Aalto University
School of Electrical
Engineering

Studies with ns-2 and ns-3 based DTN Simulators

Epidemic Routing, Spray and Wait

DTN Congestion Control

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Simulators

- ns-2.34
  - With alternative 802.11 model from University of Padova (see http://www.dei.unipd.it/wdyn/?IDsezione=5090)
  - Part of ns-2, no need for additional code
  - Transport protocol: UDP with acknowledgements and retransmissions
- ns-3.15
  - Transport protocol: TCP Newreno with default settings or UDP with acknowledgements and retransmissions
- Self-made DTN / bundle protocol module that supports:
  - Epidemic routing [1]
  - Binary spray and wait [2]
  - Return receipts / antipackets
  - A simple congestion control algorithm

Common Parameters

- Simulation time: 5000 s (random walk) or 3600 s (traces)
- Random walks, generated by CMU's setdest program (part of ns-allinone package)
  - 40 mobile nodes, selecting random direction and speed at random times
  - Maximum speed: 20 m/s
  - Pause length: 2 s (always pause before taking new direction & speed)
  - Area size: 10 m * 10 m – 2000 m * 2000 m
- Real/synthetic traces (SF cab trace or Helsinki city center trace from ONE simulation)
  - 116 mobile nodes, moving according to trace file
  - Area size 5700 m * 6600 m (SF) or 4500 m * 3400 m (Helsinki)
- Traffic
  - Random walks: each node sends a 1 B – 20 KB bundle (uniform distribution) to a randomly selected node at t = 10…210s, t = 210…410s etc
  - Traces: 10 KB to 100 KB bundles with 10 KB granularity
  - The bundles are fragmented to 1500-byte IP packets before sending to MAC layer
- Routing
  - Epidemic routing or binary spray and wait (default number of copies: 16)

DTN Parameters

- Hello message interval: 100 ms
  - ns-2: Hello message has room for 500 bundle/receipt IDs, it has a fixed size of 20 bytes
  - ns-3: Hello size is limited to 2280 bytes and it depends on the number of stored bundles
- Bundle retransmission timeout: 1000 s
- Bundle lifetime: 750 s
- Storage size
  - Random walks: 250 KB or 2 MB (50/50)
  - SF trace: 1.375 MB or 11 MB (50/50)
  - Helsinki trace: 6 MB
  - A bundle can be generated only if there is sufficient buffer space
- Antipacket mechanism, VACCINE [3]
  - Return receipts act as antipackets: bundles are deleted and nodes get immunity against this particular bundle as the receipt is forwarded towards the bundle source
  - Whatever the bundle routing scheme, antipackets are spread in an epidemic manner [4]
  - Antipacket lifetime: min(retransmission timeout - bundle forwarding time, bundle lifetime)
  - Antipacket size: 10 bytes

Congestion Control

- A bundle can be forwarded only to such intermediate node whose current buffer occupancy is under the threshold of 0.7/0.8/0.9/parameter times buffer size
- We get this information in Hello messages
- Can be used with any DTN routing scheme

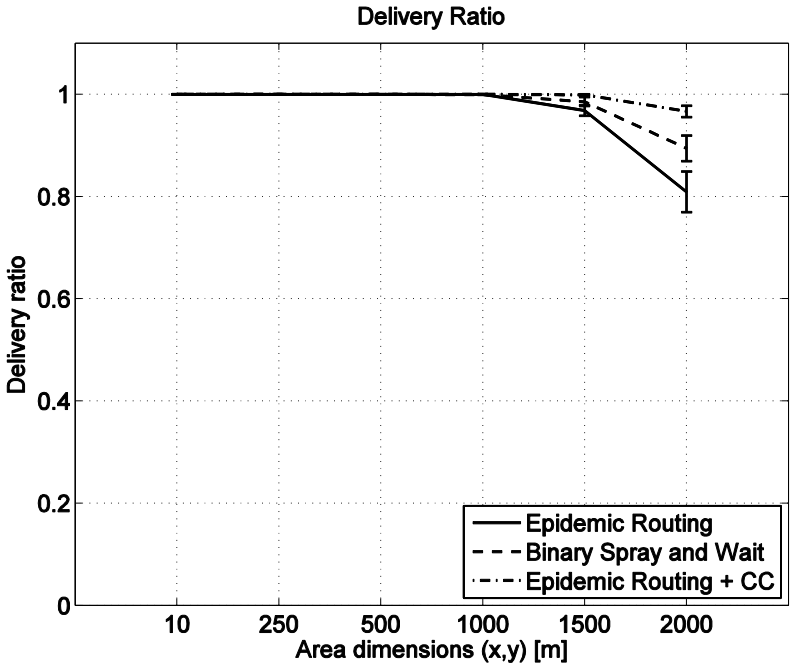
WLAN Parameters (1/2)

- ns-2 PHY parameters: IEEE 802.11g used (dei80211mr model, see http://www.dei.unipd.it/wdyn/?IDsezione=5090)
  - noise_ 9.75e-12 W (-80 dBm, Pn = kTB = 1.38*10^-23 J/K * 290 K * 2.437e9 Hz)
  - Pt_ 0.0178 W (12.5 dBm)
  - freq_ 2.437 GHz
  - L_ 1.0
  - Transmission range of 66 m – 130 m, depending on the modulation and coding scheme (MCS)
  - Signal-to-noise ratio (SNR) based link adaptation used → MCS
  - MCS, packet size & SNR → packet error rate (PER)
- ns-3 PHY parameters (transmission range of ~130 m):
  - RxNoiseFigure 7
  - TxPowerLevels 1
  - TxPowerStart & TxPowerEnd 12.5 dBm
  - m_channelStartingFrequency 2.407 GHz
  - TxGain & RxGain 1.0
  - EnergyDetectionThreshold -74.5 dBm
  - CcaMode1Threshold -77.5 dBm

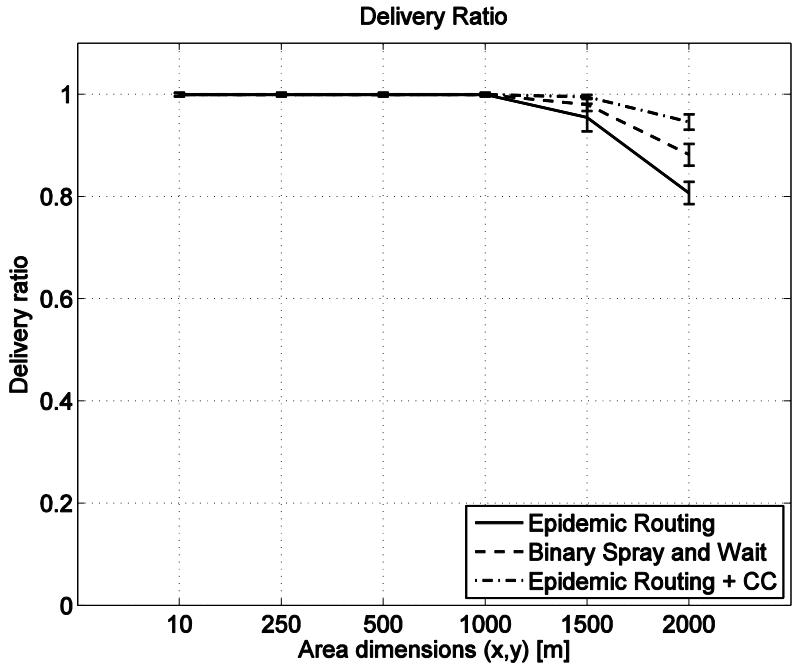
WLAN Parameters (2/2)

- ns-2 & ns-3 IEEE 802.11g MAC parameters:
  - CWMin 15
  - CWMax 1023
  - RTSThreshold 0 B (RTS/CTS for all packet sizes)
  - ShortRetryLimit 7
  - LongRetryLimit ns-2: 4, ns-3: 7
  - SlotTime ns-2: 9 µs, ns-3: 20 µs (no support for short slot time)
  - SIFS ns-2: 16 µs, ns-3: 10 µs

Random Walks: Delivery Ratio



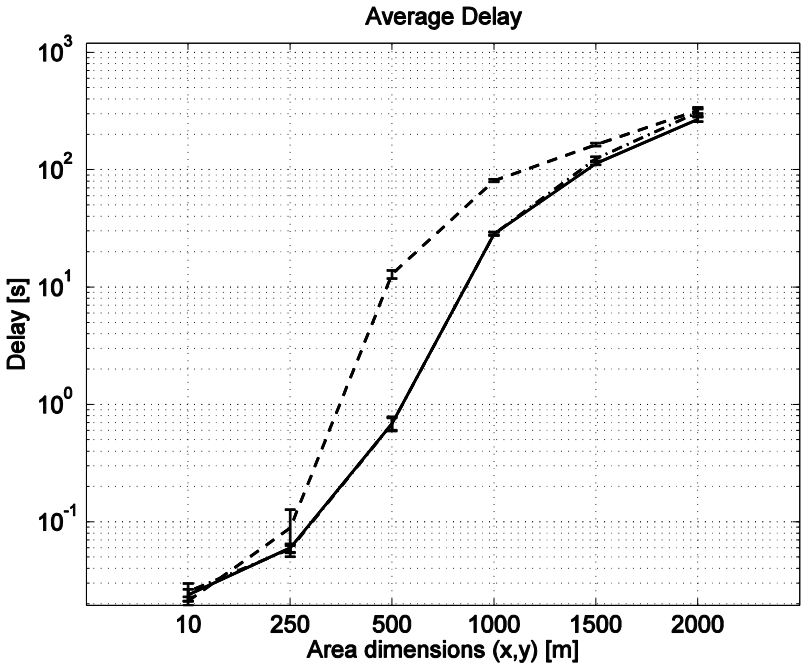
ns-2



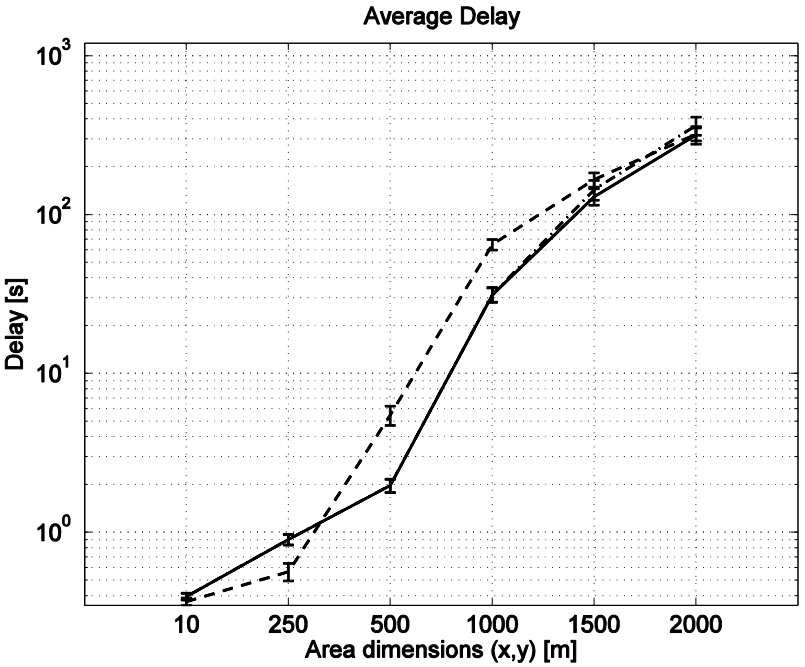
ns-3

Epidemic Routing
Binary Spray and Wait
Epidemic Routing + CC

Random Walks: Average Delay



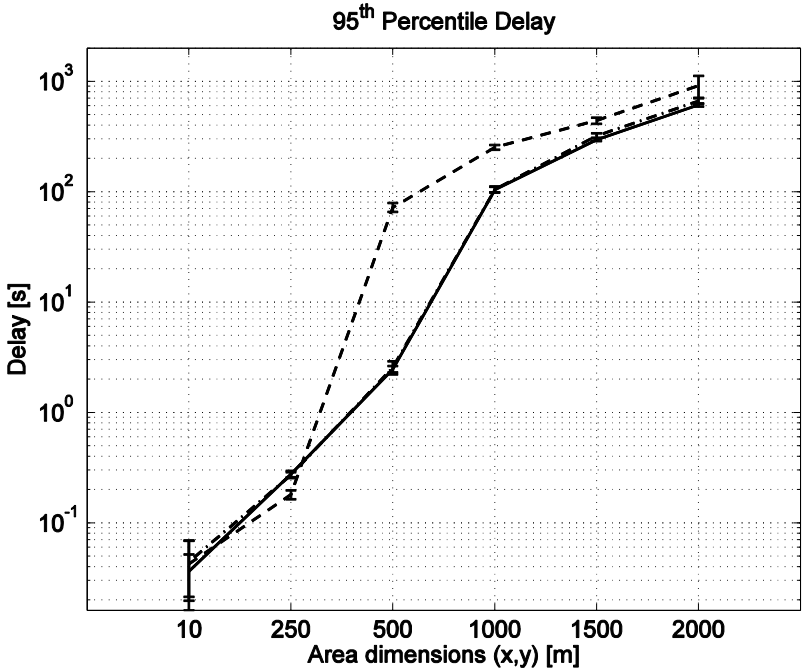
ns-2



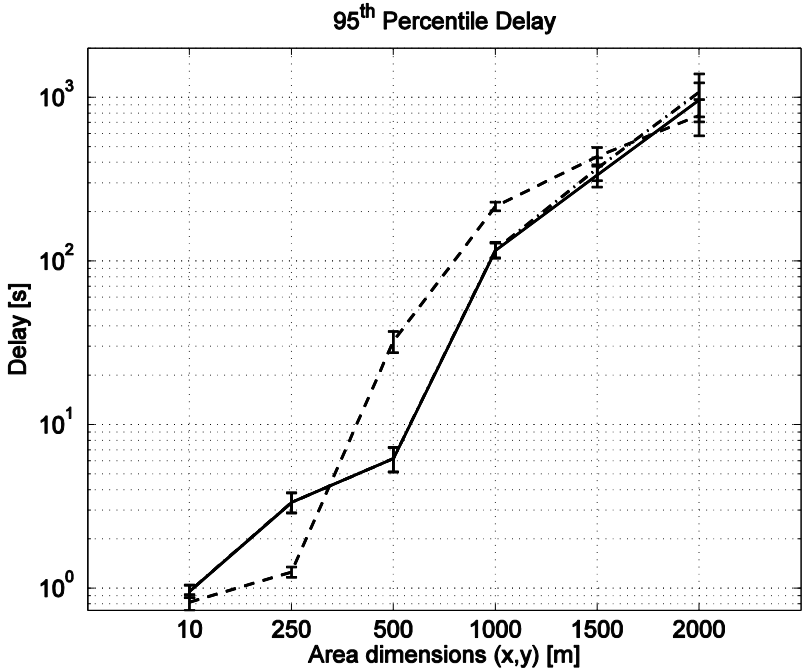
ns-3

Epidemic Routing
Binary Spray and Wait
Epidemic Routing + CC

Random Walks: 95th Percentile Delay



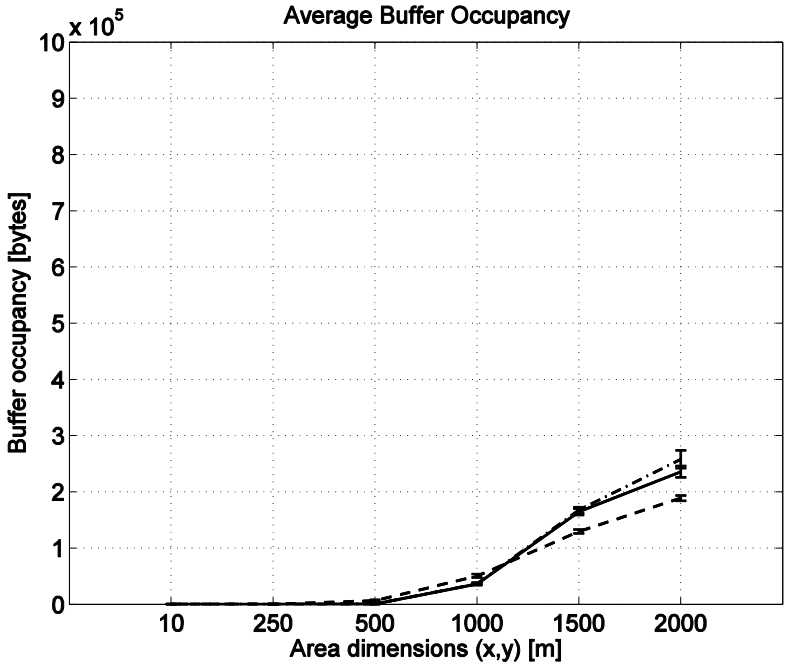
ns-2



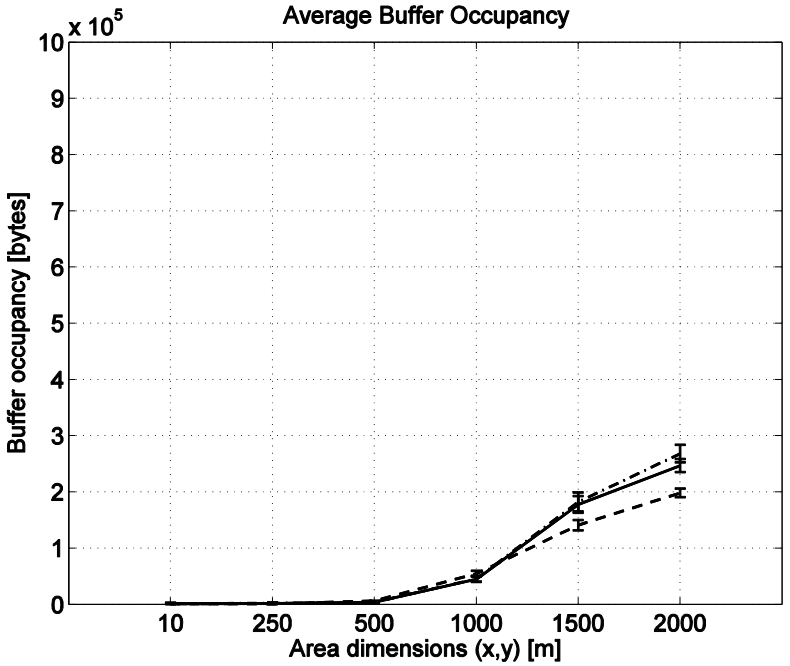
ns-3

Epidemic Routing
Binary Spray and Wait
Epidemic Routing + CC

Random Walks: Average Buffer Occupancy



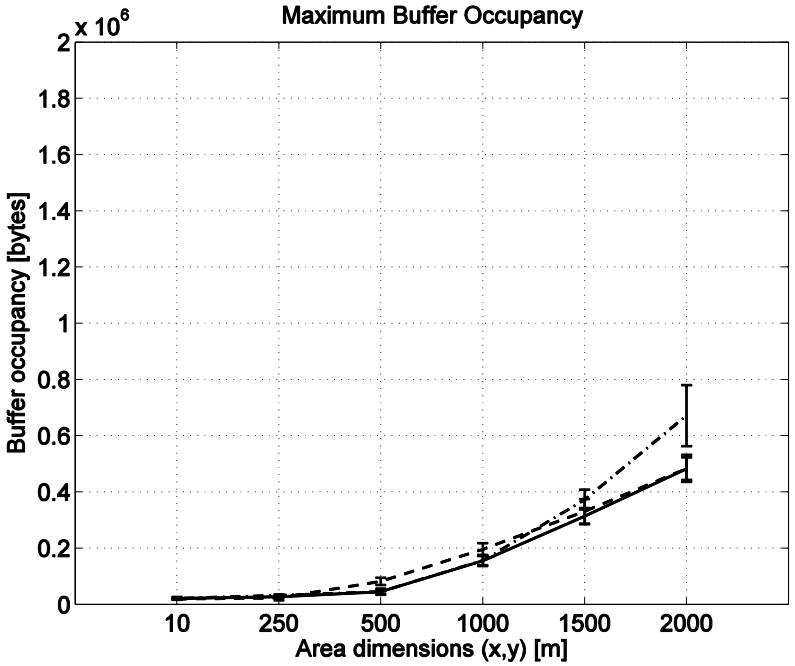
ns-2



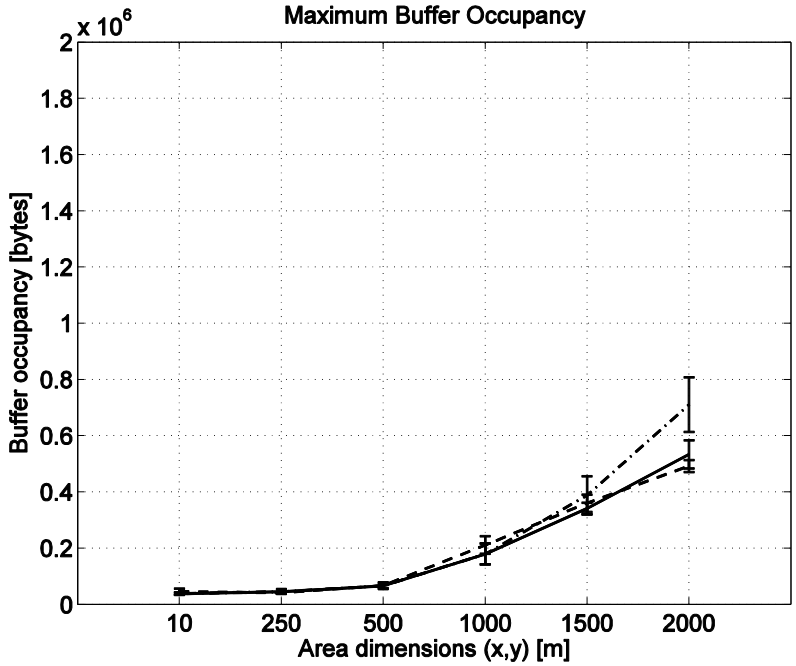
ns-3

Epidemic Routing
Binary Spray and Wait
Epidemic Routing + CC

Random Walks: Maximum Buffer Occupancy



ns-2



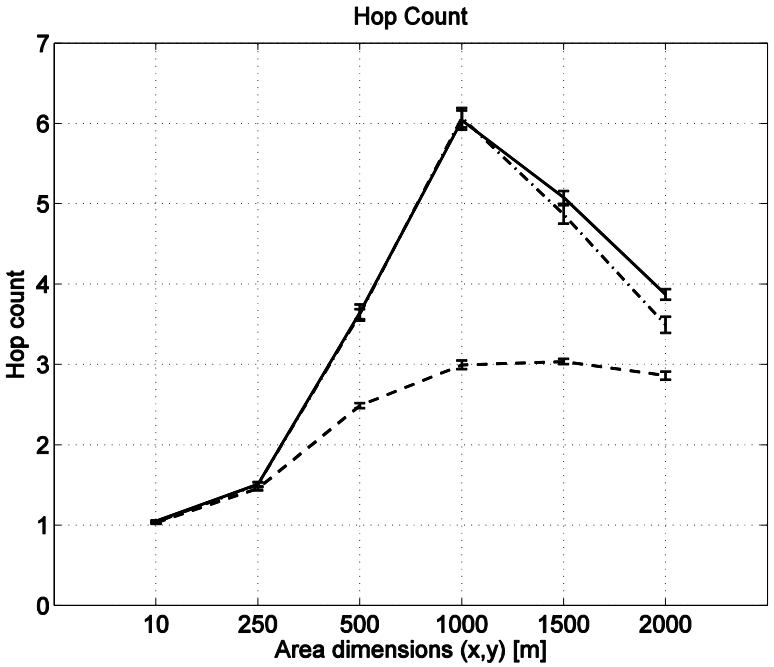
ns-3

Epidemic Routing

Binary Spray and Wait

Epidemic Routing + CC

Random Walks: Hop Count



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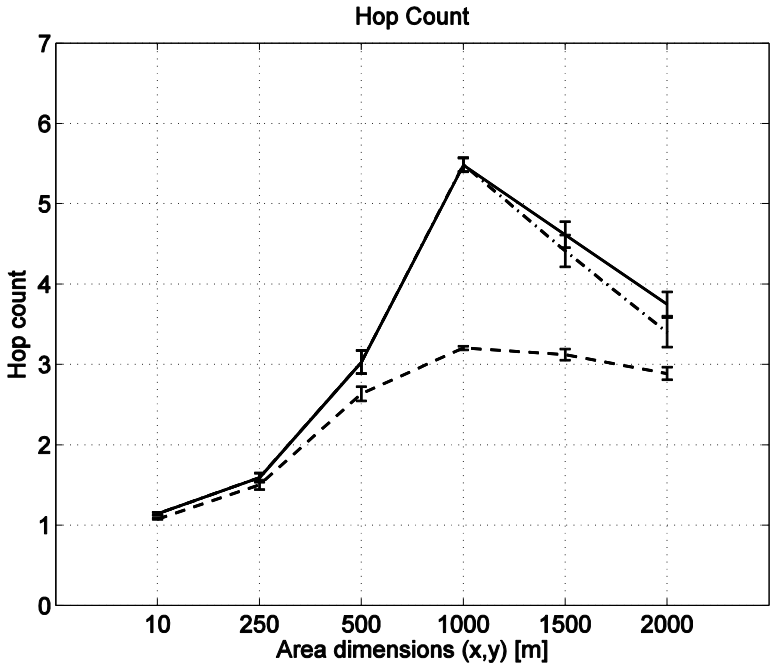
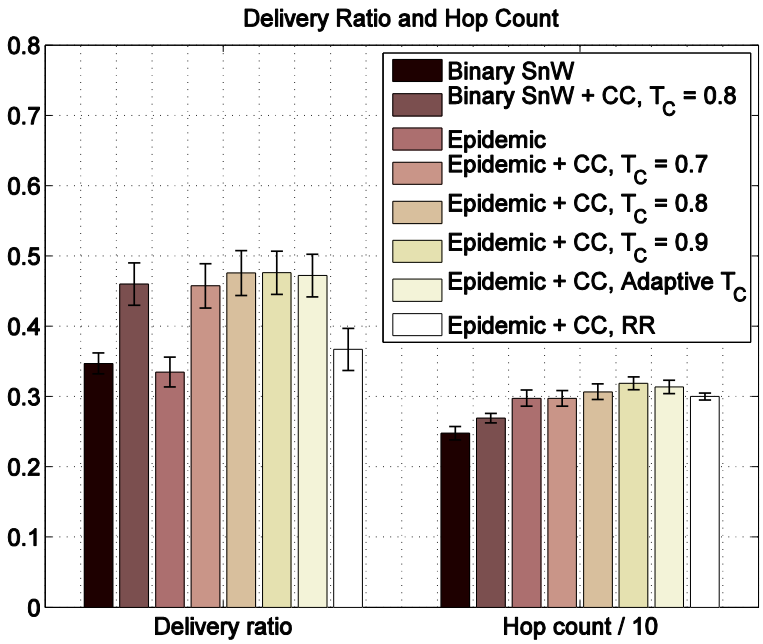


ns-3

Epidemic Routing
Binary Spray and Wait
Epidemic Routing + CC

SF Trace: Delivery Ratio and Hop Count



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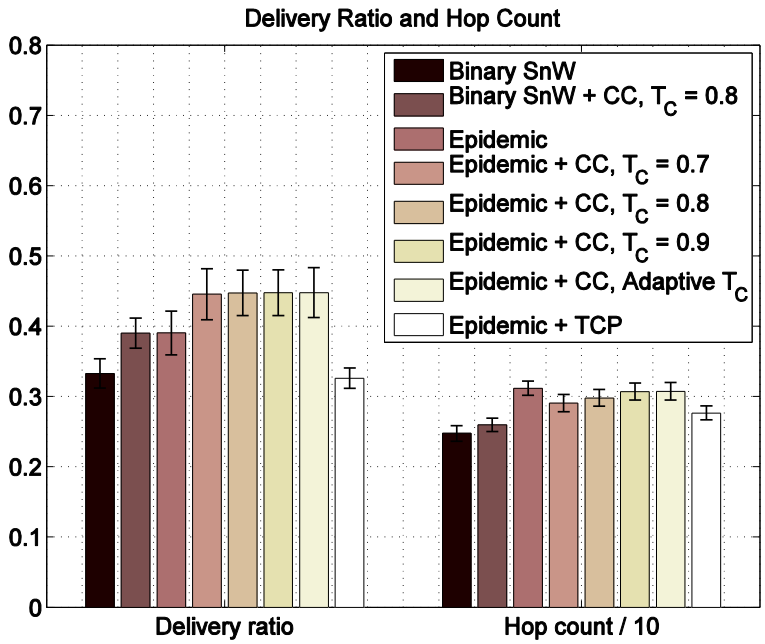

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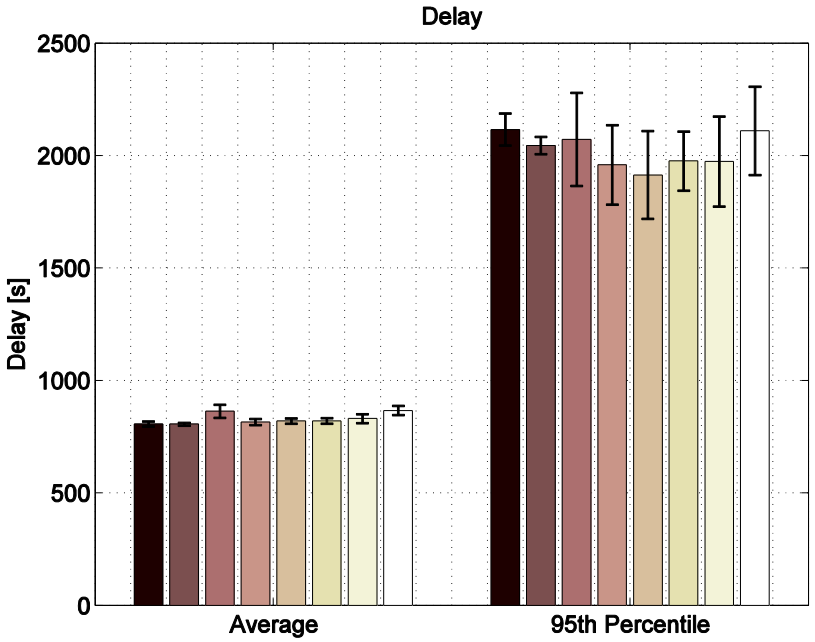
SF Trace: Delay



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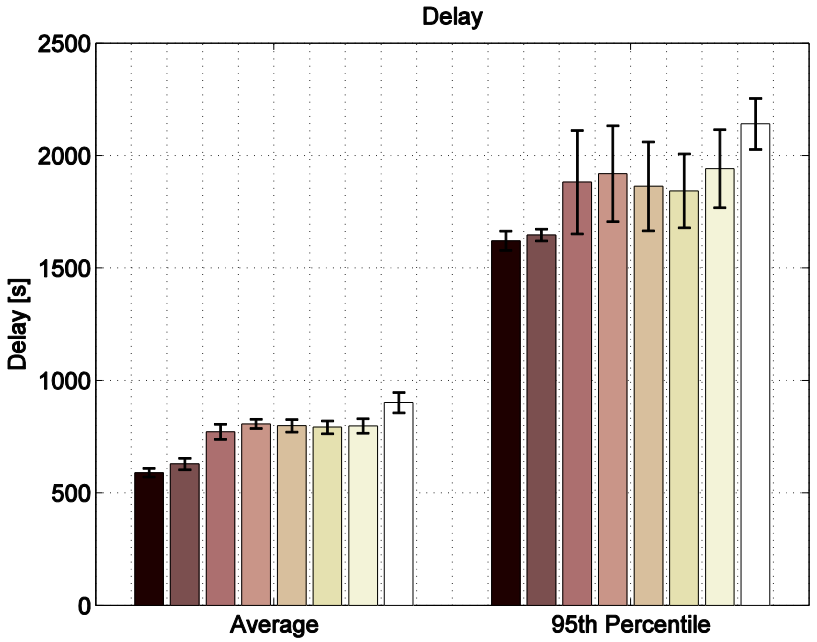
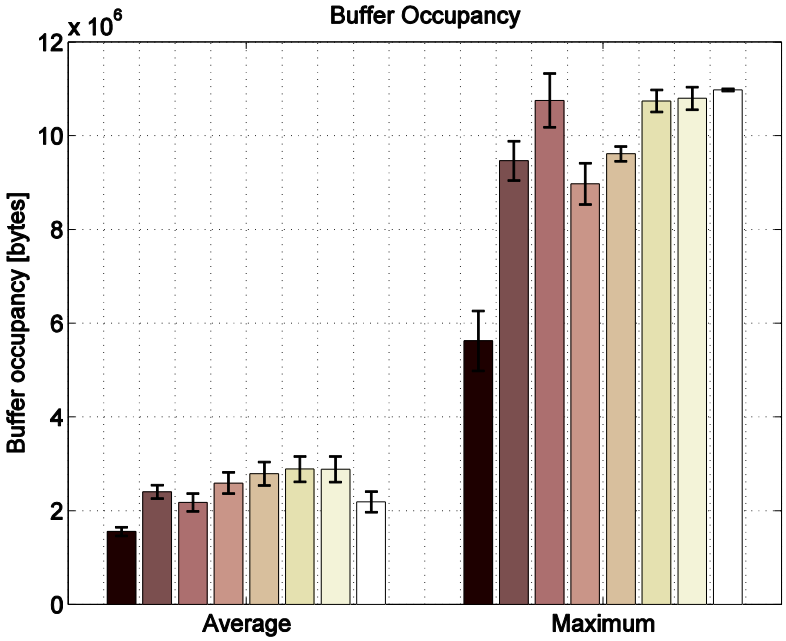


ns-3

SF Trace: Buffer Occupancy



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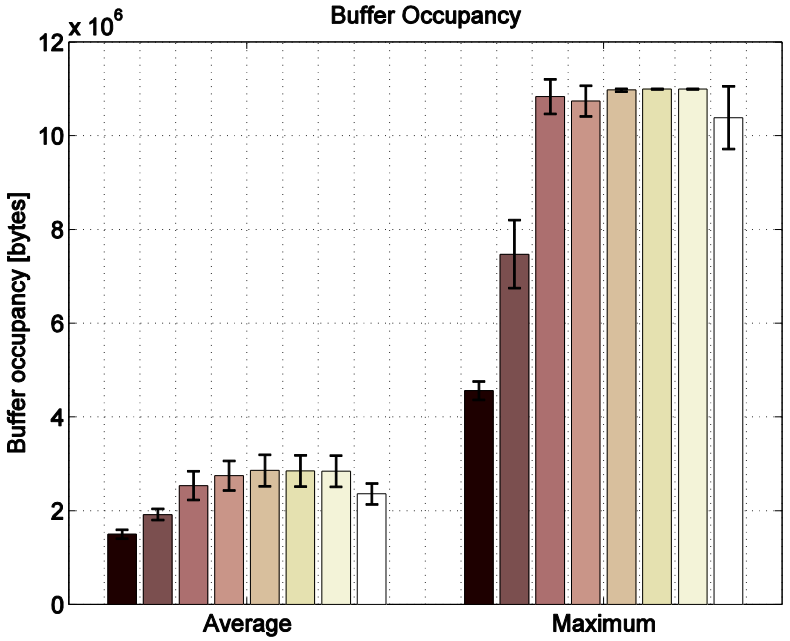
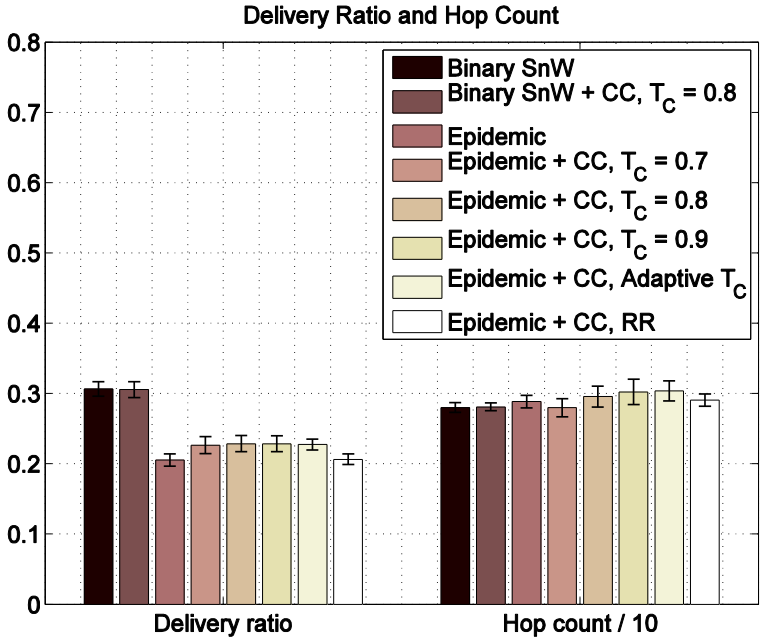
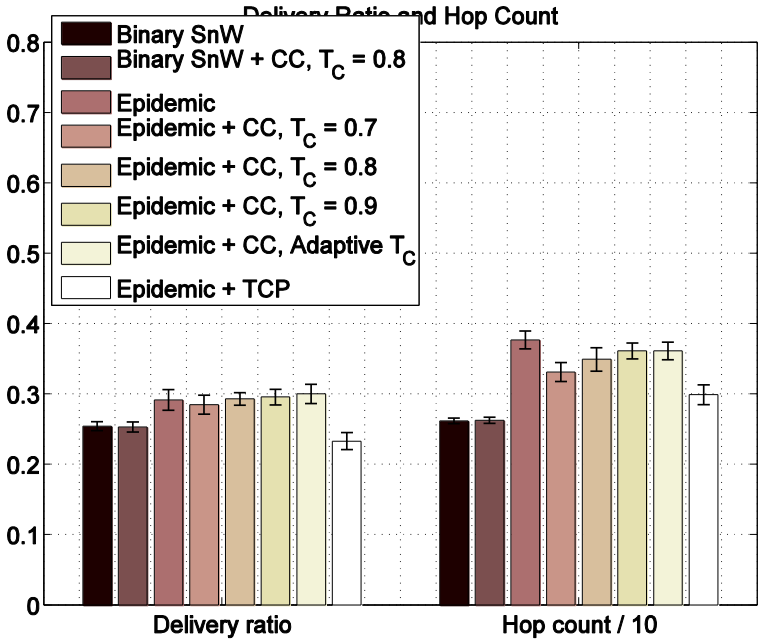


ns-3

Helsinki Trace: Delivery Ratio and Hop Count



ns-2



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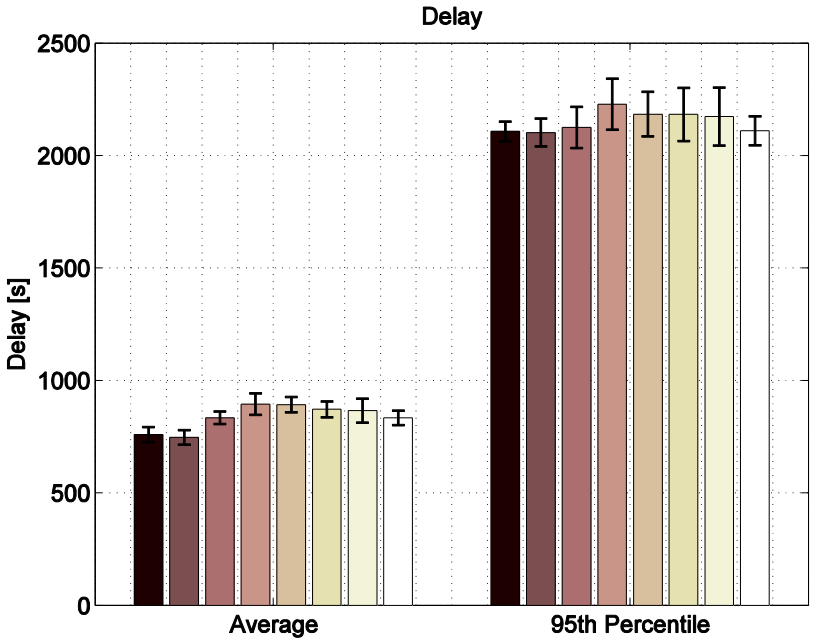
Helsinki Trace: Delay



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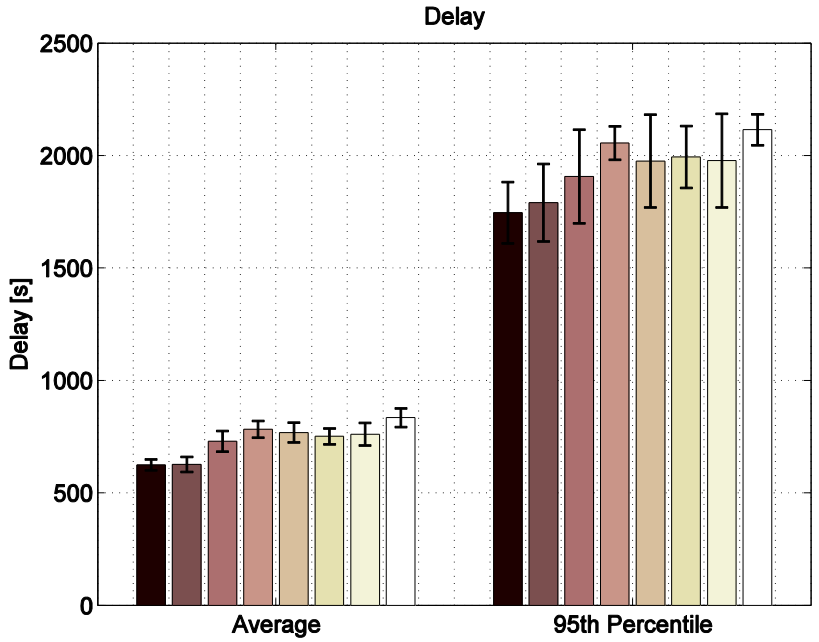
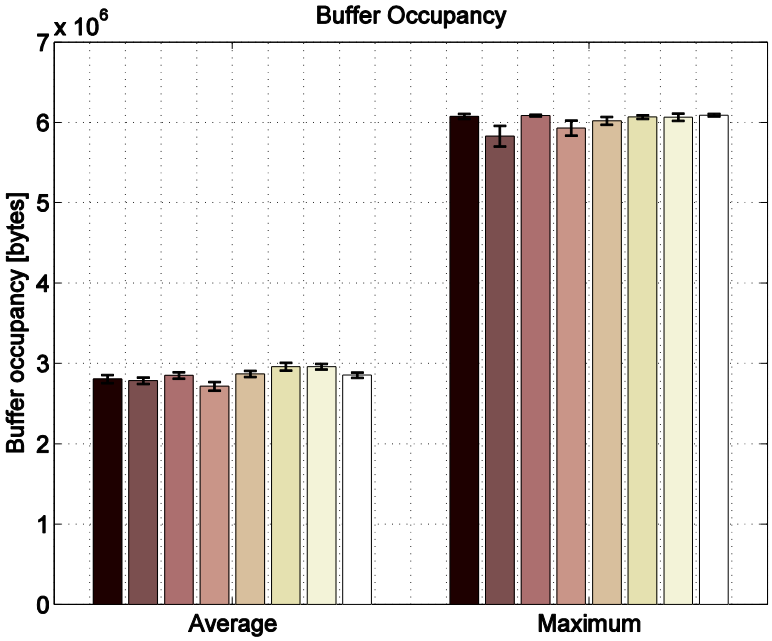


ns-3

Helsinki Trace: Buffer Occupancy



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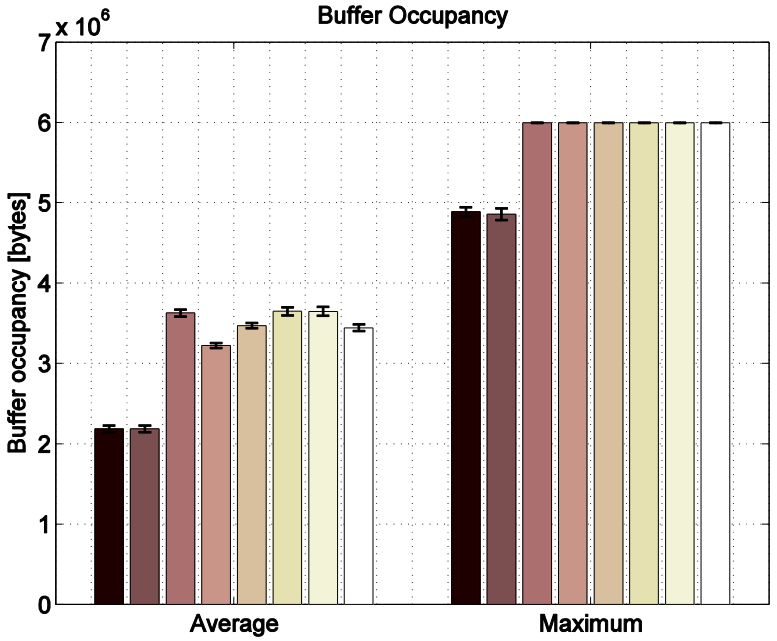

ns-3

References

1. A. Vahdat and D. Becker, “Epidemic routing for partially connected ad hoc networks,” tech. rep., Duke University, April 2000.
2. T. Spyropoulos, K. Psounis, and C. Raghavendra, “Spray and wait: an efficient routing scheme for intermittently connected mobile networks,” Proceedings of the 2005 ACM SIGCOMM Workshop on Delay-Tolerant Networking, Philadelphia, PA, USA, Aug. 22–26, 2005, pp. 252-259.
3. Z.J. Haas and T. Small, “A new networking model for biological applications of ad hoc sensor networks,” IEEE/ACM Trans. Netw., 14, 1, Feb. 2006, pp. 27–40.
4. B.D. Walker, J.K. Glenn, and T.C. Clancy, “Analysis of Simple Counting Protocols for Delay-Tolerant Networks,” CHANTS'07, Sep. 2007, Montréal, Québec, Canada.