Link Correlation and Network Coding in Broadcast Protocols for Wireless Sensor Networks

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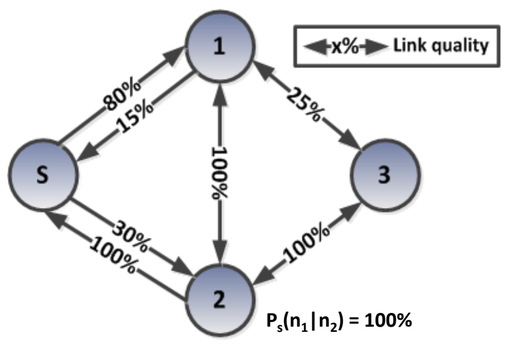
Background

Correlated packet reception can be beneficial for sensor network broadcast protocols

Link correlation based *single packet flooding* has been devised without requiring explicit ACK

Can link correlation be equally useful to design multi-packet flooding

Depends on the extent of the link correlation present in the network



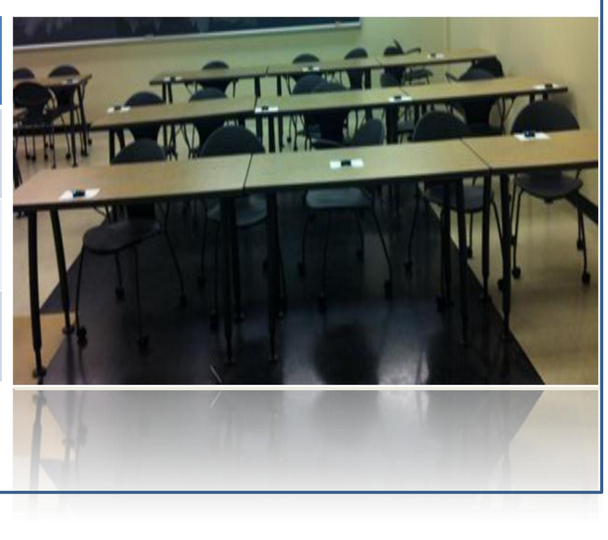
[Node 1 and 2 experience 100% correlated reception of packets sent from S]

Overhearing a transmission from node 2, S can estimate reception at node 1 without receiving a direct ACK from node 1.

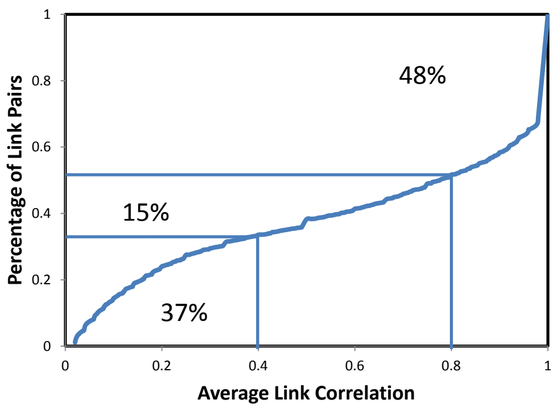
Testbed Setup

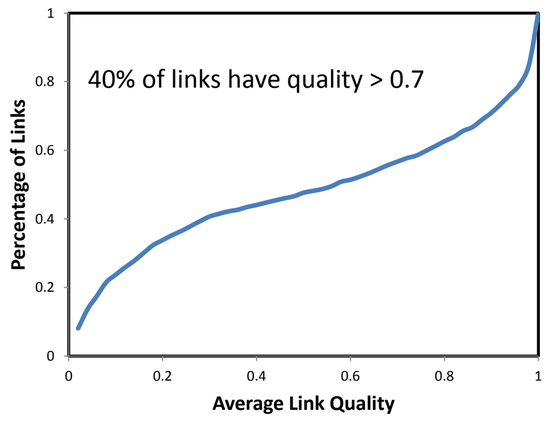
- Multihop network
- 18-30 battery-powered TelosB motes were placed in different indoor environments

Environment	Topology (Motes)	Tx Power Level
Multilevel Classroom	5x6 Grid (30 motes)	2
Community Lounge	Random (20 motes)	1
Apartment Room	3x6 Grid (18 motes)	1

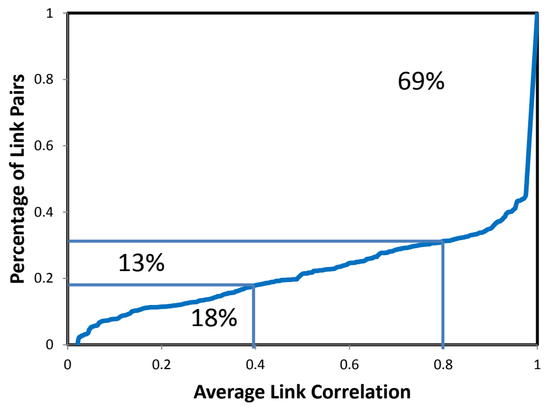


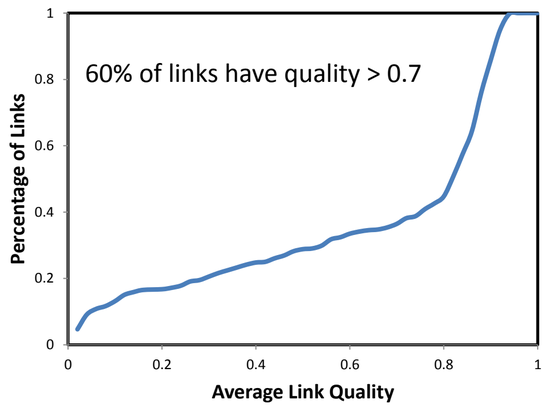
Testbed Results





Multilevel Classroom





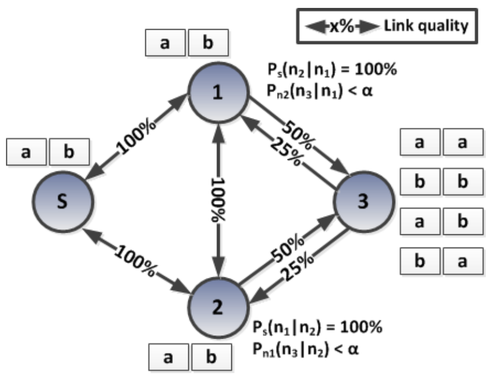
Apartment Room

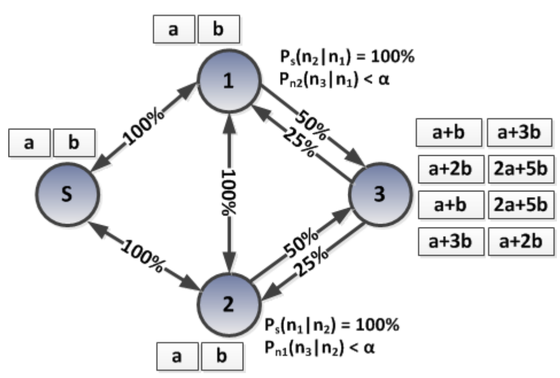
Multi-packet Flooding Problem

Multi-packet flooding problem becomes challenging due to varying link correlation

Reliability degradation

Redundant data transmissions

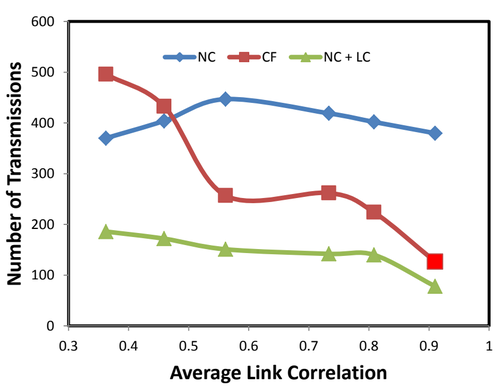




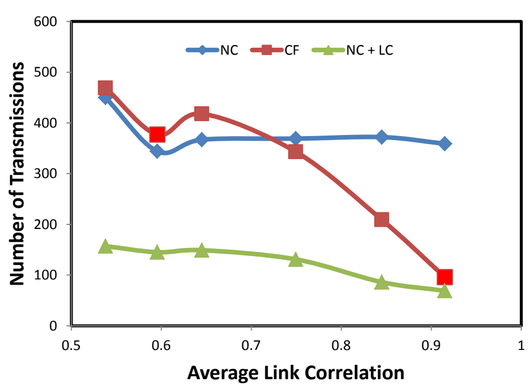
Introducing network coding over link correlation

- ✓ Improved reliability
- ✓ Reduced transmissions

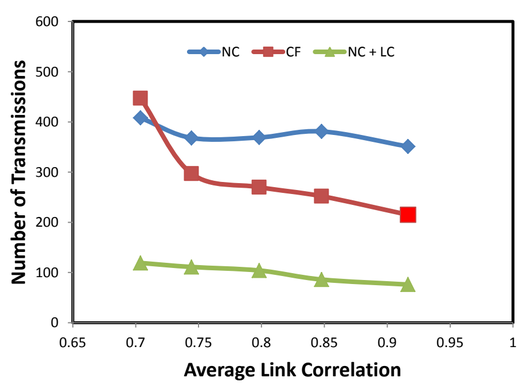
Effect of Link Correlation



PRR = 0.4



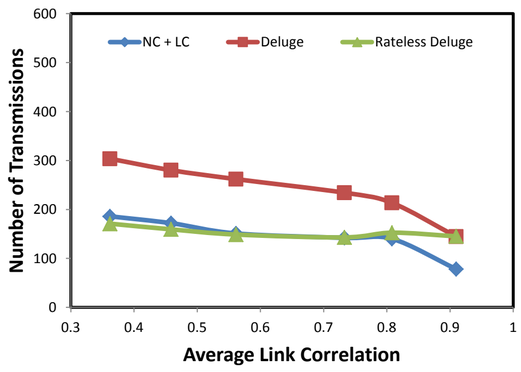
PRR = 0.6



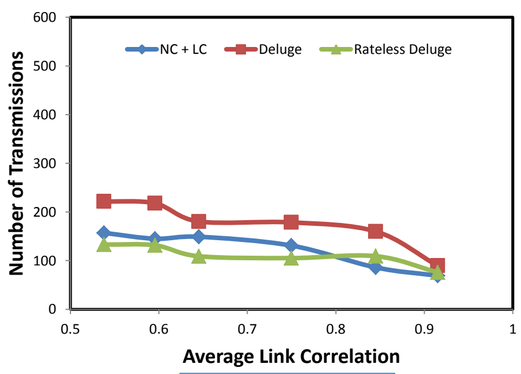
PRR = 0.7

- NC is unaffected by changes in link correlation
- CF performs better than NC in case of high link correlation
- CF lacks perfect reliability
- NC+LC performs better than both

Performance Comparison



PRR = 0.4



PRR = 0.6

- Rateless Deluge is no better than Deluge when link correlation is high
- For links with low PRR, NC+LC performs significantly better than both
- For networks with high PRRs and link correlation, performance is dominated by the link qualities rather than the link correlations

Protocol	Number of Transmissions		Reliability	Explicit Control Message	Projected Delay
	Low correlation	High Correlation			
CF	High	Low	Not perfect	Not required	Too high
Deluge	High	Low	Perfect	Required	High
Rateless Deluge	Moderate	Moderate	Perfect	Required	High
NC + LC	Moderate	Low	Perfect	Not required	Low

Future Works

Devise a protocol exploiting both link correlation and network coding to disseminate a large object with fewer transmissions and minimum delay.