TCP over Radio Links with Power Control and Link Level Retransmissions

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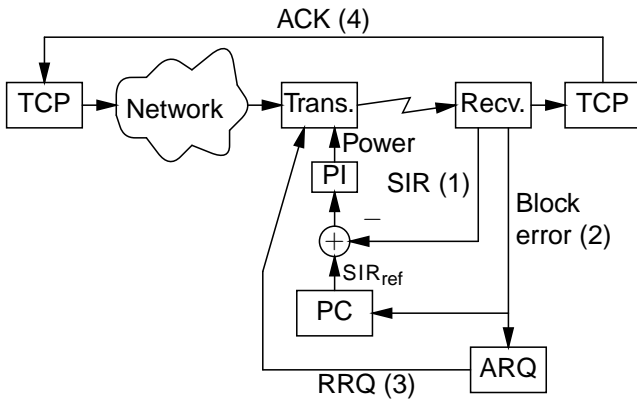
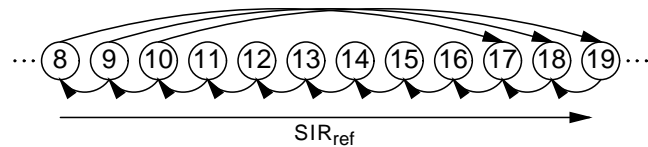Department of Signals, Sensors and Systems, KTH, Stockholm

## TCP over Radio Link

Note the four cascaded feedback loops:

(1) Inner loop of power control
(2) Outer loop of power control
(3) Retransmissions of damaged blocks
(4) TCP congestion control

Power Control

The inner loop is a fast controller tracking SIR_{ref}. The outer loop is a Markov chain driven by block errors.

SIR_{ref} is decreased in small steps when no error occurs, and increased by a larger step when an error occurs.
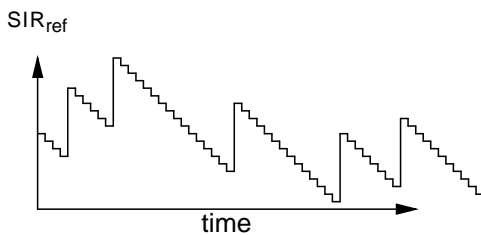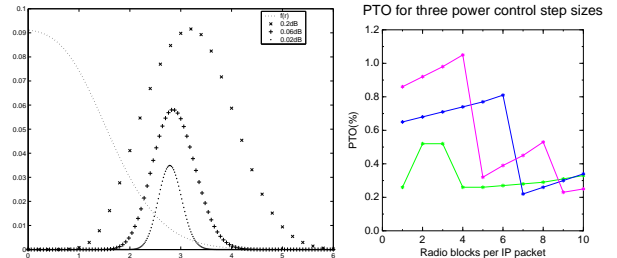
SIR$_{ref}$

time

Typical variation of SIR_{ref} with time.

Link Layer

The underlying Markov chain determines the block errors. Damaged blocks are scheduled for retransmission.

Retransmit

TCP properties

PTO for three power control step sizes

Left: Stationary distribution of the power control Markov chain. Right: The TCP P_{TO} probability, for three values of the SIR_{ref} step size (green is smallest, red is largest).

$$P_{TO} = P(\text{spurious timeout}) = P(X > E(X) + 4\sigma(X))$$

- X uniformly distributed $\implies P_{TO} = 0$
- X Gaussian $\implies P_{TO} \approx 0.015\%$
- $\sigma(X) < \infty \implies P_{TO} < 1/16 \approx 6\%$

For our radio link, the above figures gives a P_{TO} that is of the order 1%.

Conclusions

- The control loops below the IP layer interact with TCP congestion control.
- From a model of these control loops, we can derive IP-level properties.
- In particular, we get a probability of spurious timeouts on the order of 1%, two orders of magnitude larger than for links with Gaussian delay.

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