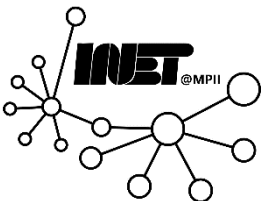
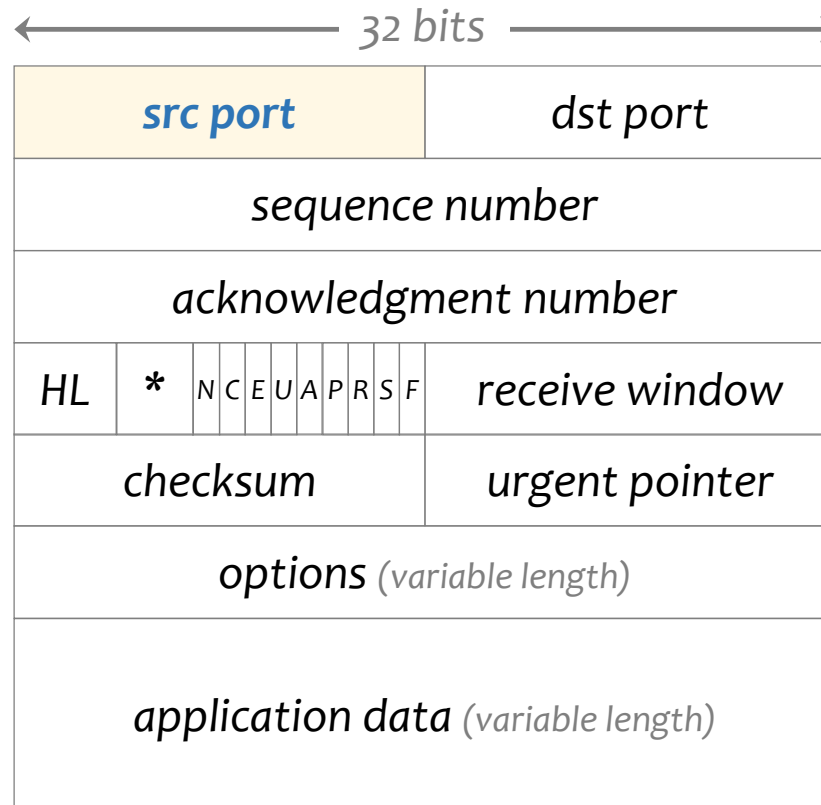
TCP: Segment structure



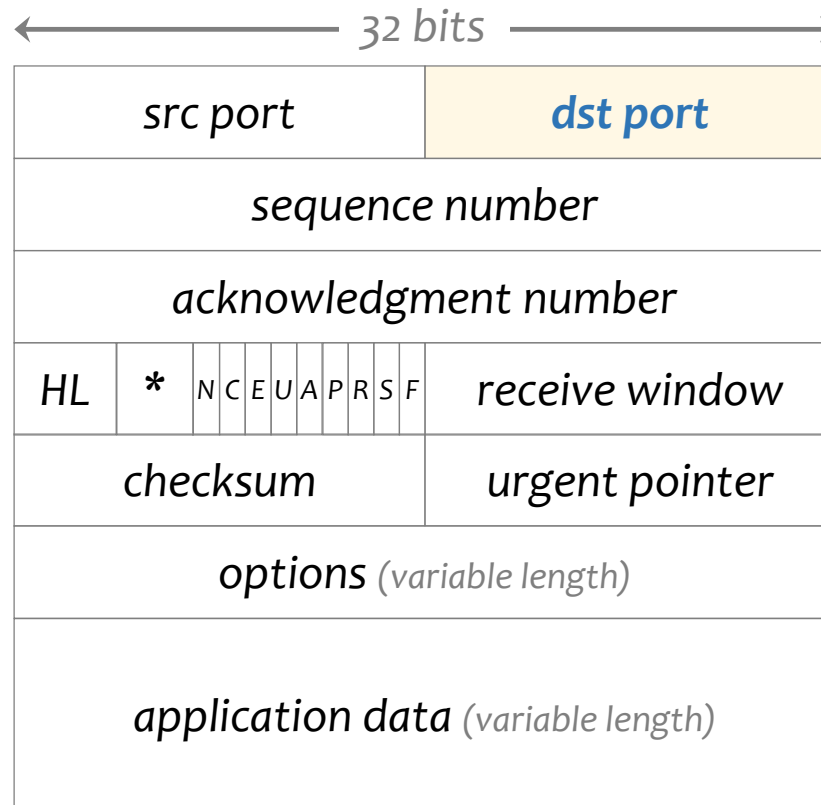
TCP: Segment structure



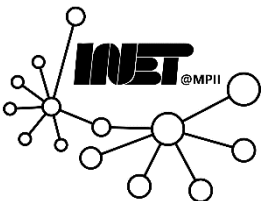
Source port number
[0,65535]



TCP: Segment structure



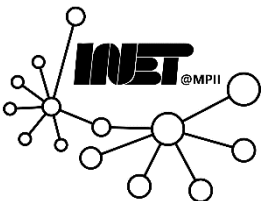
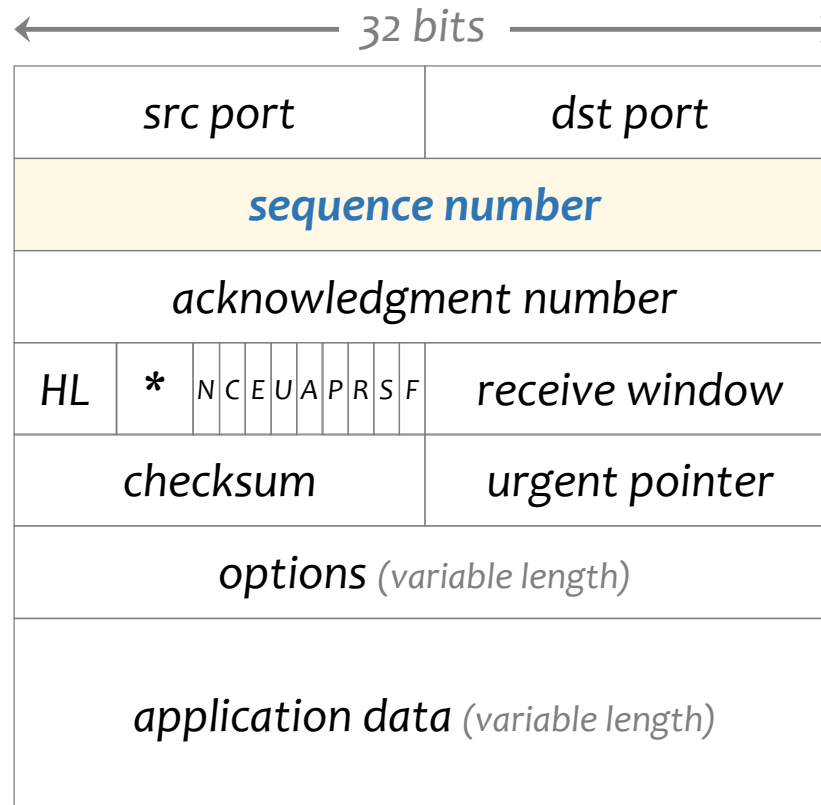
Destination port number
[0,65535]



TCP: Segment structure



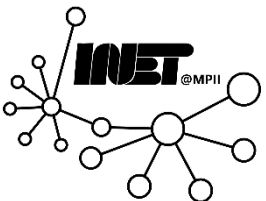
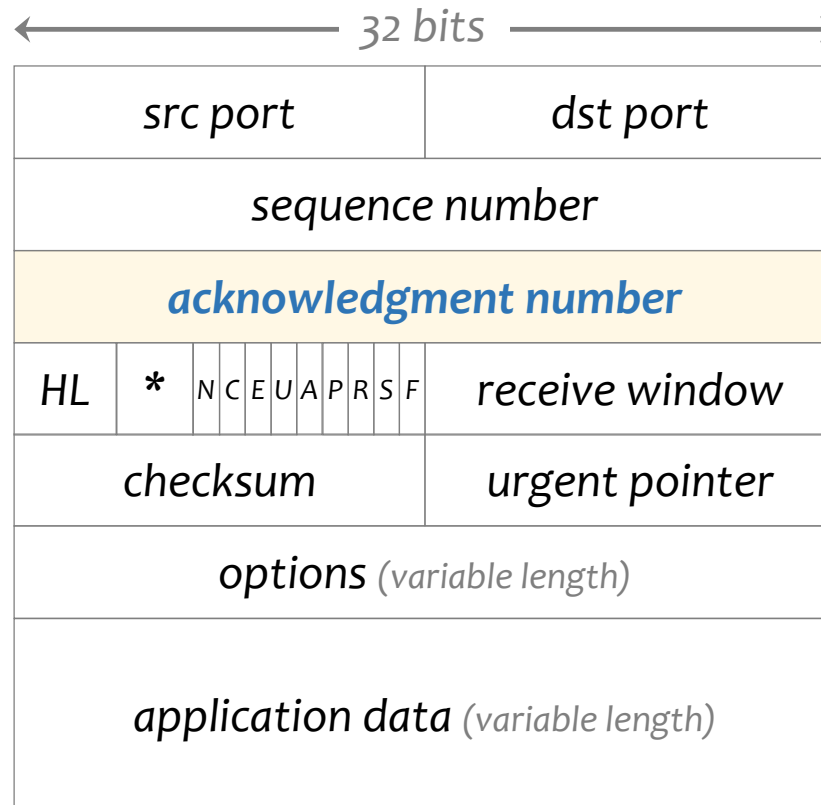
Sender sets the field to indicate which segment is being sent.



TCP: Segment structure



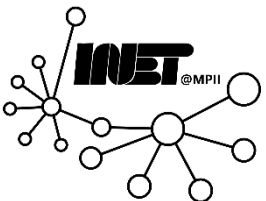
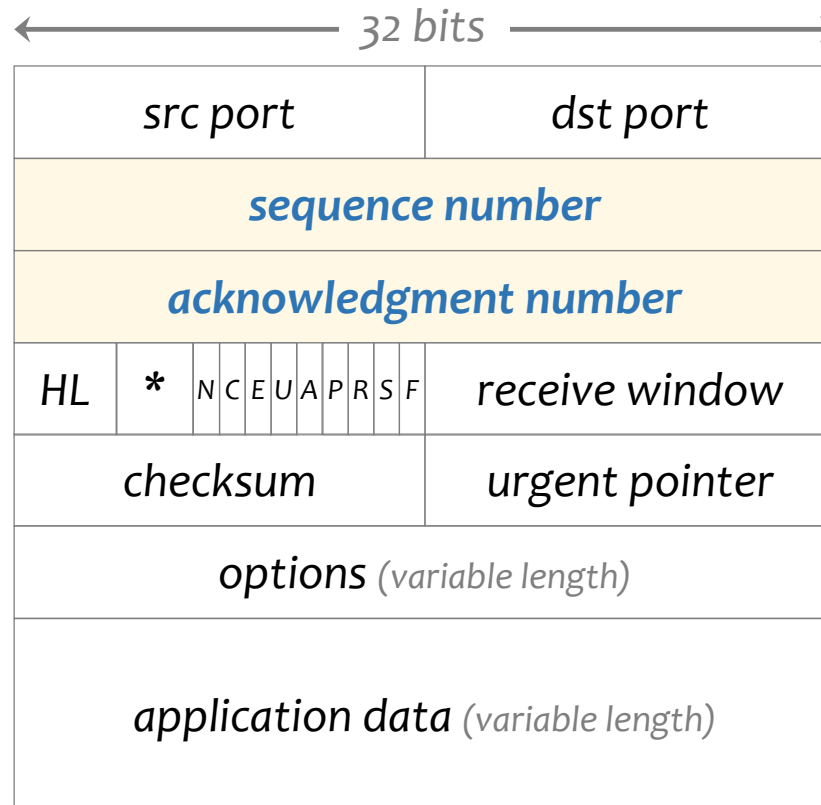
Receiver sets the field to indicate what was received.



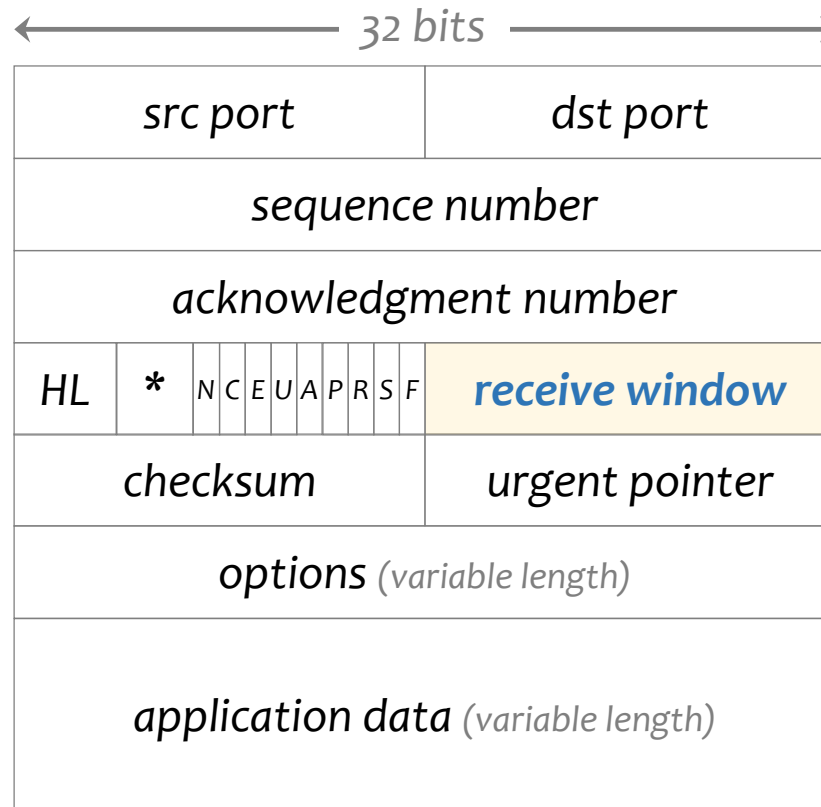
TCP: Segment structure



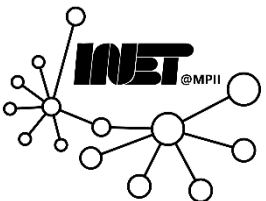
Counting by *bytes*,
not segments!



TCP: Segment structure



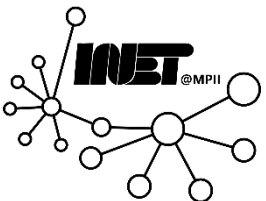
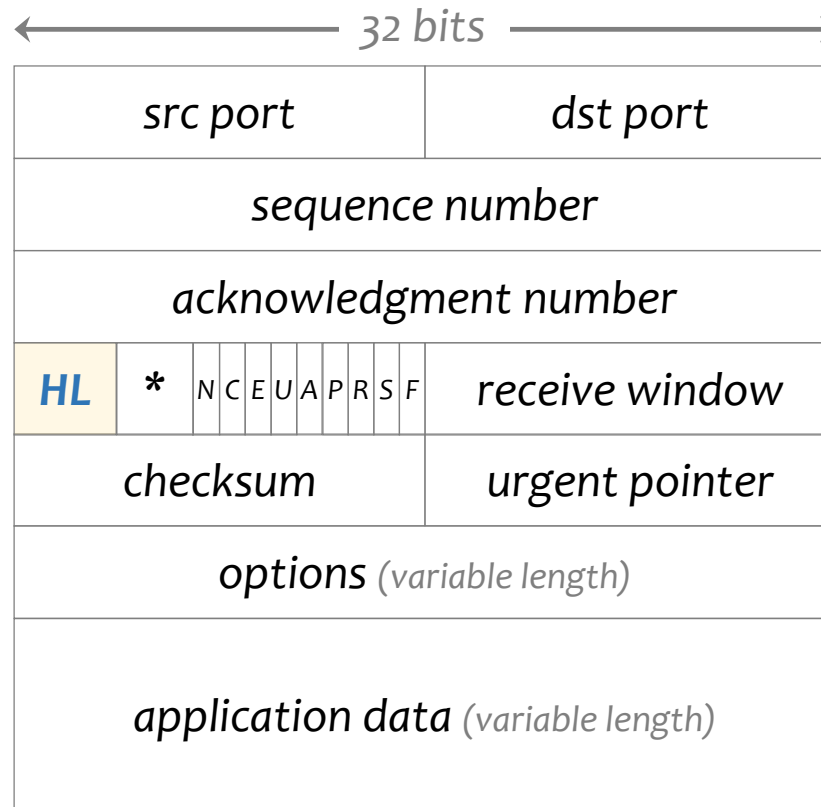
Size (in bytes) that receiver is willing to accept.



TCP: Segment structure



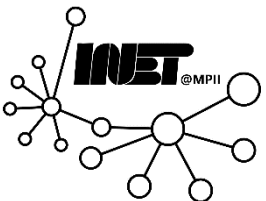
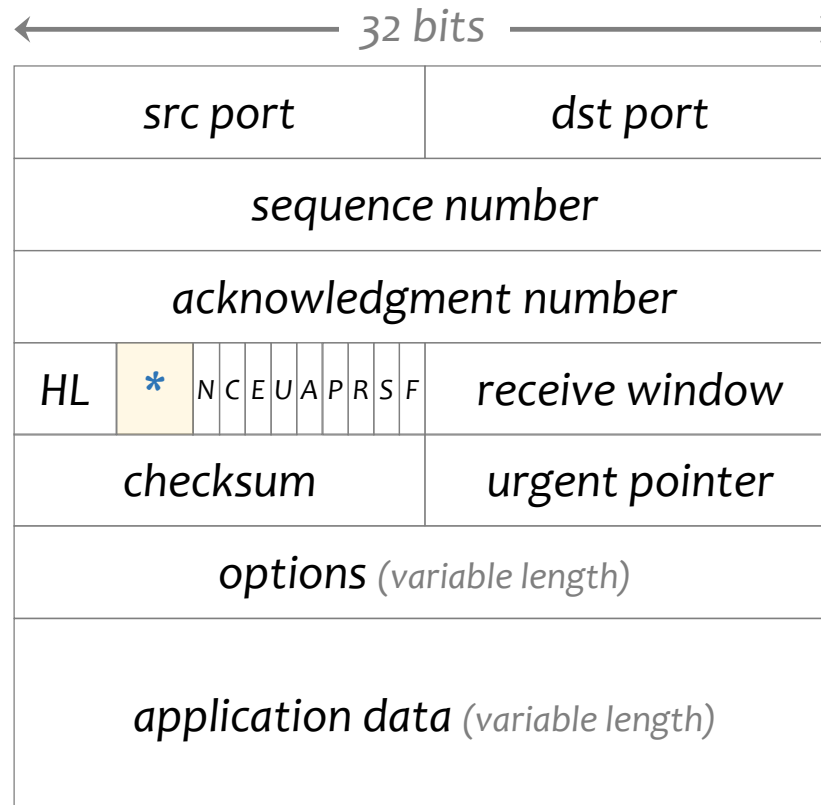
Data offset
(or header length)



TCP: Segment structure



Reserved
(unused)

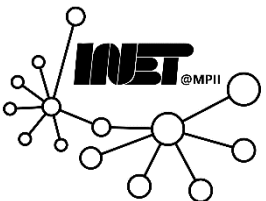
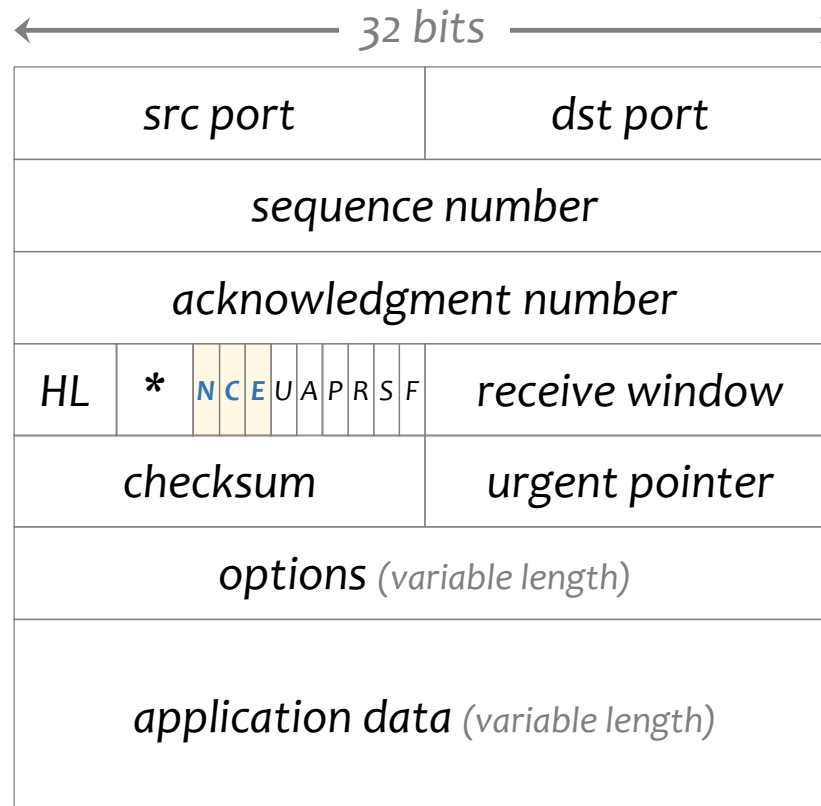


TCP: Segment structure



Explicit Congestion
Notification (ECN).

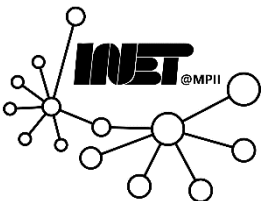
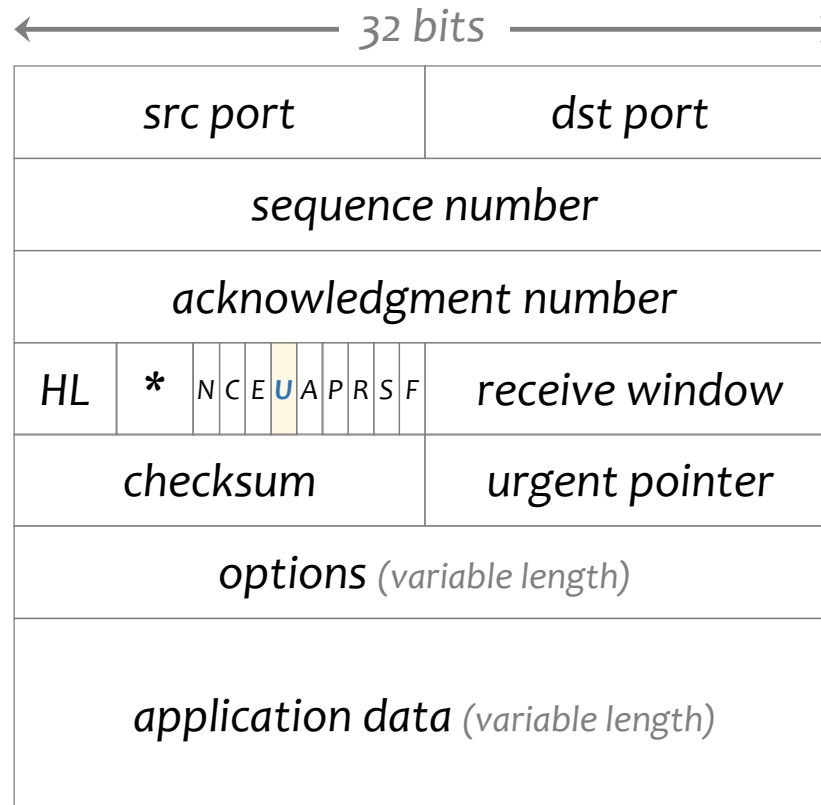
Nonce <N>,
Congestion Window Reduced
(CWR) <C>, and ECN-Echo <E>.



TCP: Segment structure



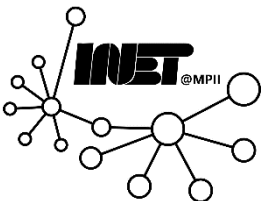
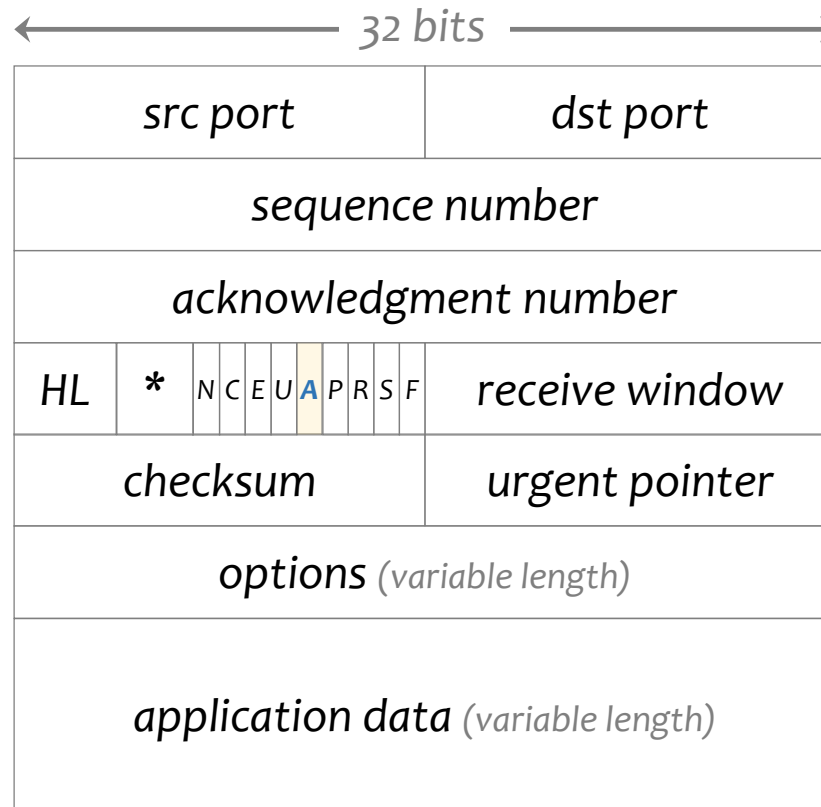
Urgent (**URG**) data



TCP: Segment structure



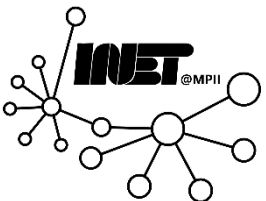
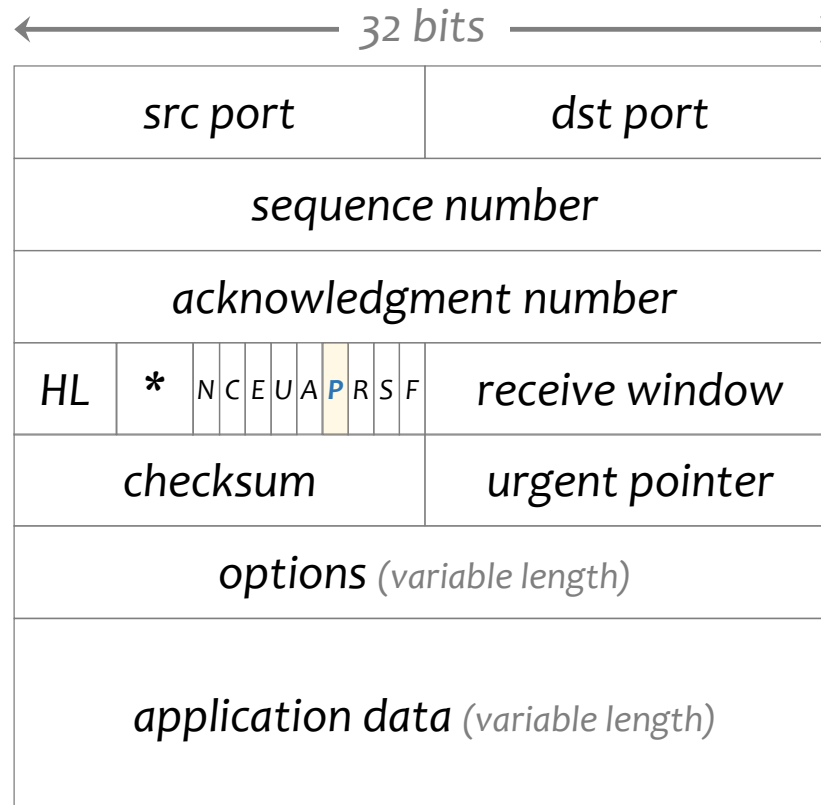
Acknowledgment (**ACK**) flag



TCP: Segment structure



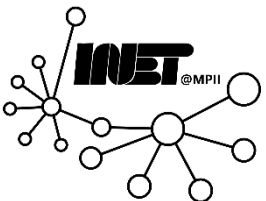
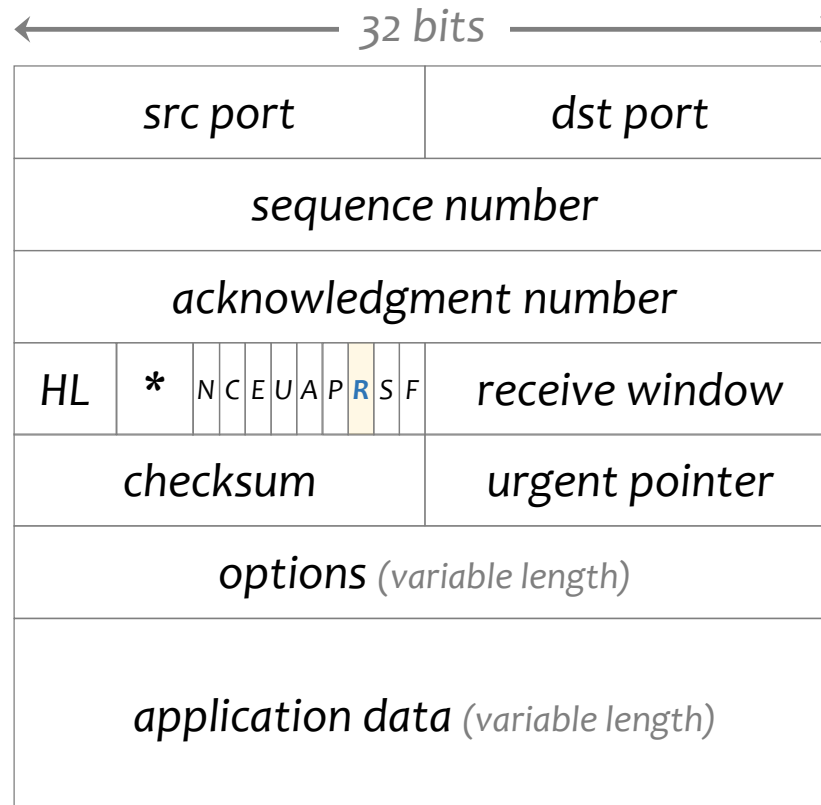
Push (PSH) data



TCP: Segment structure



Reset (**RST**) the connection

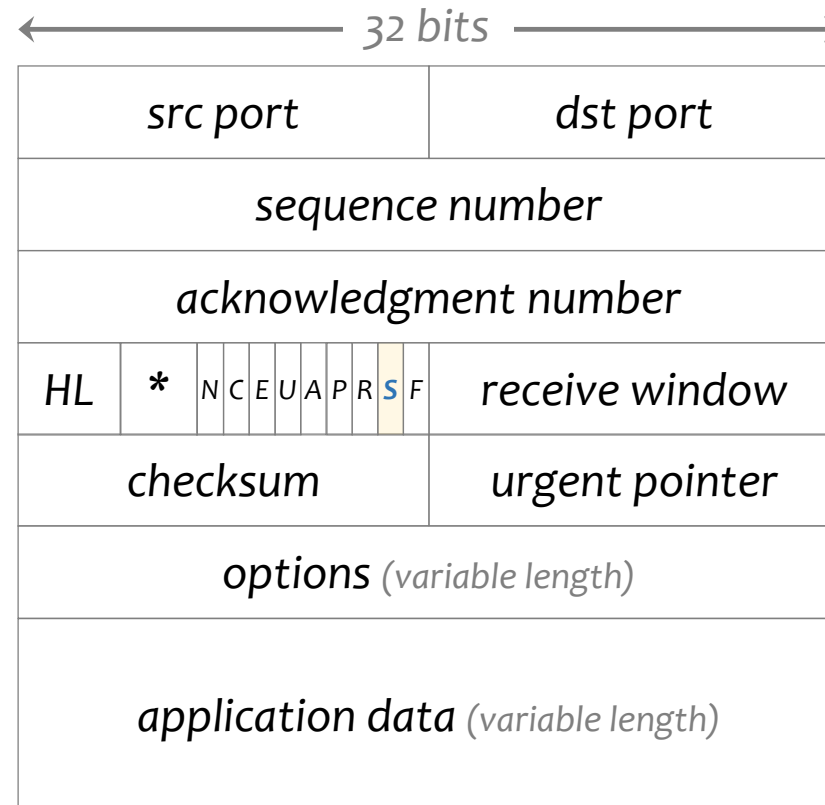


TCP: Segment structure



Synchronize (**SYN**)
sequence numbers

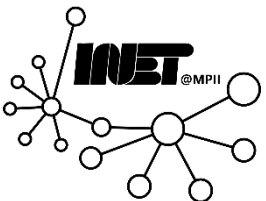
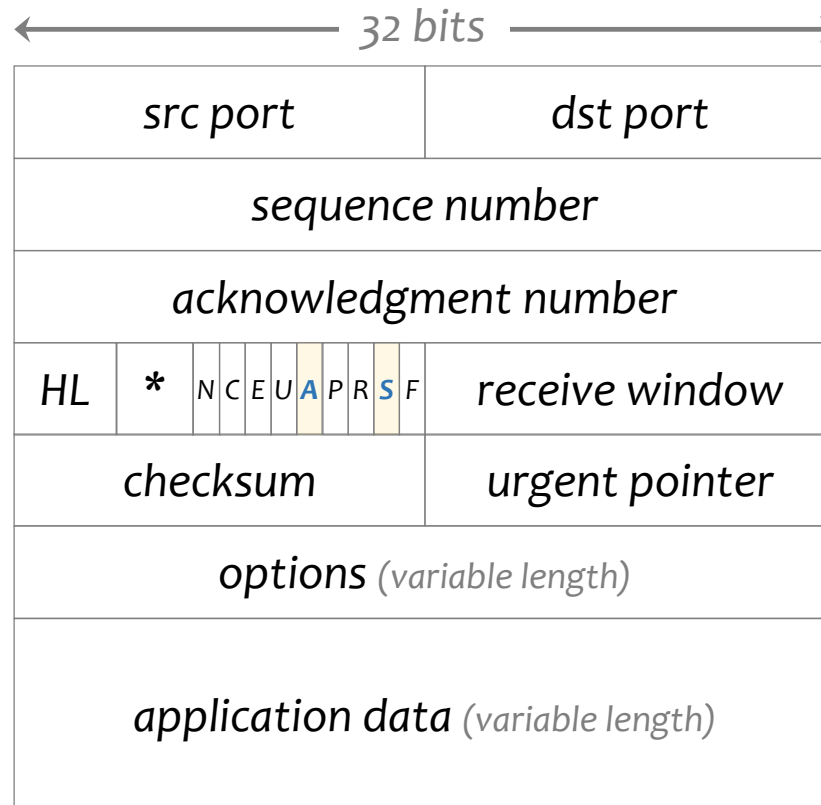
(only the first segment from
each end should have this flag)



TCP: Segment structure



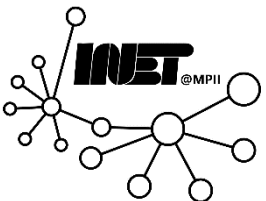
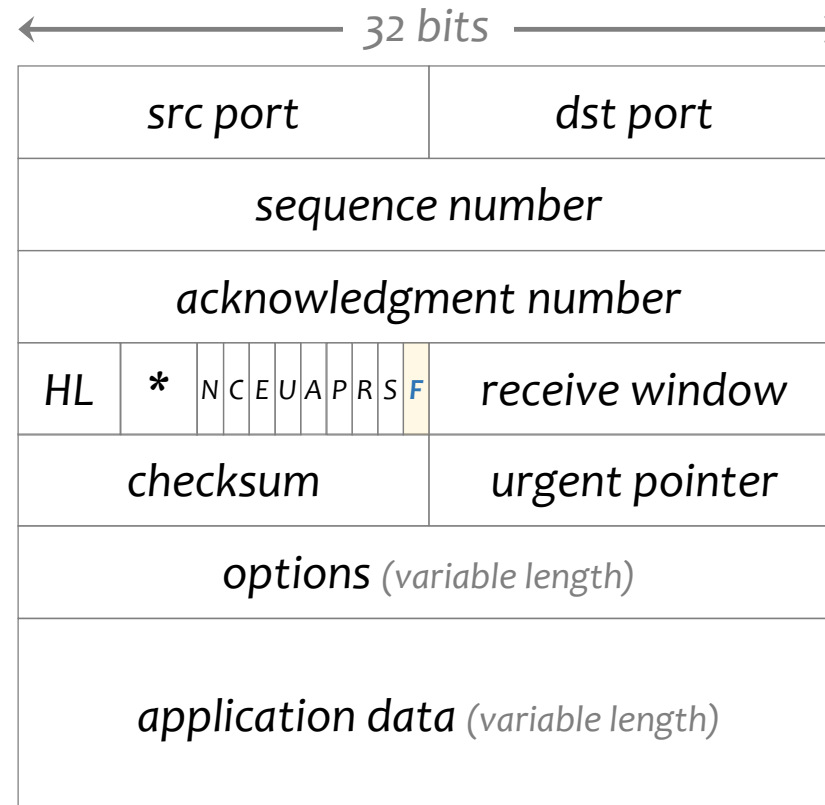
Combinations of **SYN** and **ACK** fields are used during TCP connection establishment.



TCP: Segment structure



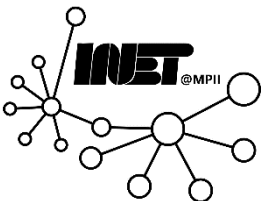
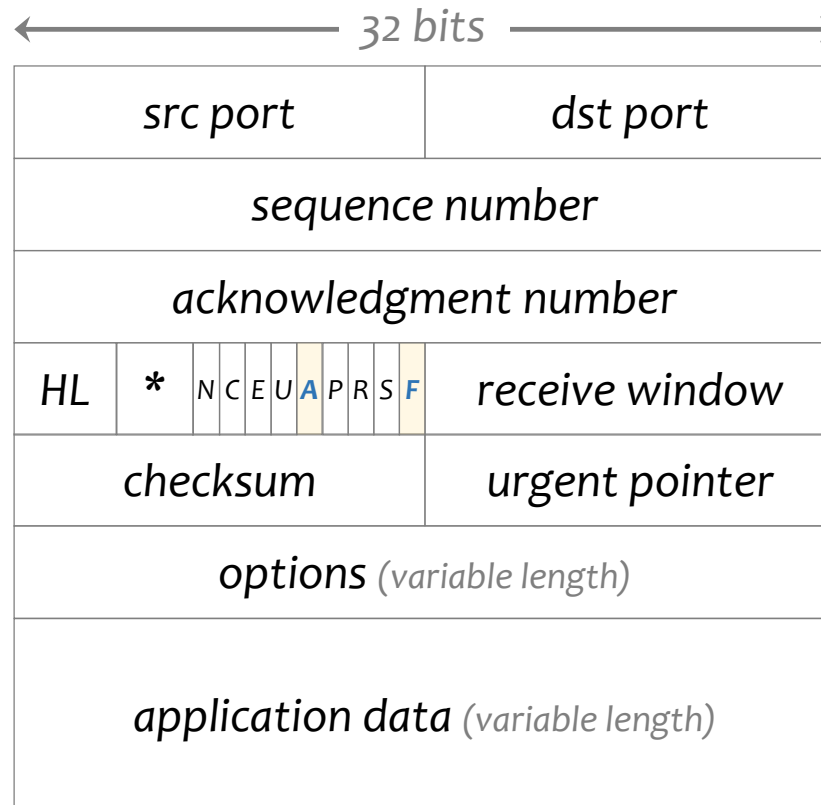
FIN flag indicates the last segment



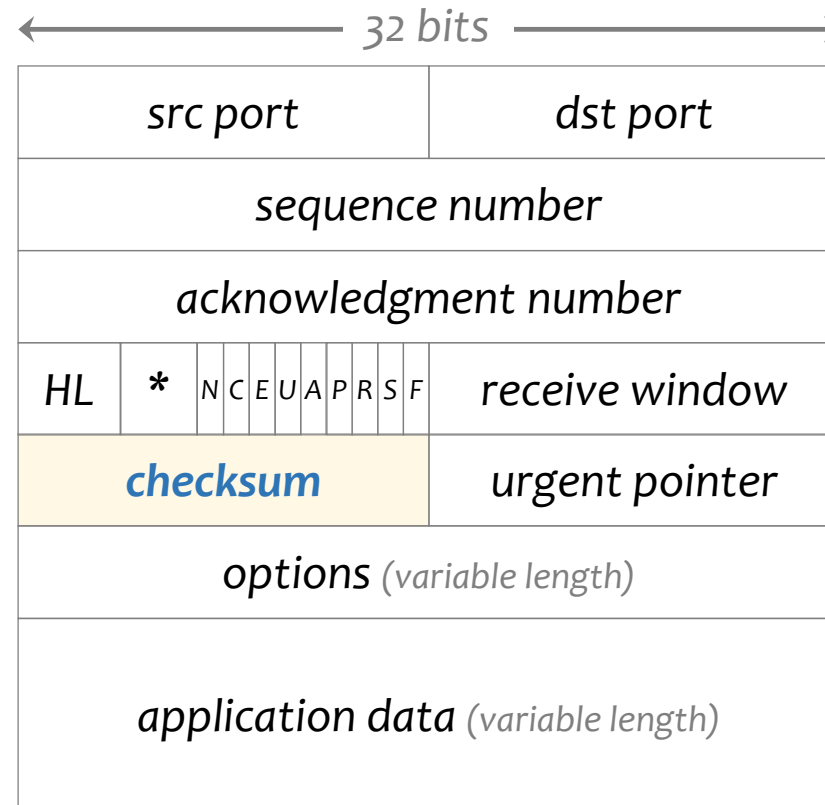
TCP: Segment structure



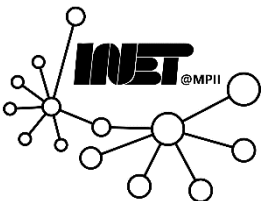
Combinations of **FIN** and **ACK** fields are used during TCP connection **termination**.



TCP: Segment structure



Checksum field helps in error checking

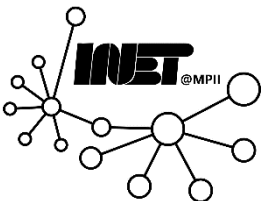
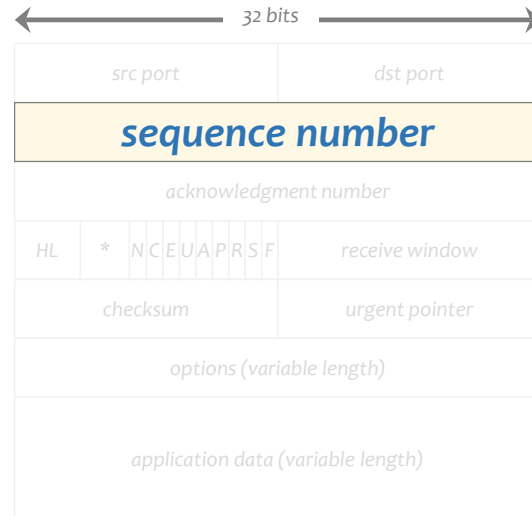


TCP: Sequence Numbers



Counting *bytes* not *segments*!

- Byte stream “*number*” of first byte in *segment’s* data



TCP: Sequence Numbers



Counting **bytes** not **segments**!

- Byte stream “*number*” of first byte in *segment’s* data

