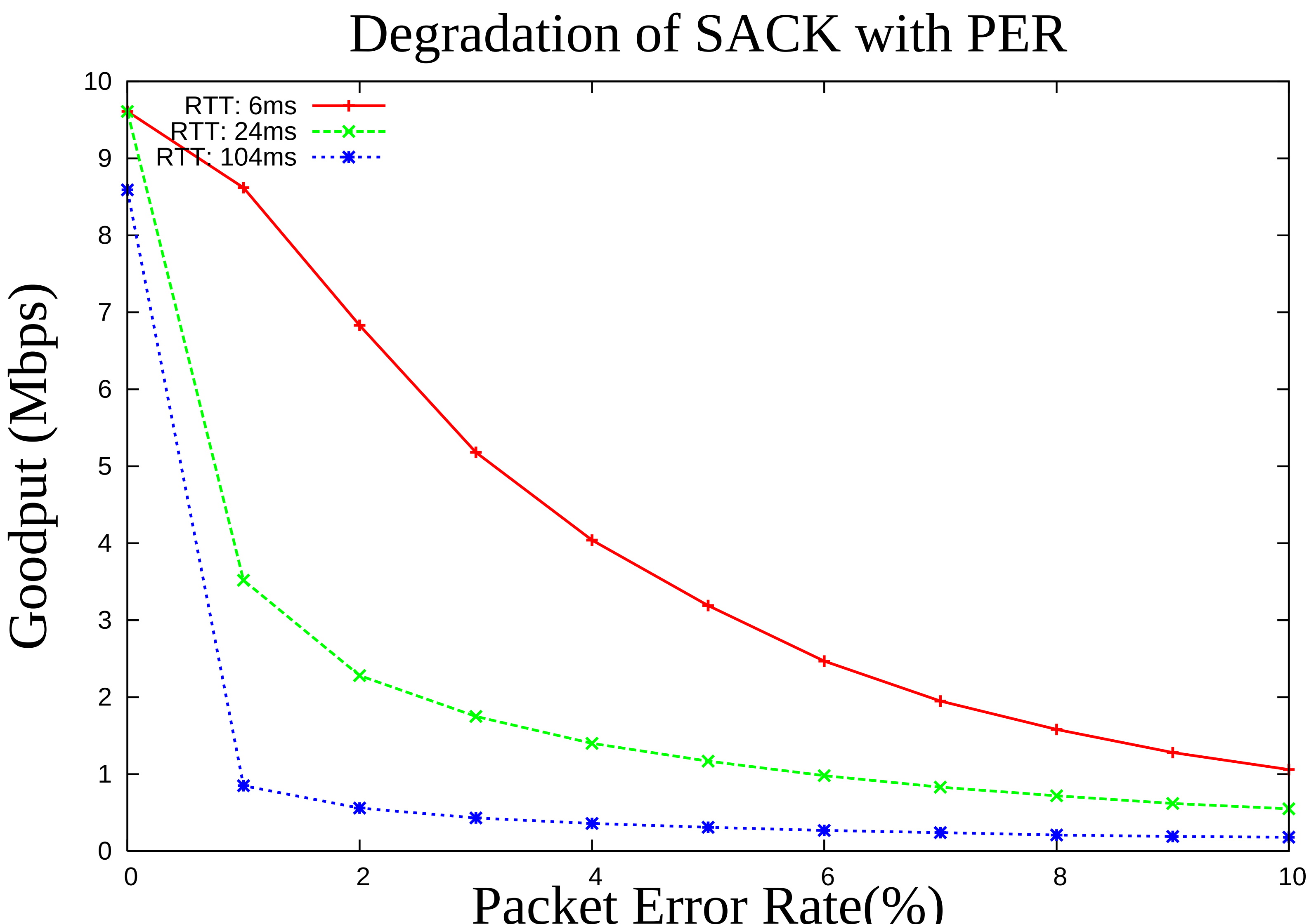
Robust Transport for Lossy MANETs

Shivkumar Kalyanaraman (RPI)
K. K. Ramakrishnan (AT&T Labs Research)

Students: *Vijay Subramanian, Omesh Tickoo*

Email: shivkuma@ecse.rpi.edu, kkrama@research.att.com
Google: "**Shiv RPI**" and "**KK AT&T**"

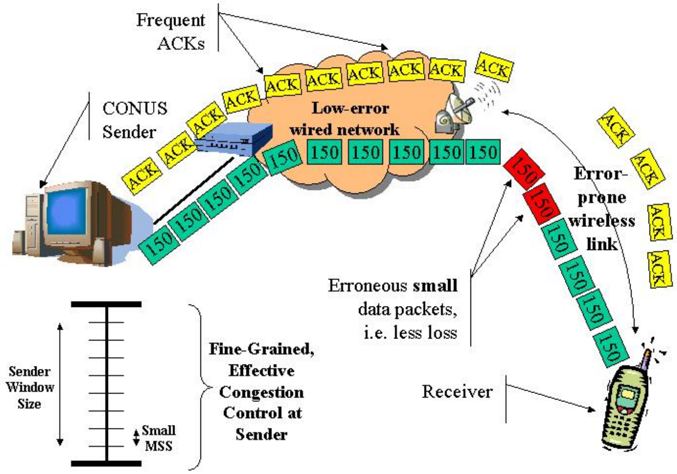
TCP/SACK Performance w/ Erasures



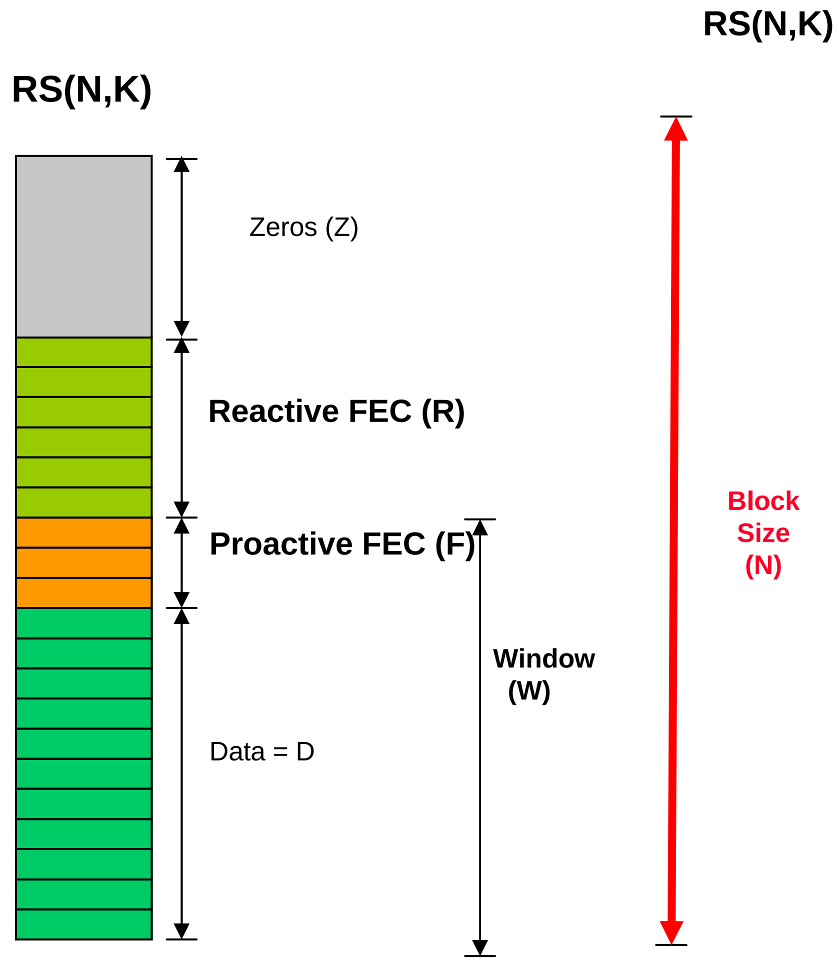
AT&T

Rensselaer

Building Blocks

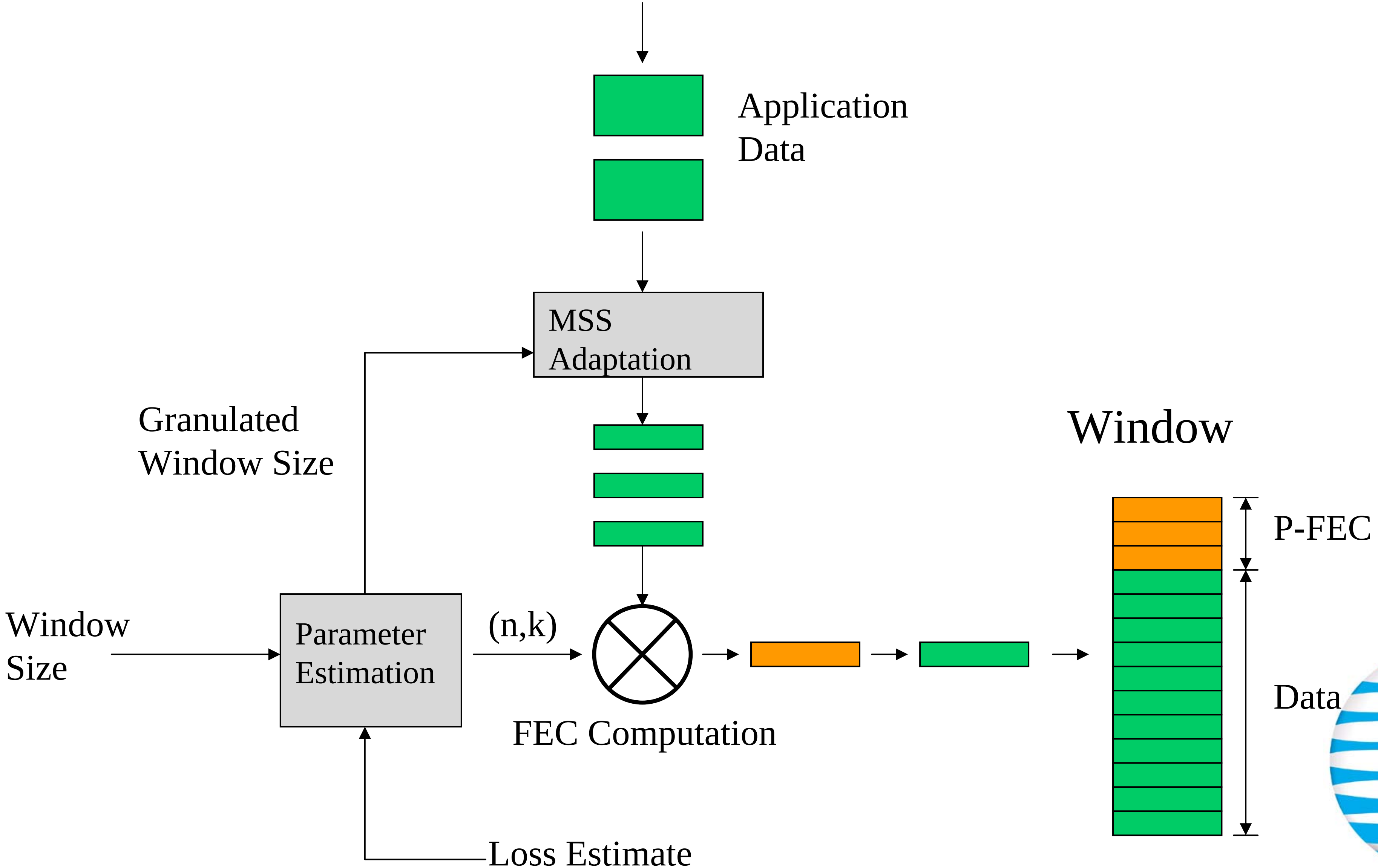


Adaptive MSS



Proactive and Reactive FEC

The LT-TCP Framework



Performance Results: 10 Mbps bottleneck

SACK: Uniform vs Bursty Errors

	ERROR RATE					
PARAMETER	0 percent	10 percent	20 percent	30 percent	40 percent	50 percent
Goodput(Mbps)	9.158	1.098	0.233	0.048	0.01	0.003807
Number of Timeouts	0	267	287	135	52	26
Throughput (Mbps)	9.52	1.272	0.306	0.073	0.018	0.007984

TABLE II

TCP-SACK W/ ERASURES: TCP GOODPUT AND THROUGHPUT, THOUGH ACCEPTABLE AT 0% PER, DRAMATICALLY REDUCES A 10% PER. FEWER TIMEOUTS AT HIGHER PER REFLECT LONGER TIME SPENT IN EACH TIMEOUT DUE TO TIMER-BACKOFF (KARN'S ALGORITHM).

	ERROR RATE			
PARAMETER	0 %	10 %	20 %	30 %
Sender Throughput (Mbps)	9.987	3.80	1.60	0.71
Receiver Throughput (Mbps)	9.986	3.45	1.35	0.55
Goodput(Mbps)	9.602	3.23	1.21	0.48
95% CI Lower Bound (Goodput)	9.600	2.46	1.07	0.31
95% CI Upper bound (Goodput)	9.602	3.99	1.36	0.65
Number of Timeouts	0	763	782	579

LT-TCP: Uniform vs Bursty Errors

MULTI-SOURCE	ERROR RATE					
PARAMETER	0 percent	10 percent	20 percent	30 percent	40 percent	50 percent
Number of Timeouts	0	2.64	9.28	17.1	51.5	137
Goodput(Mbps)	9.56	6.76	5.42	4.34	3.45	2.74
Throughput(Mbps)	9.99	8.99	7.99	6.98	5.97	4.91
Number of ECNs	456	518	532	581	672	572
Proactive FEC Used (%)	0	15	25	35	46	56
Reactive FEC Used (%)	0	12	16	21	24	25

TABLE II

LT-TCP W/ ERASURES FOR ERROR RATES 0-50 %. PERFORMNCE IS MUCH BETTER THAN SACK AND IS NEAR OPT THROUGHPUT / GOODPUT WERE MEASURED AT THE RECEIVER.

	ERROR RATE			
PARAMETER	0 %	10 %	20 %	30 %
Sender Throughput (Mbps)	9.987	9.95	9.34	4.72
Receiver Throughput (Mbps)	9.98	8.95	7.52	3.54
Goodput(Mbps)	9.527	6.62	4.77	2.04
95% CI Lower Bound (Goodput)	9.51	6.59	4.70	1.80
95 % CI Upper Bound (Goodput)	9.54	6.64	4.83	2.28
Number of Timeouts	0	34.7	238.3	789
Proactive FEC (%)	0	20	34	39
Reactive FEC (%)	0	7	11	13

Bursty cases: Gilbert ON-OFF model with loss probability **2p** during the ON periods

Issues and Future Work in CBMANETs

- **"Done":**
  - TCP performance w/ significant residual erasure rates
  - Initial LT-TCP building block
- **Future: Study Implications of CBMANETs:**
- **Future:Design TCP and cross-layer designs to operate well over such networks**
  - Optimal division of functions between link/transport layers
    - Control of MAC layer scheduling options guided by transport-layer goals
  - Effects of interference-induced erasures in unplanned/ad-hoc environments
  - Variability in delays, loss rates, capacity, path availability
    - Size of buffer needed & buffer management strategy as a function o… variability
  - Behavior in multi-hop wireless ad-hoc environments
    - Erasure loss, congestion, limited buffering at ea…
  - Value of multi-path techniques:
    - tolerance to disruption, pote… …g and load-balancing
  - Issues with large ba… …uct, large RTT (VCP- our recent sigomm paper)
    - especially … …esidual loss rates
  - Cust… …s for QoS sensitive applications
- …entations, testbeds, field-trials

Needs a study of cross-layer design issues