CSE-322

(Computer Networking Sessional)

Report on NS2-Offline

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1. Personalized Parameters

1.1 Wireless MAC Type: IEEE 802.15.4

- A standard for low rate wireless communications in Wireless Personal Area Networks.
- For short distance communication as in home automation systems, medical devices, and industrial automation systems.
- Key features: low power consumption, low cost, and low data rates (250 kbps or less)
- Designed to communicate in 2.4 GHz ISM band
- **NB:** *There were complications in the 802.15.4 + AODV combination in the ns2 simulation, so all data was collected using IEEE 802.11 instead. Details are mentioned later.*

1.2 Routing Protocol: AODV (Ad-hoc On-demand Distance Vector)

- AODV is a routing protocol for mobile ad-hoc networks (MANETs).
- Reactive Protocol that only establishes routes between nodes when they are needed to transmit data
- Helps conserve network resources and reduce control overhead
- Good for low bandwidth, dynamic topology changes and high mobility

1.3 Agent: TCP Reno

- TCP Reno is a TCP congestion control algorithm (An improved Version of TCP Tahoe)
- Slow-start: sender starts with a small congestion window and gradually increases this until maximum window size reached or packet loss occurs
- Fast Retransmit: Immediately retransmit lost packet without waiting for a timeout
- Fast Recovery: After retransmitting lost data, sends new data at a lower rate to allow retransmission as well as recovery from congestion

1.4 Application: FTP

- FTP is an application layer protocol that enables file transfer between client and server.
- Client initiates a connection to the server and requests a file transfer
- Server responds by either granting or denying the request; then the transfer takes place
- Has some security issues and is being replaced by SFTP, HTTPS, SCP

1.5 Node Positioning: Grid

- Row and column numbers aimed to evenly distribute nodes in a square.
- Inter-node distance aimed to utilize entire specified area of network.

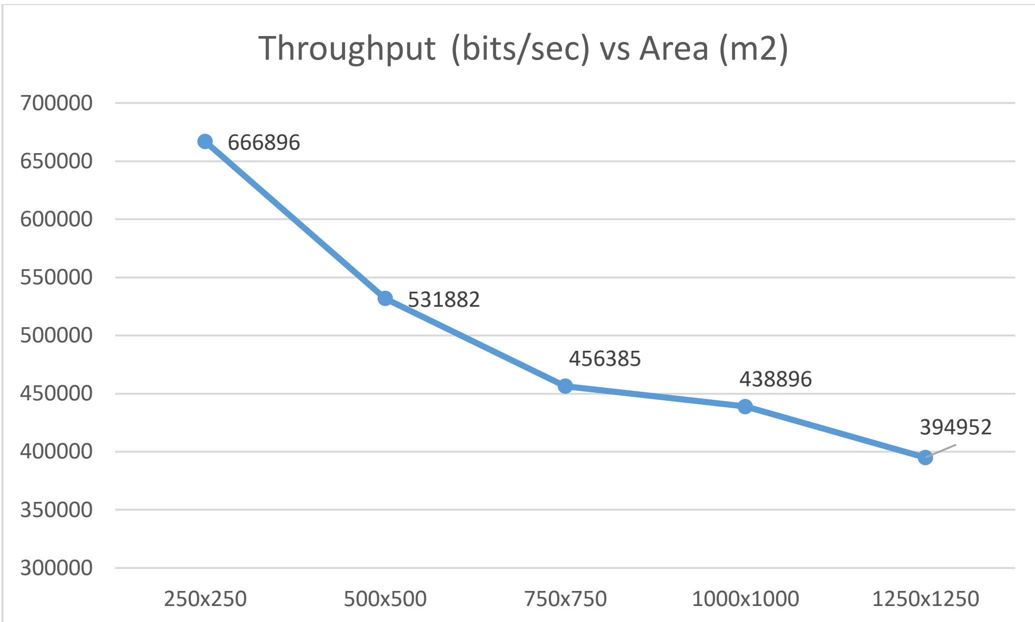
1.6 Flow: 1 Sink, Random Source

- Choose a random sink X, then for each flow choose any other node as source.

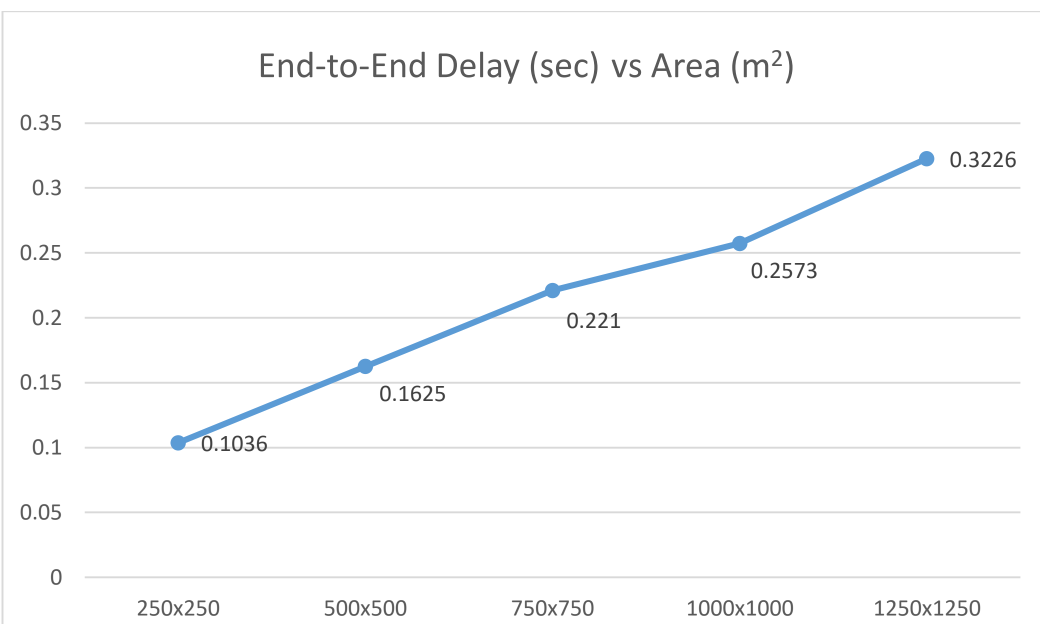
2. Graphs:

2.1 Varying Area Size:

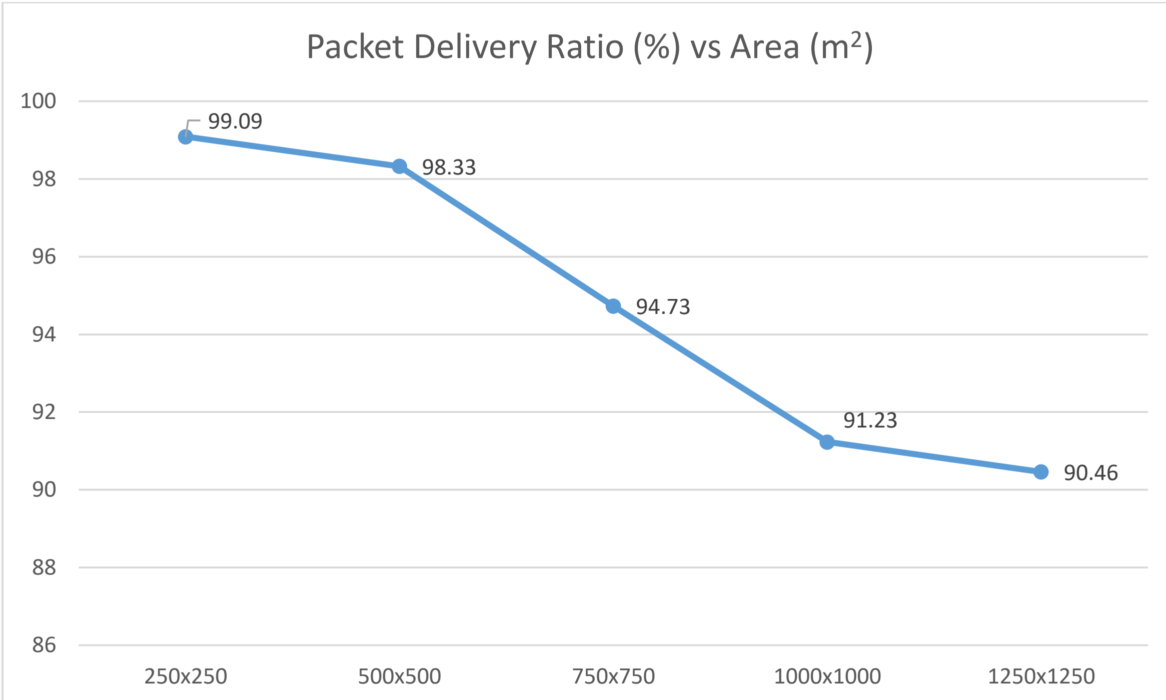
2.1.1 Throughput vs Area



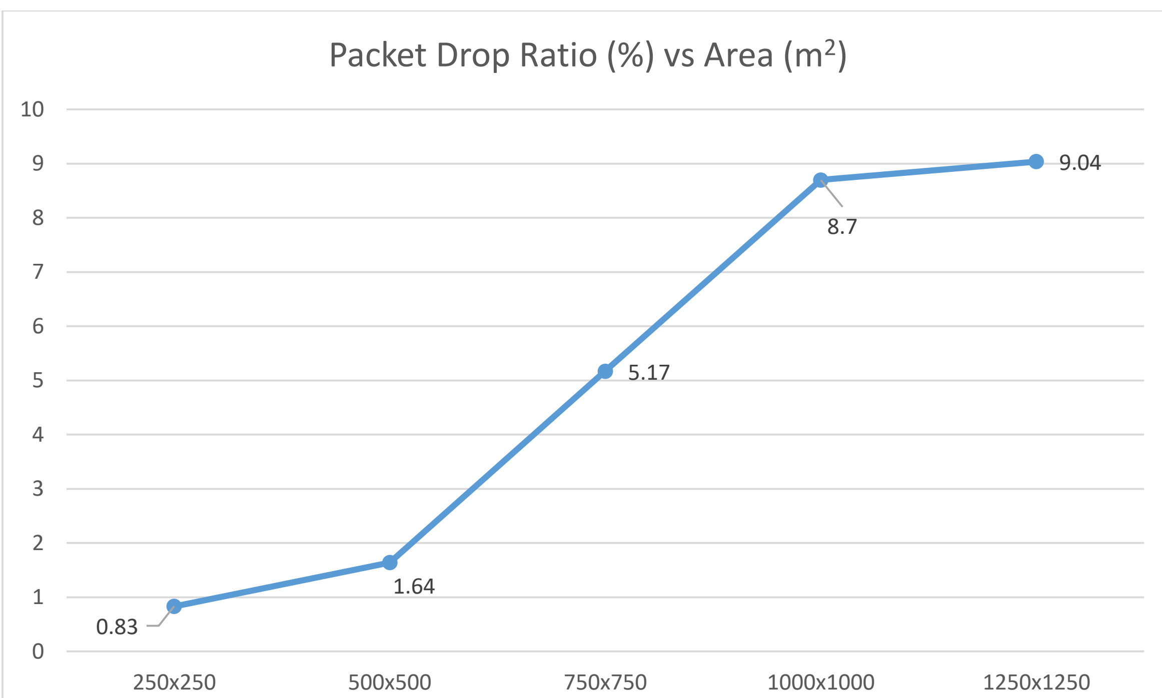
2.1.2 End to End Delay vs Area



2.1.3 Packet Delivery Ratio vs Area

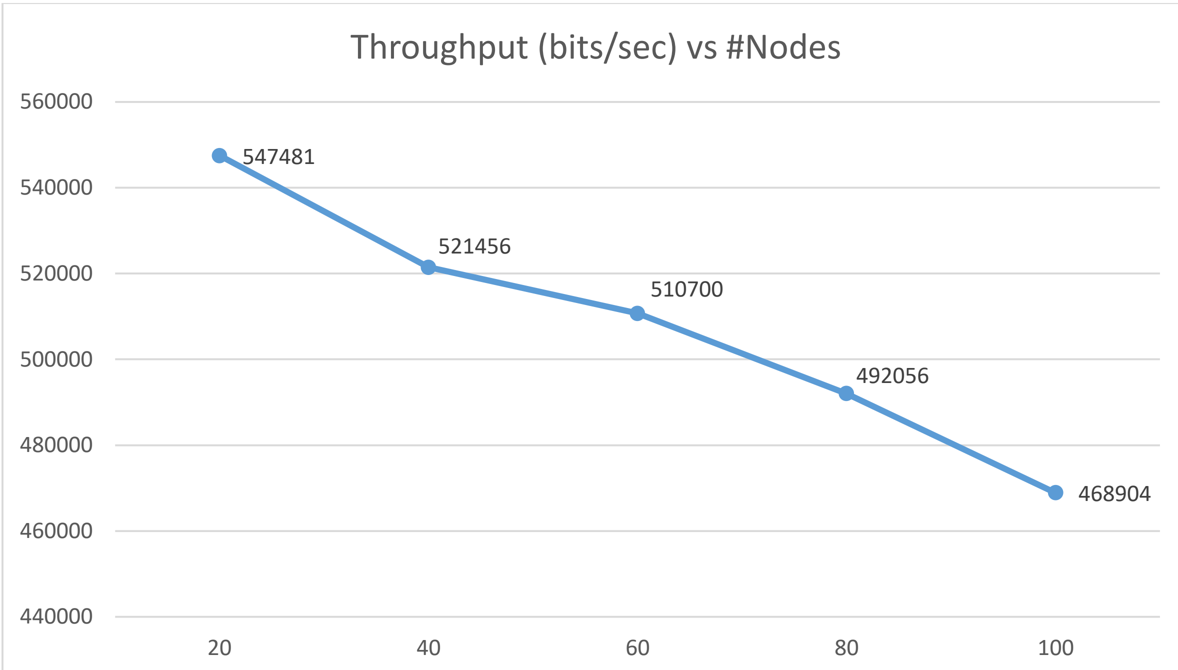


2.1.4 Packet Drop Ratio vs Area

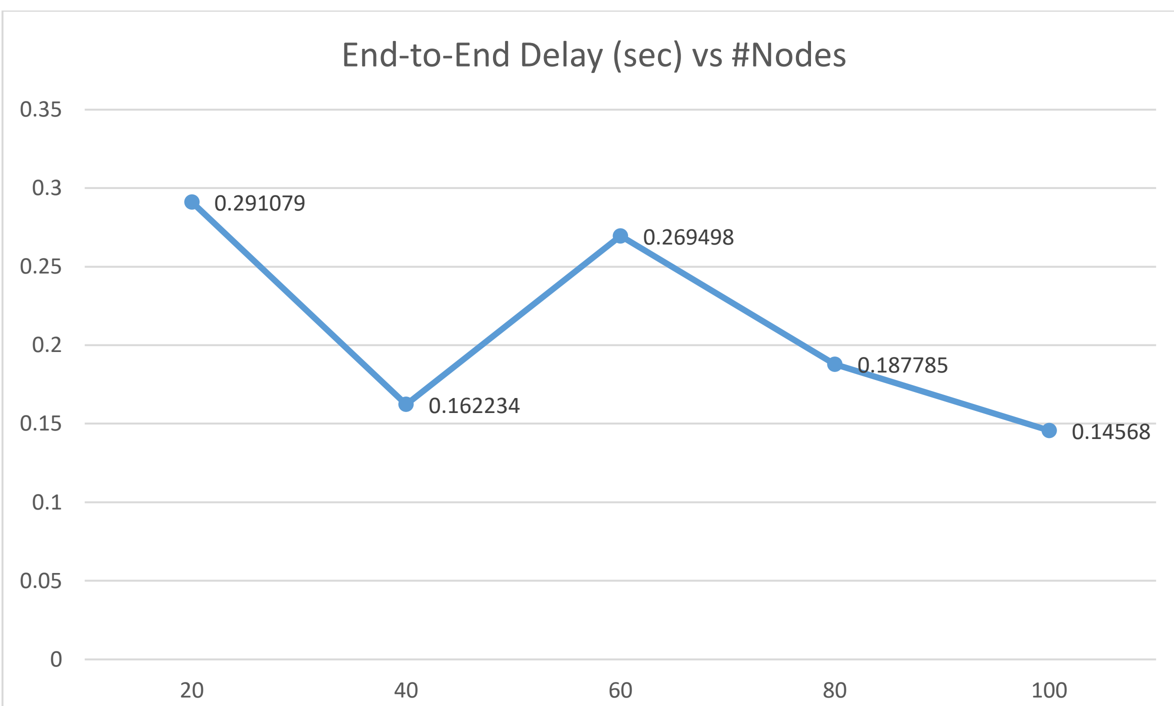


2.2 Varying Number of Nodes:

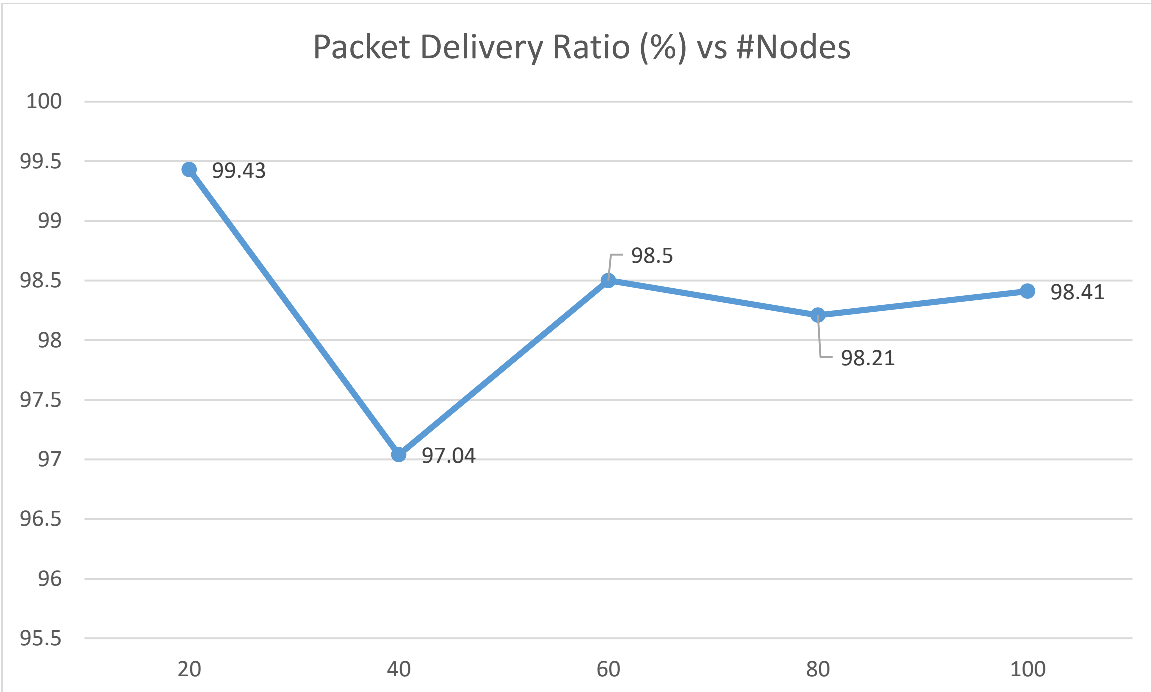
2.2.1 Throughput vs Number of Nodes



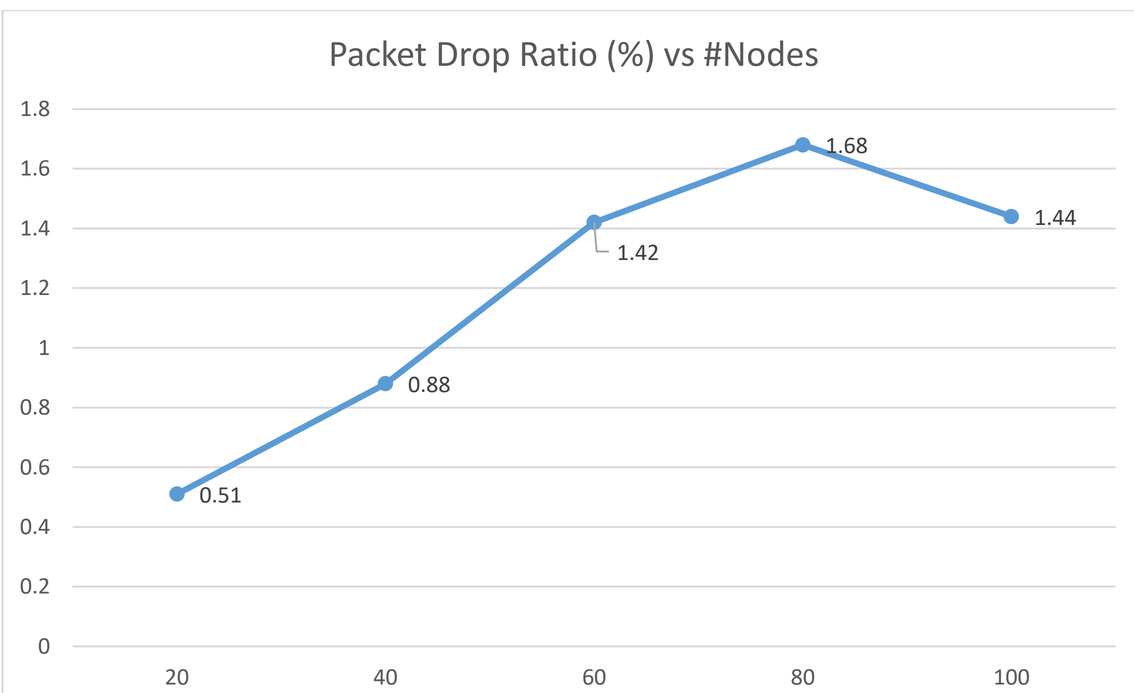
2.2.2 End to End Delay vs Number of Nodes



2.2.3 Packet Delivery Ratio vs Number of Nodes

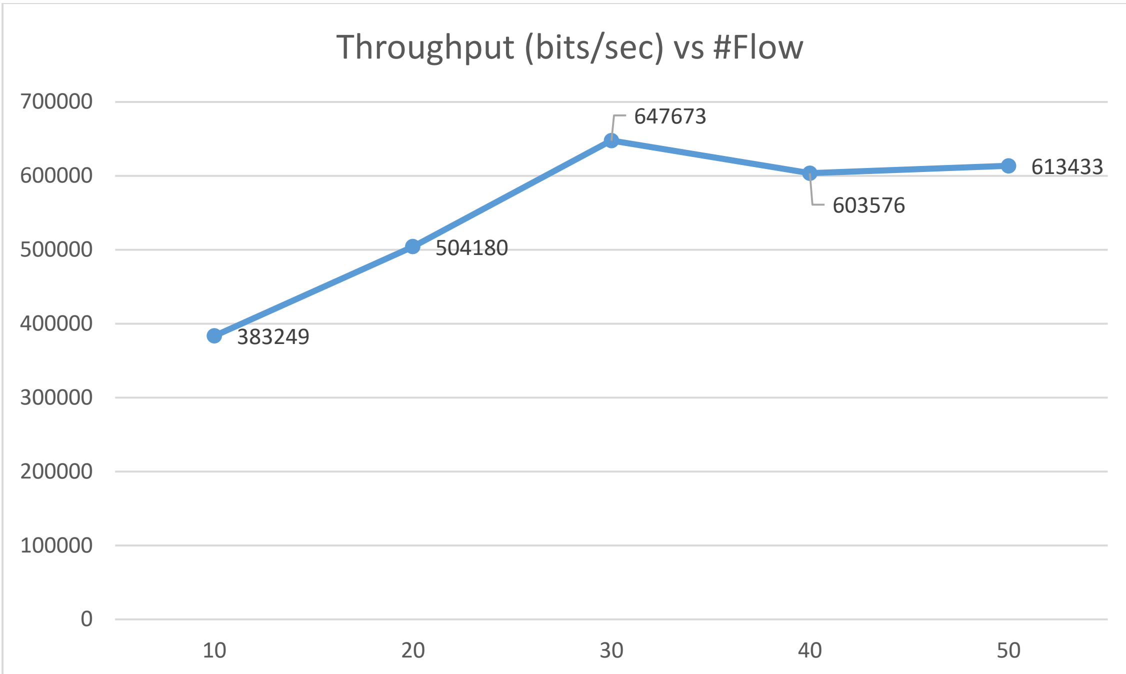


2.2.4 Packet Drop Ratio vs Number of Nodes

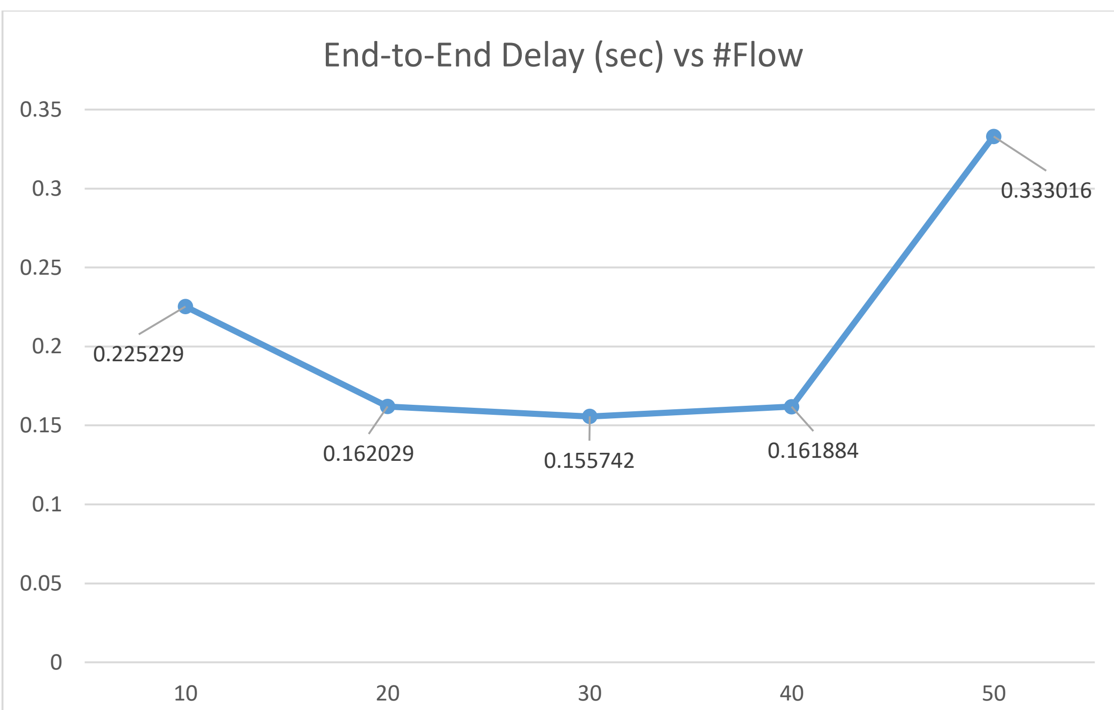


2.3 Varying Number of Flows:

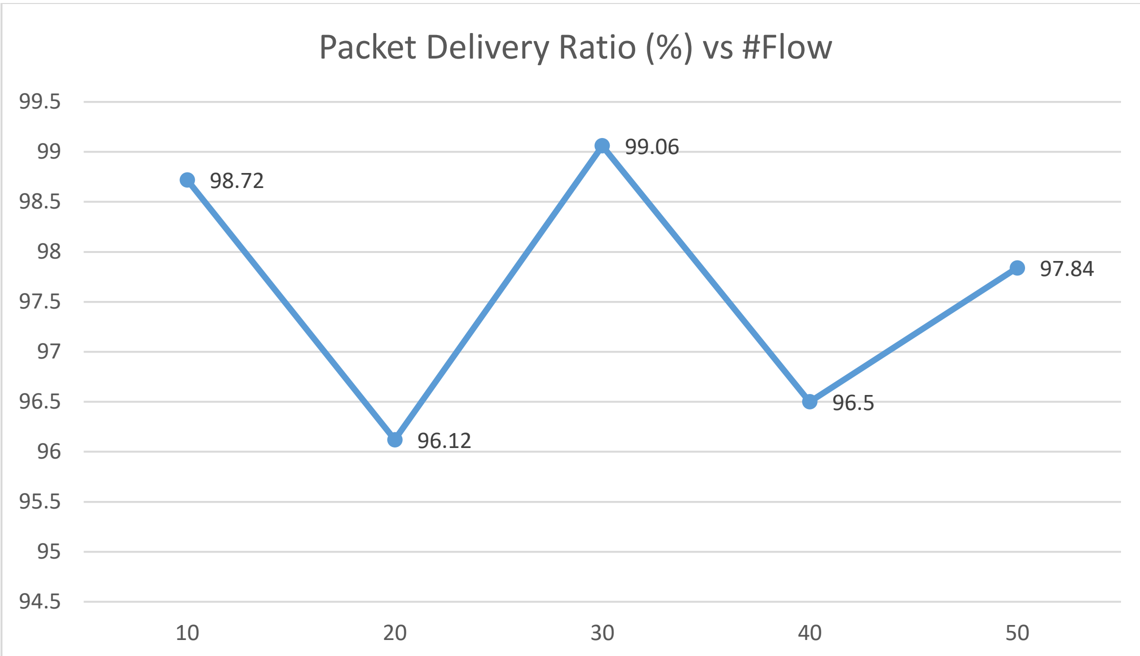
2.3.1 Throughput vs Number of Flows



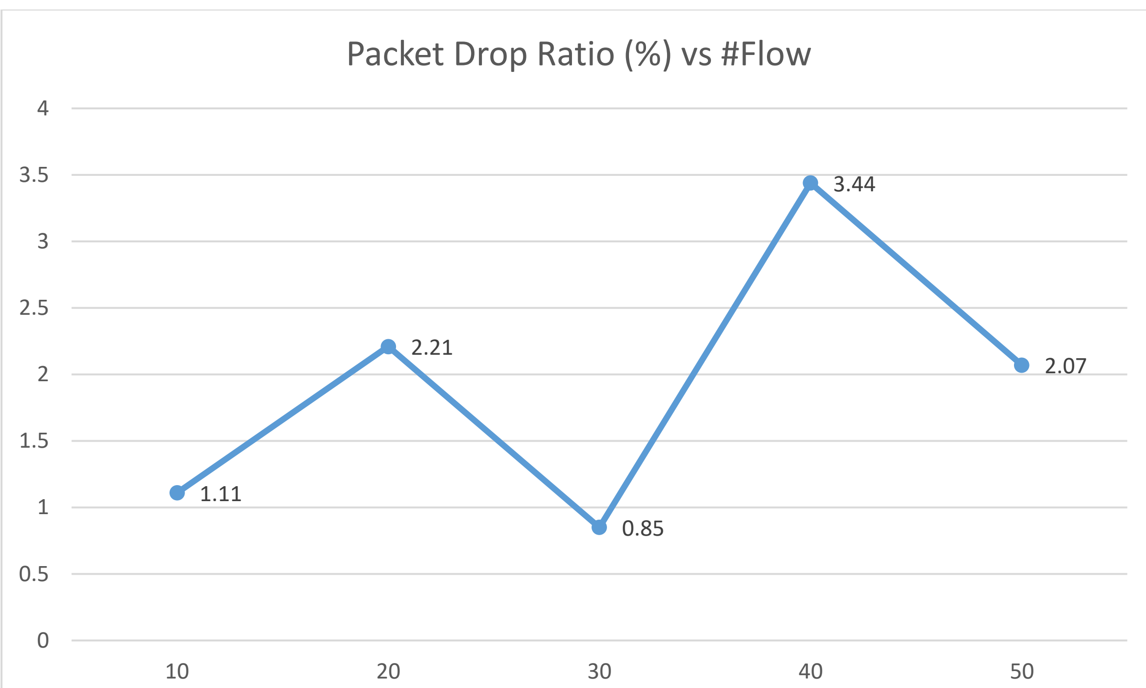
2.3.2 End to End Delay vs Number of Flows



2.3.3 Packet Delivery Ratio vs Number of Flows



2.3.4 Packet Drop Ratio vs Number of Flows



3. Observations / Discussions:

- A major point of discussion is the negative throughput that arises when using the combination of (Agent) IEEE 802.15.4 and (Routing protocol) AODV.
    - Data bytes = (packet_size – header_size), and TCP header size is fixed at 20 Bytes
    - Some TCP packets seem to have a size of 16 bytes (including header), which should not be possible.
    - As such, data byte counts to -4, and consequently, throughput = (Σ data bytes) / time evaluates to negative
    - Since no possible reason/ solution to the above problem was found at the time of conducting data collection, the Agent type was switched to IEEE 802.11
- Packets delivery rate + Packet Drop rate ≠ 1. This is because even after simulation ends, some packets are on the way. These are count as sent, but never received or dropped. So the sum is always less than 1
- Trends for change in area:
    - The throughput uniformly decreases with increase in area. Probable explanation may include decrease in transmission strength with increase in distance of transmission.
    - End to end delay increase is also expected since distance between nodes also increase
    - Decrease in packet delivery rate (and consequently increase in packet drop rate) is observed with increasing distance
- But the change in observed parameters for the other two cases (change in #node and #flow) is not as uniform as in the previous case. Randomness in data can be observed in most cases.
- Trends with increase in #nodes,
    - Throughput decreases, since random sources may be further from the source, requiring more jumps and getting lost in the process
    - Packet delivery ratio decreases, and packet loss increases for the same reason
    - No observable trend for End to end delay from collected data

- Trends with increase in #flow,
    - Throughput increases, by definition.
    - The other observable parameters do not seem to follow any specific trend.

4. Appendix:

4.1 Definitions:

4.1.1 Throughput:

$$\frac{(\ \Sigma\ (\mathrm{PacketSize}-\ \mathrm{HeaderSize})*\ 8)}{\mathrm{time}}\ (\mathrm{bits/sec})$$

4.1.2 End-to-End Delay:

$$\frac{\Sigma\ (\mathrm{receivedTime}-\ \mathrm{sentTime})}{\mathrm{totalPacketCount}}\ (sec)$$

4.1.3 Packet Delivery Ratio:

$$\frac{ReceivedPackets}{SentPackets}*100\ \%$$

4.1.4 Packet Drop Ratio:

$$\frac{DroppedPackets}{SentPackets}*100\ \%$$

4.2 Chart:

		Throughput (bits/sec)	End-to-End Delay (sec)	Packet Delivery Ratio (%)	Packet Drop Ratio (%)
Area	250x250	666896	0.1036	99.09	0.83
	500x500	531882	0.1625	98.33	1.64
	750x750	456385	0.221	94.73	5.17
	1000x1000	438896	0.2573	91.23	8.7
	1250x1250	394952	0.3226	90.46	9.04
Nodes	20	547481	0.291079	99.43	0.51
	40	521456	0.162234	97.04	2.21
	60	510700	0.269498	98.5	1.42
	80	492056	0.187785	95.65	4.31
	100	468904	0.14568	98.41	1.44
Flow	10	383249	0.225229	98.72	1.11
	20	504180	0.162029	96.12	3.83
	30	647673	0.155742	99.06	0.85
	40	603576	0.161884	96.5	3.44
	50	613433	0.333016	97.84	2.07