Burstiness and Scaling in Low Power Wireless Link Simulation

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Burstiness in Low Power Wireless Networks

- *Burstiness* is the quality of a link having periods of success and periods of losses at certain time scales.
  - Considers *temporal correlation* between successes and failures in packet reception.
- It has been observed that wireless networks have a correlated (i.e. bursty) reception patterns.
  - IEEE 802.11 Mesh Networks [SIGCOMM 2004]
  - Low Power Wireless Sensor Networks (IEEE 802.15.4) [IPSN 2007, MSWiM 2008, SENSYS 2008]

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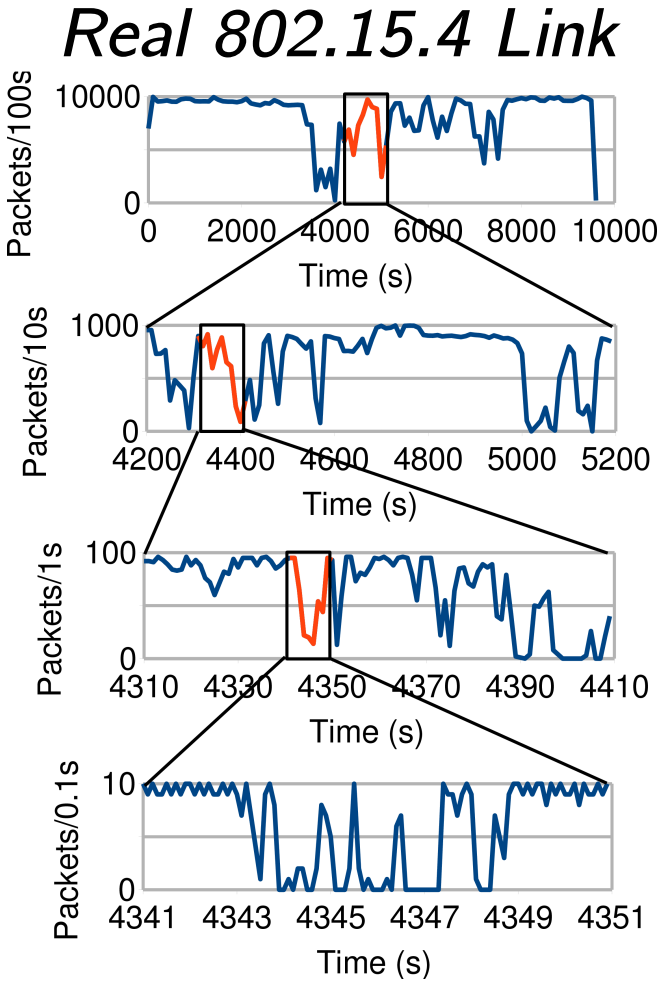
Number of Packets Received over Different Time Scales

- Studied with respect to Ethernet traffic [TON 1994]



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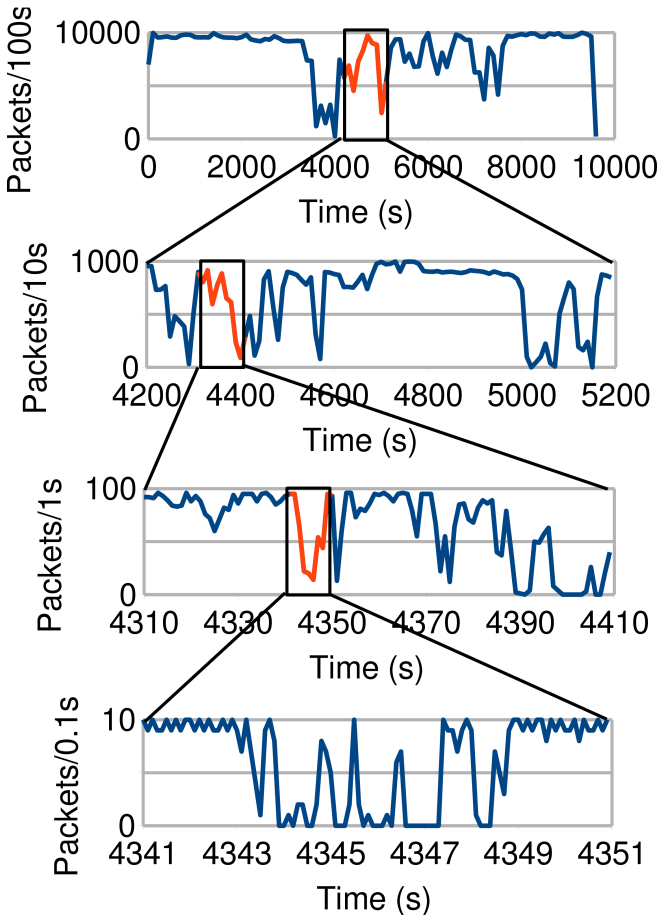
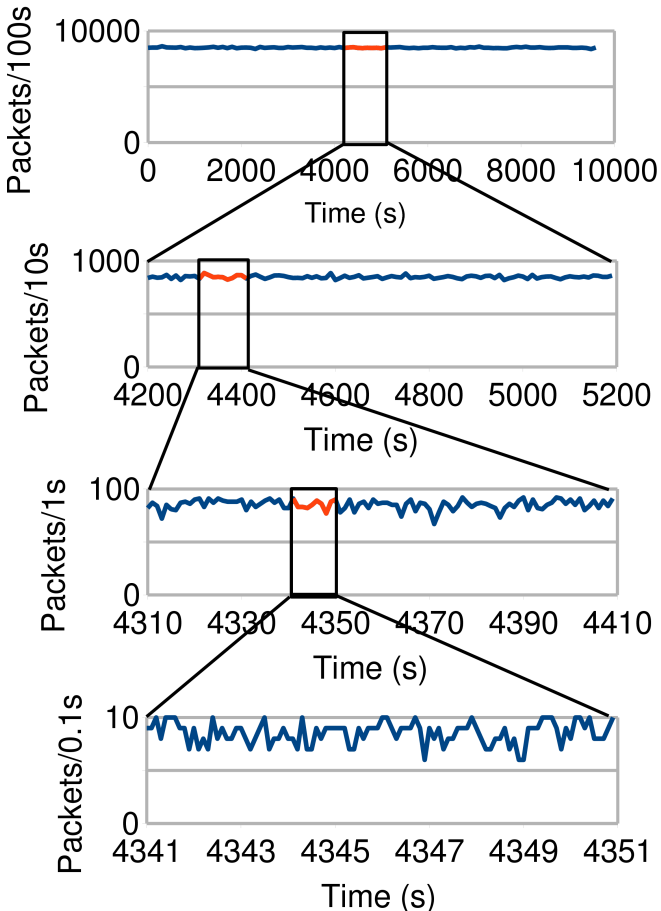
Real 802.15.4 Link



Simulated with TOSSIM

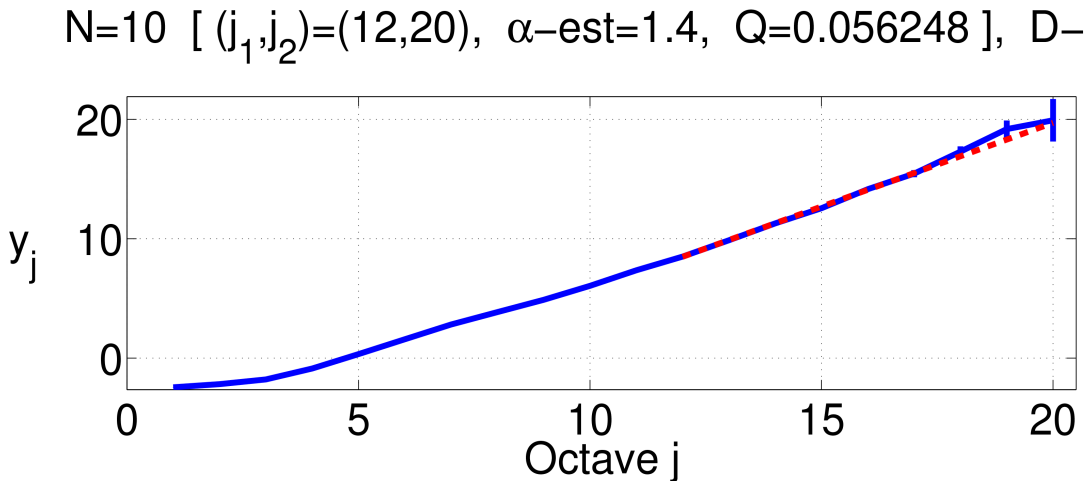


Observations

- Burstiness is observed at many time scales in the real link, but not in the simulated link.
- Simulation that does not capture burstiness leads to incorrect prediction of network behavior, which makes deployments less predictable.
- It is difficult to develop reliable protocols with incorrect underlying assumptions.

Physical Layer Scaling

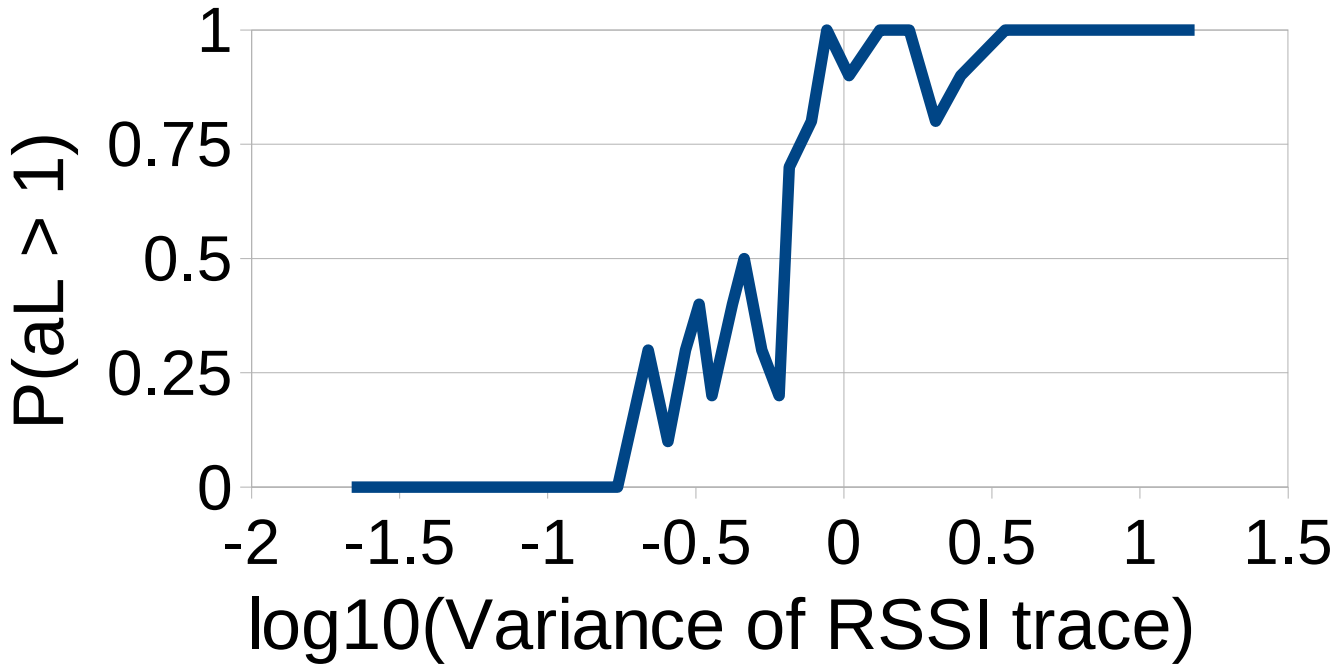
- *Logscale diagram* used to investigate scaling at the physical layer (RSSI trace) using method of Abry et. al.



- α is the slope in the asymptotic domain.
- If α > 1 (as seen here), then the data may be consistent with *statistical self similarity* or *asymptotic self similarity*, but not with long range dependence.

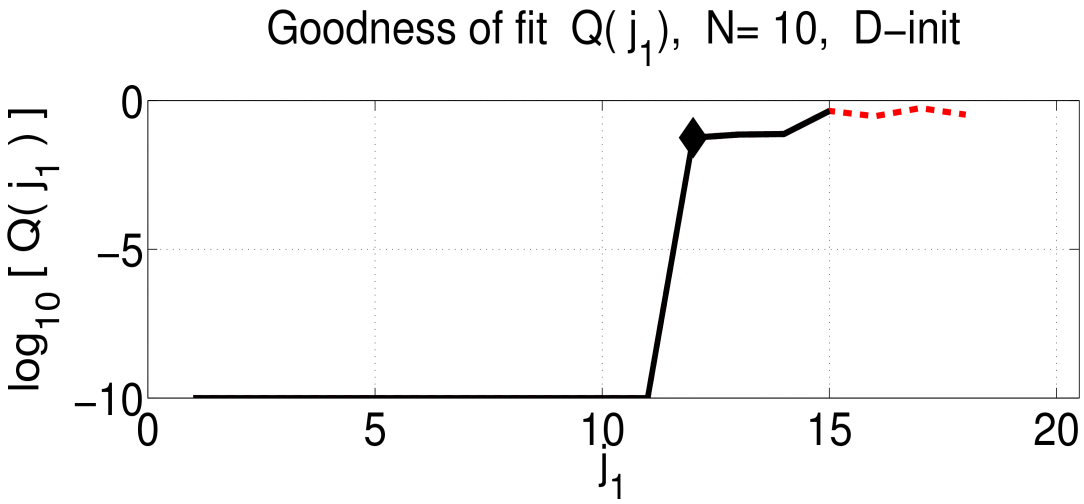
Probability of Self Similarity vs. RSSI Variance

- Relationship between average variance over groups of ten links to probability that $\alpha > 1$ in logscale diagram:



Point of the Onset of Scaling

- Onset point is timescale where scaling starts, estimated using a method suggested by Abry et. al.:



- It was previously observed by Srinivasan et. al. [SENSYS 2008] that waiting 500 ms before retransmissions improves link reliability. 500 ms may be the onset point for that study.

Simulation Framework

- Low-variance (stable) RSSI links can use classic techniques
- Evaluate if scaling is present in higher variance links
- If scaling present, determine the type of scaling and onset point
  - Model traces for time scales beyond onset point in the asymptotic domain (current, ongoing work)
  - Use current interference/signal power modeling techniques for transient domain [IPSN 2007, MSWiM 2008], possibly based on seed value from longer term simulation

Thank you!

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