TCP Control Algorithms

There are three problems that end-to-end protocols have to deal with:

- Flow control – don't overwhelm the receiver
- Congestion control – don't overwhelm the network
- Variability in response times – what timeout to use.

Congestion control is a network layer problem, but it needs some help from the end-to-end layer because it can't control the data volume directly.

The TCP/IP solution attempts to isolate the two layers, so TCP has to address the problem without IP input.

Flow Control

Effective Window Size

$$EWS = AWS - Number\ of\ bytes\ in\ transit$$

$$EWS = AWS - (LBS - LAR)$$

Let $AWS = 1000bytes$ and $MSS = 100bytes$ for a slow receiver

	Sender			Receiver			
Event	**AWS**	**LBS**	**LAR**	**EWS**	**NBE**	**LAS**	**AWS**
Start	1000	0	-1	1000	0	-1	1000
Send 0-99	1000	99	-1	900	100	99	900
Send 100-299	900	299	99	700	300	299	700
Send 300-599	700	599	299	400	600	599	400
Send 600-999	400	999	599	0	1000	999	0

A Couple of Problems

The Zero Window Problem – what happens if the window goes to zero and the sender doesn't send again and doesn't get an updated AWS.

Solution – active sender, passive receiver

The Silly Window Problem – the AWS gets small and grows in small increments. The sender continually sends very small segments.

Solution – Don't advertise windows smaller than 1 MSS.

Adaptive Retransmission

How to accomodate dynamic roundtrip response times.

A smoothing function for timeouts where:

$ERTT = Estimated\ Round\ Trip\ Time$ and
$SRTT = Sample\ Round\ Trip\ Time$

$$ERTT_t = \alpha \times ERTT_{t-1} + (1 - \alpha) \times SRTT_{t-1}$$

For example, let $\alpha = 0.7$, $ERTT_{t-1} = 100\,ms$ and

$SRTT_{t-1} = 120\,ms$

$$ERTT_t = 0.7 \times 100\,ms + (1 - 0.7) \times 120\,ms$$

$$ERTT_t = 70\,ms + 36\,ms = 106\,ms$$

The timeout period should be greater than the ERTT. The standard choice is $ERTT \times 2$.

The Karn-Partridge Algorithm

What should the adaptive retransmission algorithm do if there is a timeout?

- To which send of the message does the ACK belong and what is the SRTT?

The Karn-Partridge modification to the basic smoothing algorithm ignores the SRTT and doubles the ERTT.

The Jacobsen/Karels Algorithm

The variability in response times is a significant factor in the success of the algorithms in avoiding timeouts. The Jacobsen/Karels algorithm includes an estimate of the variance.

$$Difference = SRTT - ERTT$$
$$ERTT = ERTT + (d \cdot Difference)$$
$$Deviation_t = Deviation_{t-1} + d(|Difference| - Deviation_{t-1})$$
$$Timeout = u \cdot ERTT + f \cdot Deviation$$

Typical values are $d = 0.5, u = 1, f = 4$.

For example, if the ERTT is 200 ms, the current deviation is 50 ms, and the SRTT is 100 ms,

$$Difference = 100 - 200 = -100$$
$$ERTT = 200 + (0.5 \cdot -100 = 150$$
$$Deviation_t = 50 + 0.5(|-100| - 50) = 75$$
$$Timeout = 1 \cdot 150 + 4 \cdot 75 = 450\, ms$$