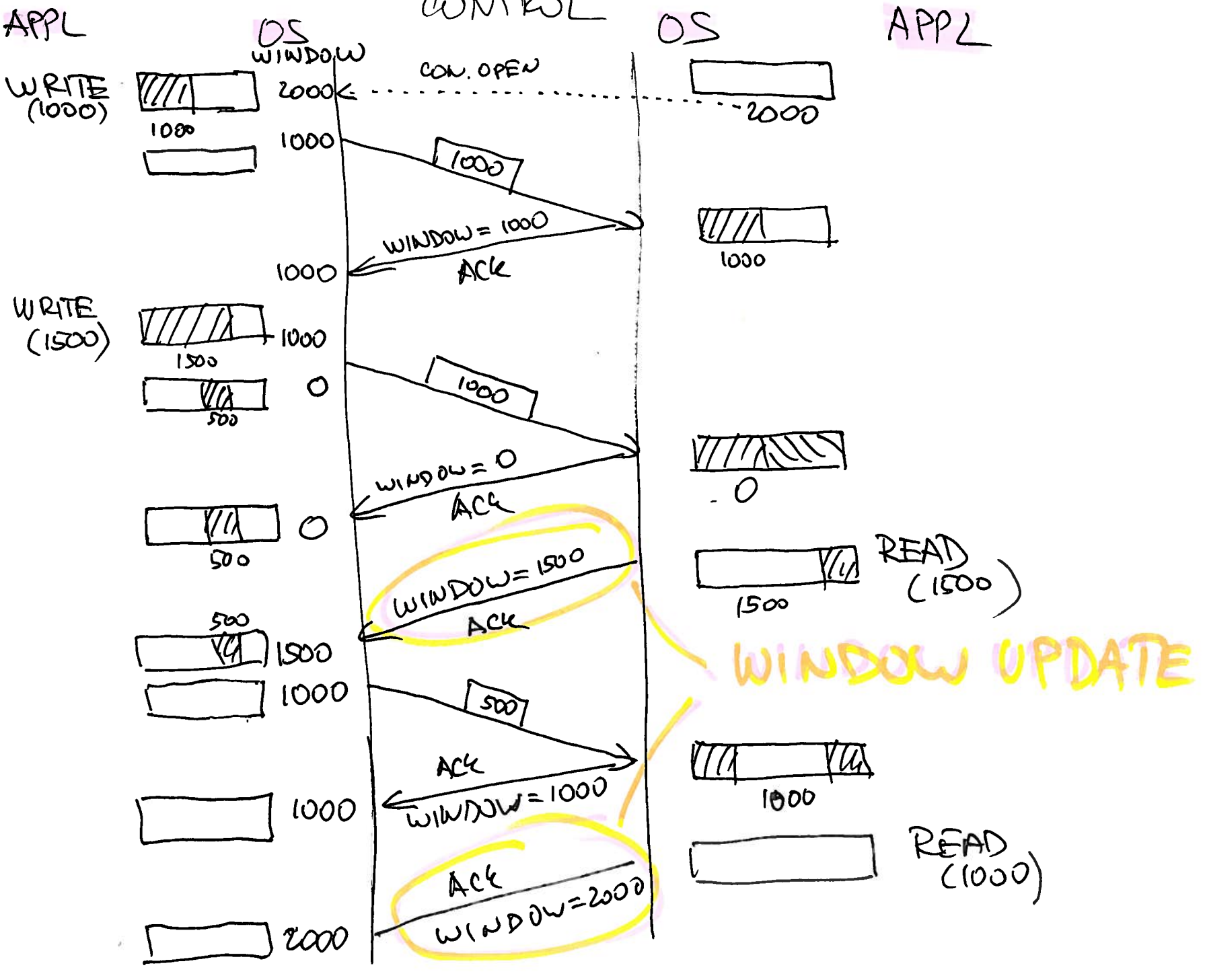
Two Types of Congestion

- Receiver Congestion
  - receiver is unable to keep up with incoming data
  - solved by *explicit* feedback from receiver to sender
- Network Congestion
  - nodes or links of the network are overloaded
  - *explicit* congestion notification (few technologies)
  - *implicit* congestion notification (Internet)

RECEIVER CONGESTION CONTROL



Implicit Congestion Cntrl.

- Round Trip Time (RTT)
  - time between data packet transmission and reception of it acknowledgement
  - increase in RTT could be interpreted as due to an increase in queue lengths in nodes (congestion)
  - or it could be due to a route change...
- Packet Loss
  - packet loss due to queue overflow (congestion)
  - packet loss due to random packet errors

Network Congestion

- No explicit indication of congestion given
- Source observes RTT and packet loss and adjusts transmission rate according to its estimate of the congestion state of the network

- Additive Increase Multiplicative Decrease (AIMD)
  - better safe than sorry

Transport Control

- Design parameters and objectives
  - used by most popular applications, majority of Internet traffic is transported over TCP
  - significant impact on congestion behavior of the Internet
  - must operate over networks with widely-varying characteristics
  - must be robust and (relatively) simple to implement

TCP Header

TCP Header

Offsets Octet		0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Source port																Destination port														
4	32	Sequence number																														
8	64	Acknowledgment number (if ACK set)																														
12	96	Data offset				Reserved 0 0 0				NS	CWR	ECE	URG	ACK	PSH	RST	SYN	FIN	Window Size													
16	128	Checksum																Urgent pointer (if URG set)														
20 ...	160 ...	Options (if Data Offset > 5, padded at the end with "0" bytes if necessary) ...																														

Another image appropriated from Wikipedia...