NWS Assignment 3 Report

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Introduction:

In this assignment, impact of RTS-CTS on 802.11 MAC performance is studied by creating Hidden node situation and then measuring Throughput, Packet Loss and number of Collisions with RTS-CTS enabled and disabled. In Part B of the assignment, a new backoff algorithm is proposed which performs better than the default algorithm for some cases.

PART A

Experiment:

A 802.11n BSS with ESSID "ASG3" consisting of one AP and 30 client stations (STAs) is created. AP and Server (remote host) are connected to the Internet (Cloud) over pointToPoint connection of datarate 100 Mbps and 2ms propagation delay. Clients are placed at uniformly random locations in the coverage area of AP in the BSS using ListPositionAllocator. ConstantPositionMobilityModel and FriisPropagationLossModel are used as Mobility model and pathloss model respectively.

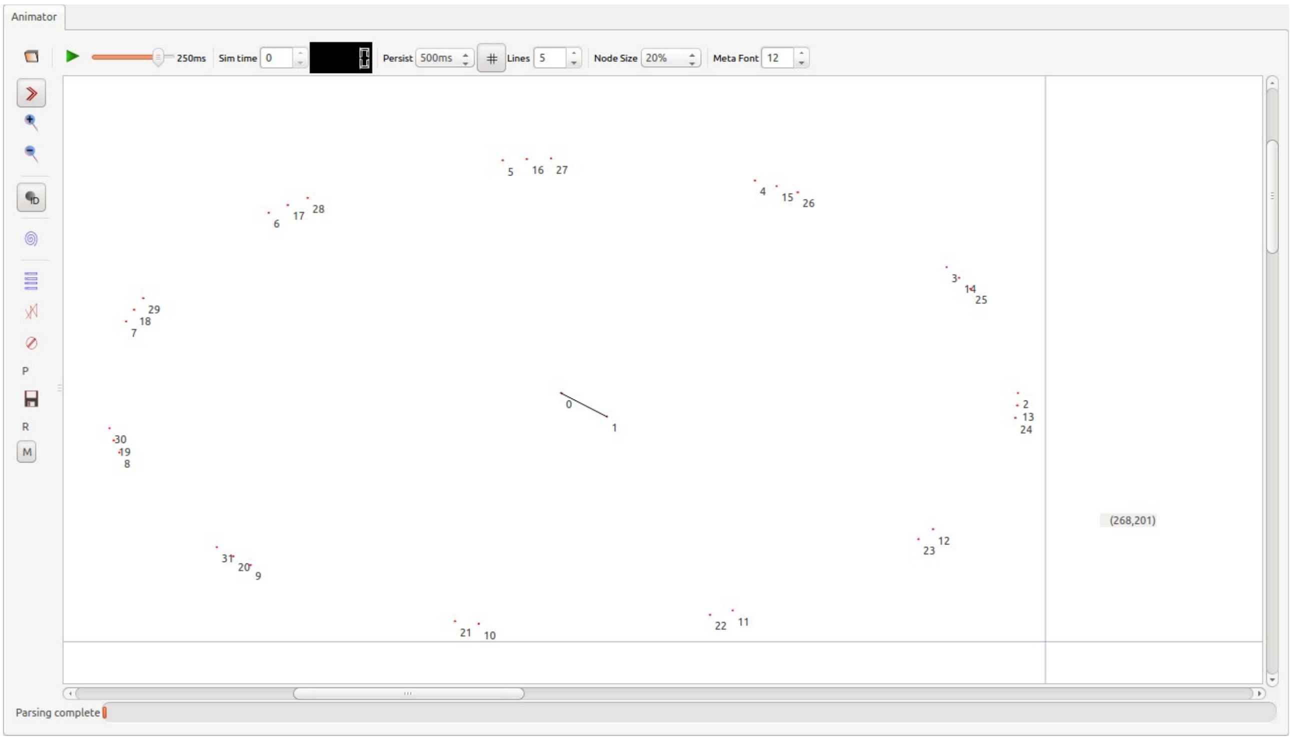


Fig. 1 : Position of 30 STAs and AP in the BSS

Hidden node problem is simulated by creating the following scenario: 1-hop BSS with radius 100 meters where every node with transmission range 100 meters can transmit/receive from the AP. Max distance between two STAs is 200 meters, e.g., S1-----AP------S2. Then a performance analysis of data trasnimssions is done based on the following cases:

1. Varying number of TCP flows by activating random stations,
2. Enabling and disabling RTS-CTS,
3. Uplink and downlink

For each of the above mentioned cases, the average results over 5 seeds are considered.

The same experiment is done with MSS (Payload Size) values of 512B and 1200B.

Note:
1. The following are the reasons are reported for RxDrop in Physical Channel by ns3:

[].

- Drop packet because plcp preamble/header reception failed
- Drop packet because of channel switching
- Drop packet because already in Rx
- Drop packet because already in Tx
- Drop packet because signal power too Small
- Drop packet because in sleep mode
- Drop packet because it was sent using an unsupported mode

Out of the above, only packet drop at "plcp preamble/header reception failed" is considered for the experiment as Collision due to interference with other stations.

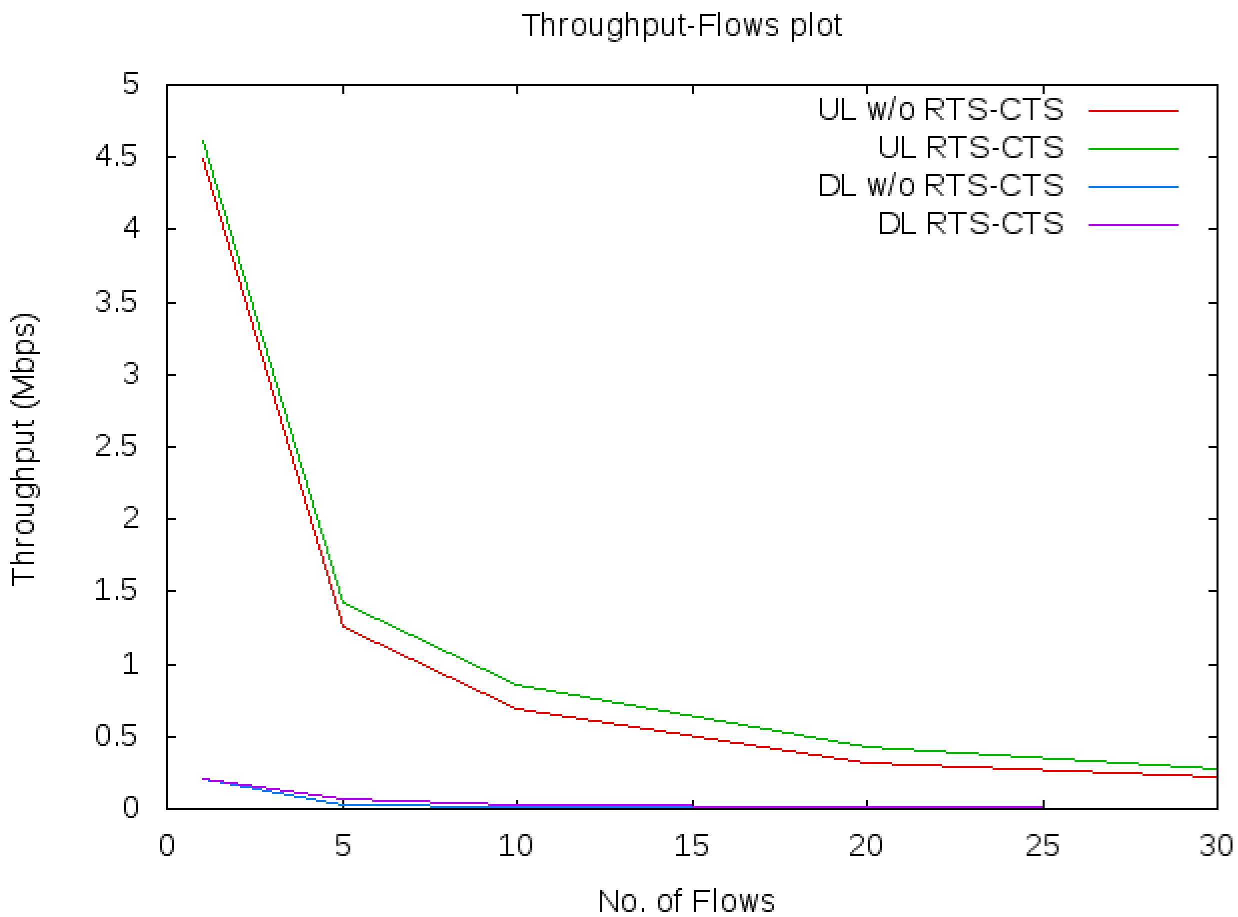
2. Use of Friis Propagation Loss Model.

[]. The RangePropagationLossModel had an error on not interpreting cumulative TCP Ack from TCP-Server. Hence, TCP Client was re-transmitting packets again and again, whose Ack was not being handled properly by TCP Client. Due to this, FriisPropagationLossModel was chosen for the experiment.

Result Set Analysis:

Result Set 1: (MSS=512B)

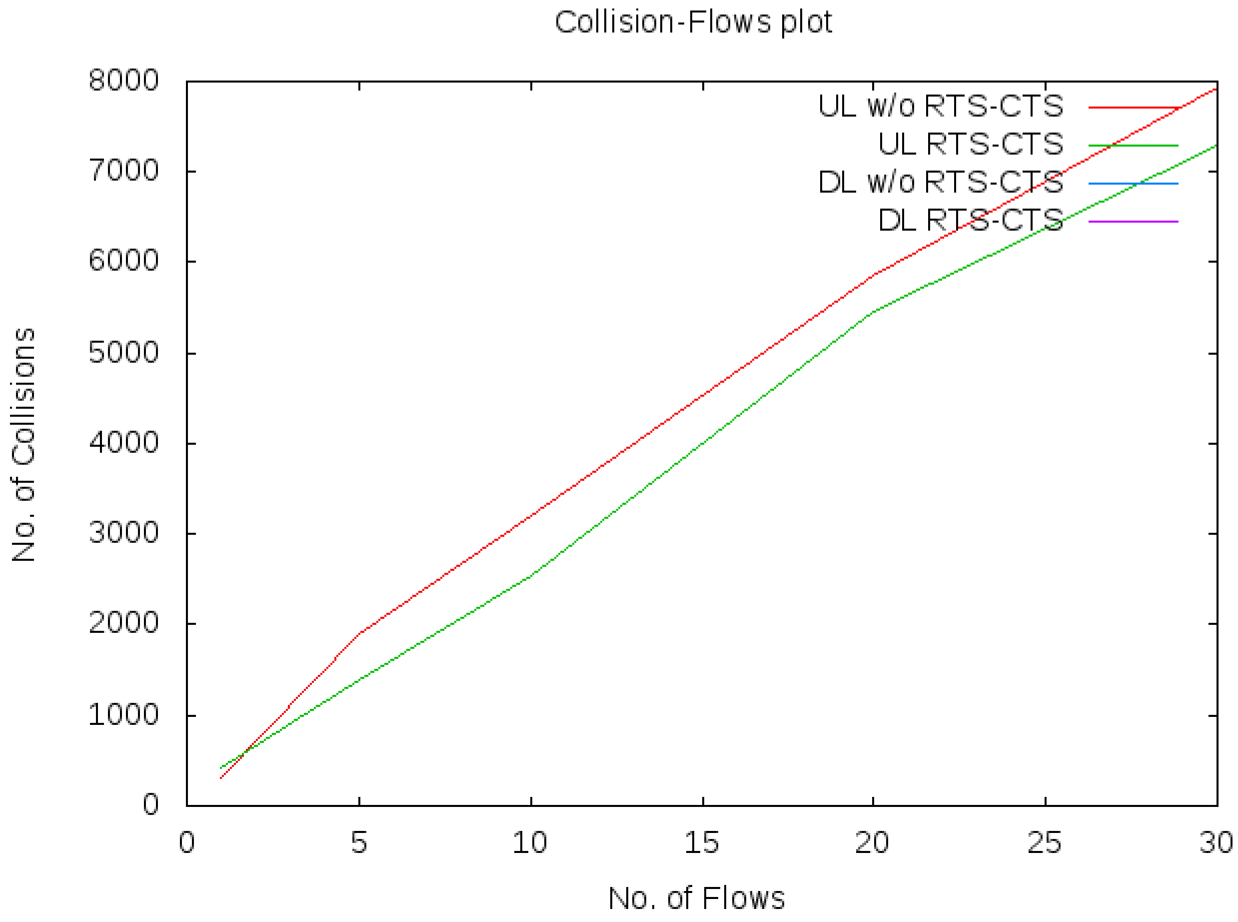
1. Throughput vs Number of Flows:



Observations:

- Throughput vs Flows: Throughput decreases with increase in number of flows because of the collsion among packets sent by different STAs.
- Throughput RTS-CTS vs Throughput w/o RTS-CTS : Throughput is more in case of RTS-CTS because RTS-CTS scheme avoids collision resulting due to Hidden Stations in the network.

2. No. Of collisions vs Number of Flows:

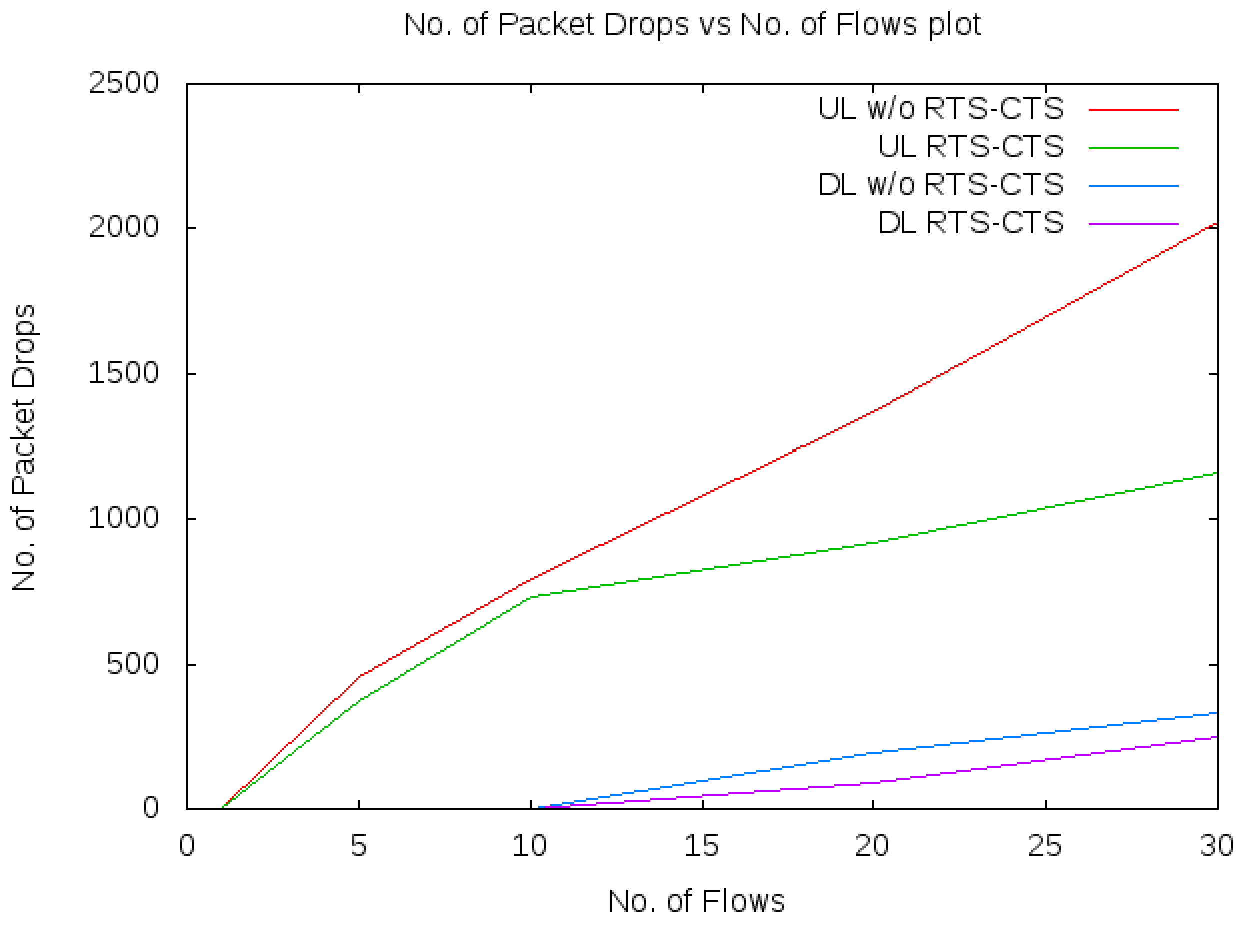


Observation:

- Collisions vs Flows: The no. Of collisions increases with increase in the no. of flows due to interference/collision with the packets of other stations.

- RTS-CTS collision vs w/o RTS-CTS collision: The number of collisions is less in RTS-CTS scenario compared to w/o RTS-CTS scenario.

3. No of packet drops vs Number of Flows:



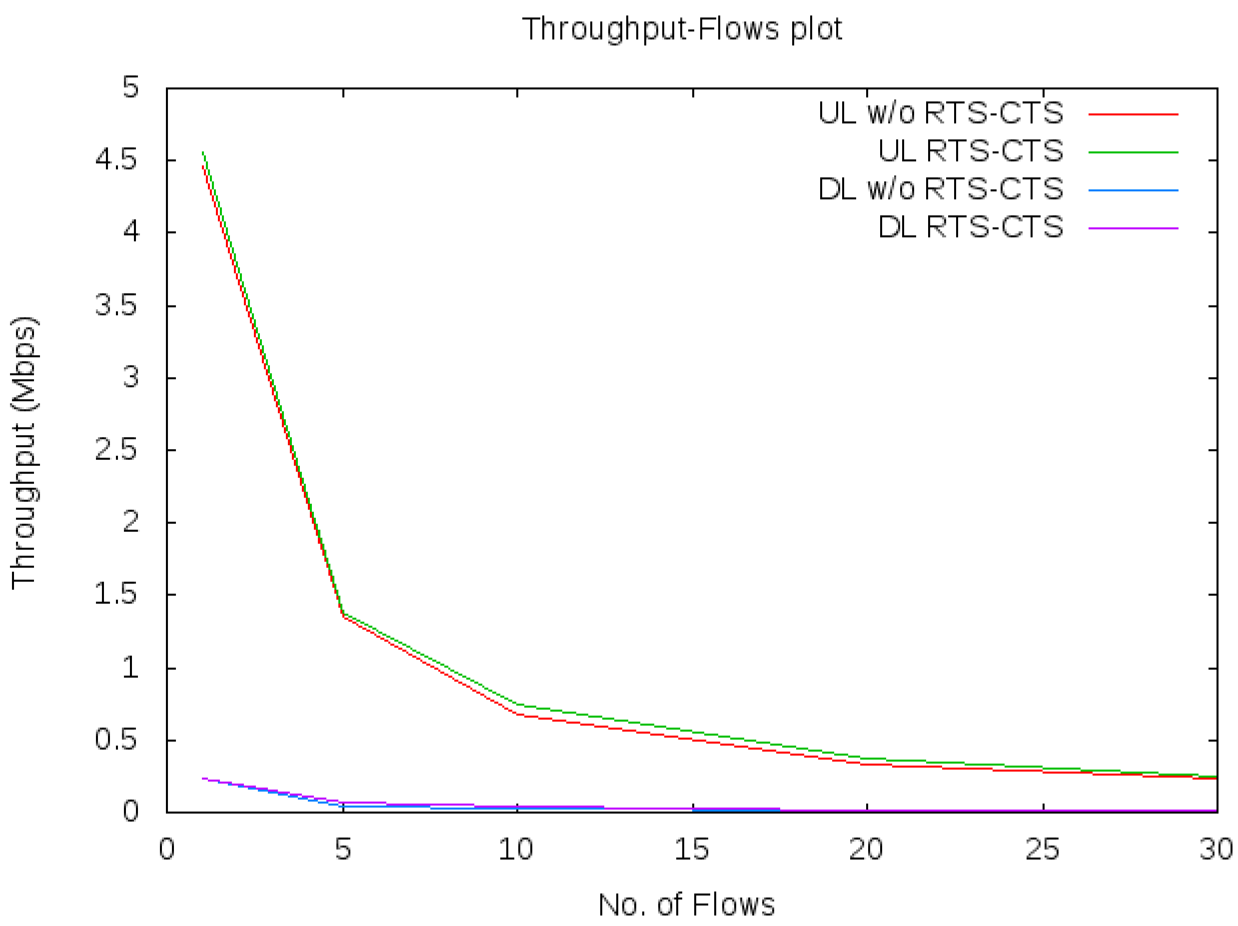
Observation:

- Packet Drops vs Flows: Packet drops increases with increase in the no. Of flows due to many factors like collision with other packets, etc.

- RTS-CTS packet drop vs w/o RTS-CTS packet drop: The number of packet drops decreases in RTS-CTS scenario compared to w/o RTS-CTS scenario.

Result Set 2: (MSS=1200B)

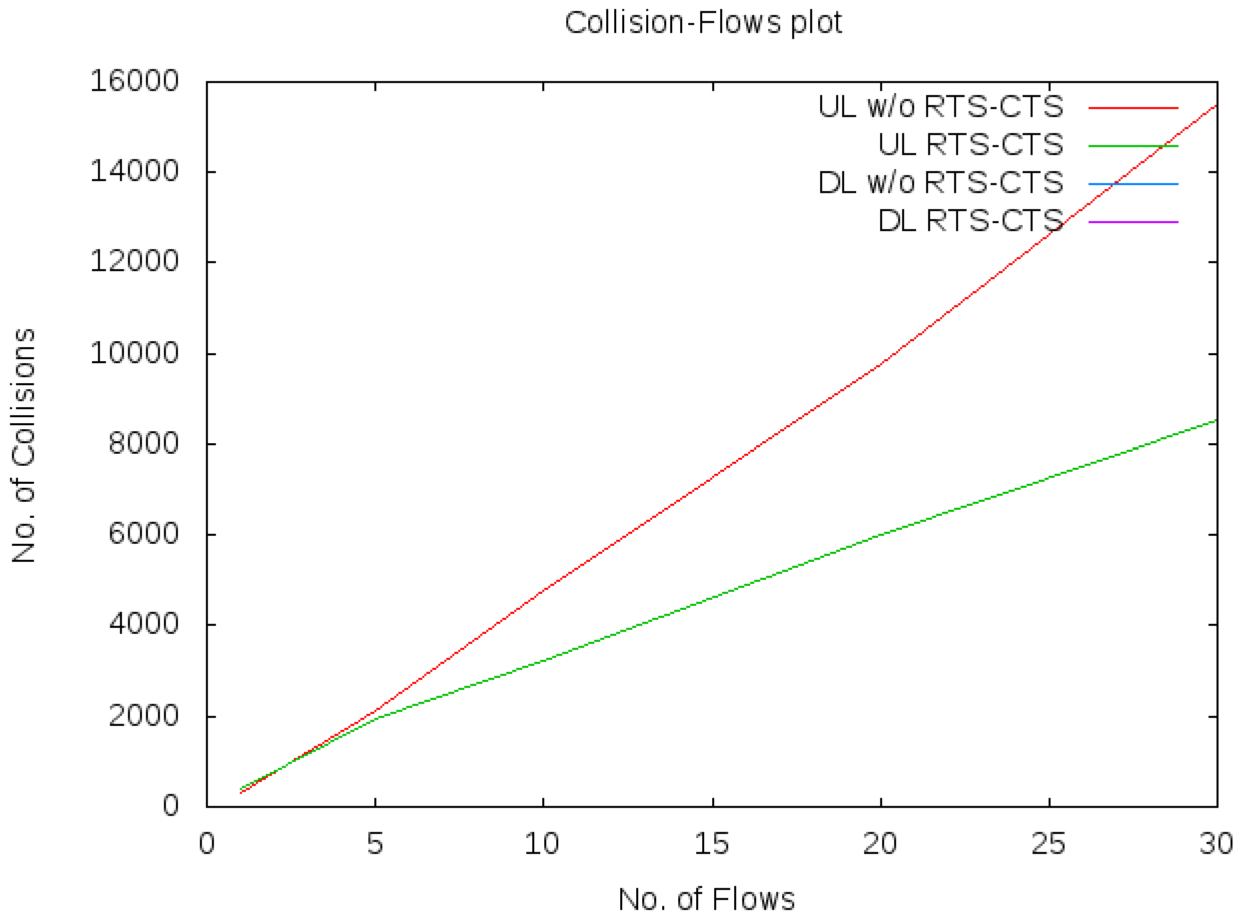
1. Throughput vs Number of Flows:



Observations:

- Throughput vs Flows: Same as above. Throughput decreases with increase in number of flows because of the collsion among packets sent by different STAs.
- Throughput RTS-CTS vs Throughput w/o RTS-CTS : Same as above. Throughput is more in case of RTS-CTS because RTS-CTS scheme avoids collision resulting due to Hidden Stations in the network.
- Throughput with 512 MSS vs 1200 MSS: Mixed results, sometimes the throughput with 512 MSS is more than 1200 MSS, and vice versa.
    - Possible reasons:
      Due to high collisions/packet drops, the improvement in throughput by taking 1200 MSS is not clearly visible.

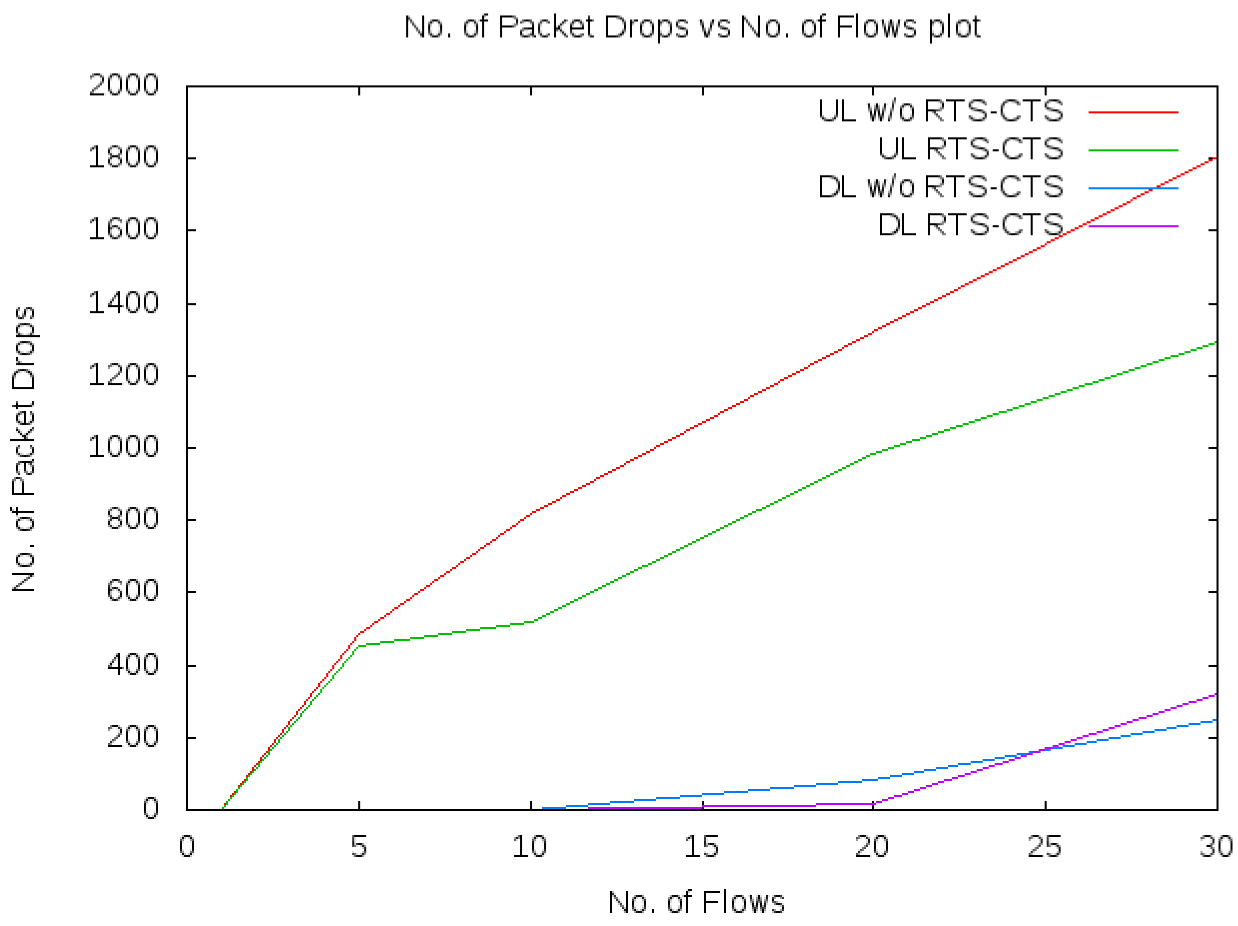
2. No. Of collisions vs Number of Flows:



Observation:

- Collisions vs Flows: Same as above. The no. Of collisions increases with increase in the no. of flows due to interference/collision with the packets of other stations.
- RTS-CTS collision vs w/o RTS-CTS collision: Same as above. The number of collisions is less in RTS-CTS scenario compared to w/o RTS-CTS scenario.

3. No. of packet drops vs Number of Flows:



Observation:

- Packet Drops vs Flows: Same as above. Packet drops increases with increase in the no. Of flows due to many factors like collision with other packets, etc.

- RTS-CTS packet drop vs w/o RTS-CTS packet drop: Same as above. The number of packet drops decreases in RTS-CTS scenario compared to w/o RTS-CTS scenario.

PART B

The following are some drawbacks of the standard Backoff algortihm.

1. If a STA sends packets successfully, it will have a great probability to capture channel again in a short time when competing for the channels with others which have a larger backoff value.

2. The increase in the number of STAs will cause more collisions in the network with high load, which degrades network performance. CW will reset to the minimum value CW min after each successful transmission and it cannot reflect the competitive conditions of the current channel accurately, which may lead to more data conflicts, thusthe STA will enter into the backoff stage again increasing the access delay and resulting in a sharp decline in the system throughput.

Standard DCF Operation:

On successful transmission of packet, CW is reset to CWmin. On i-th collision, the CW is set to a random value between CW*(1 to 2^i-1). Higher the 'i' means a big contention window size due to i-collisions. The collisions are mainly because of a large number of active nodes.

Proposed DCF Operation: (Impactful on large no. of active stations in the network)
Let the Contention window increase exponentially during the first few collisions, after a threshold number of collisions, it should increase linearly.

Changes:

*/ns3/ns-allinone-3.25/ns-3.25/src/wifi/model/dcf-manager.cc, Line: 101

```
void

DcfState::UpdateFailedCw (void) {
-  m_cw = std::min ( 2 * (m_cw + 1) - 1, m_cwMax);
+  // Proposed
+  // After crossing the Threshold (5times m_cwMin) : Increase Linearing
+  // Similar to TCP Congestion Control Mechanism
+
+  if( m_cw >= 32*m_cwMin)
+  {
+      m_cw = std::min(m_cw + m_cwMin, m_cwMax);
+  }
+  else
+  {
+      m_cw = std::min ( 2 * (m_cw + 1) - 1, m_cwMax);
+  }

}
```

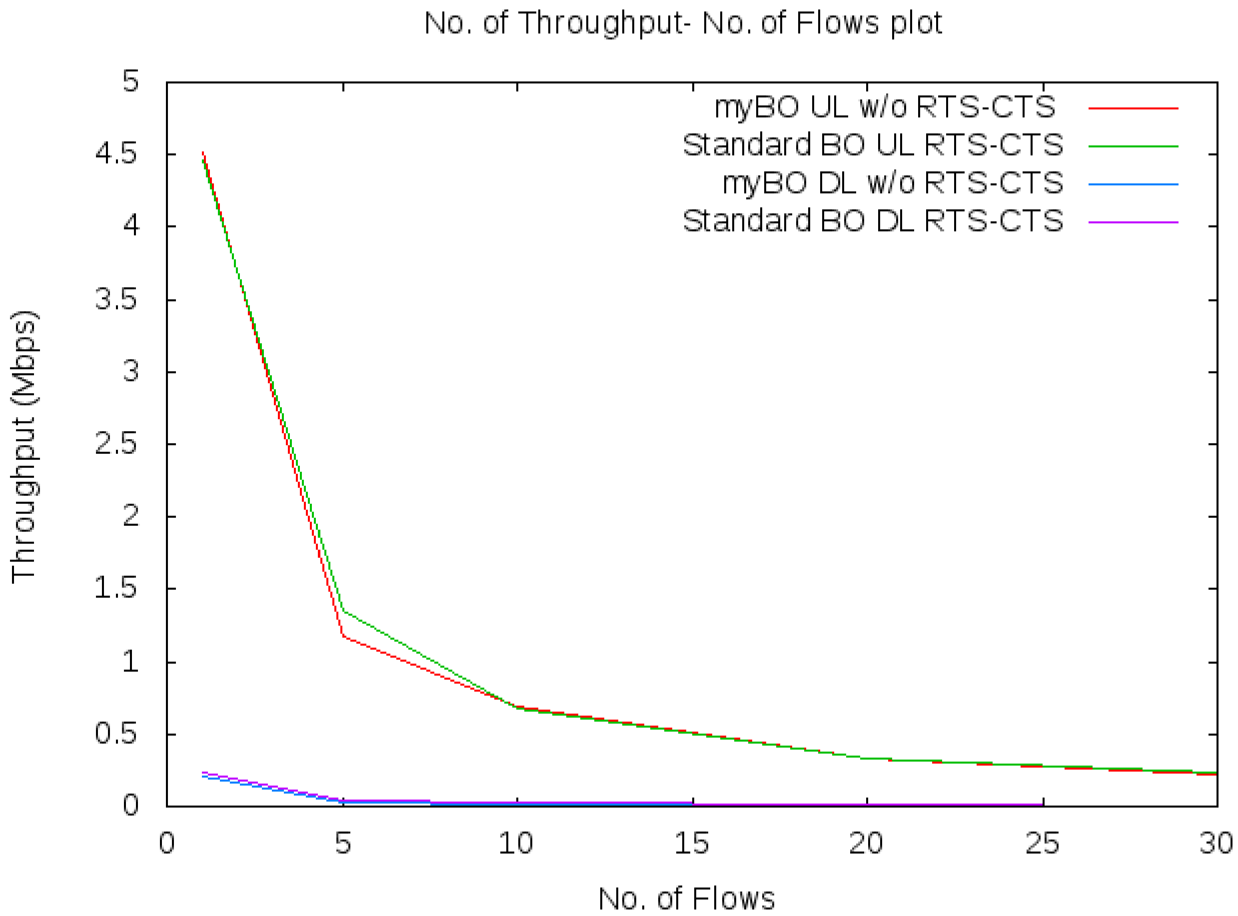
References:

1. Pessimistic Backoff for Mobile Ad hoc Network by Saher S. Manaseer and Muneer Masadeh
2. Optimized Backoff Algorithm of IEEE 802.11 DCF for Collision Resolution by Yingxia Sun, Dewei Yang, Weizhen Tian, Wenlong Liu.
3. IB-MAC: Improvement of the Backoff Algorithm for better MAC - TCP protocols interactions in MANET, Sofiane HAMRIOUI, Mustapha LALAM

RESULTS:

Scenario : Without RTS-CTS & Uplink for 512B MSS or 1200B MSS for any of traffic loads of varying no. of TCP flows.

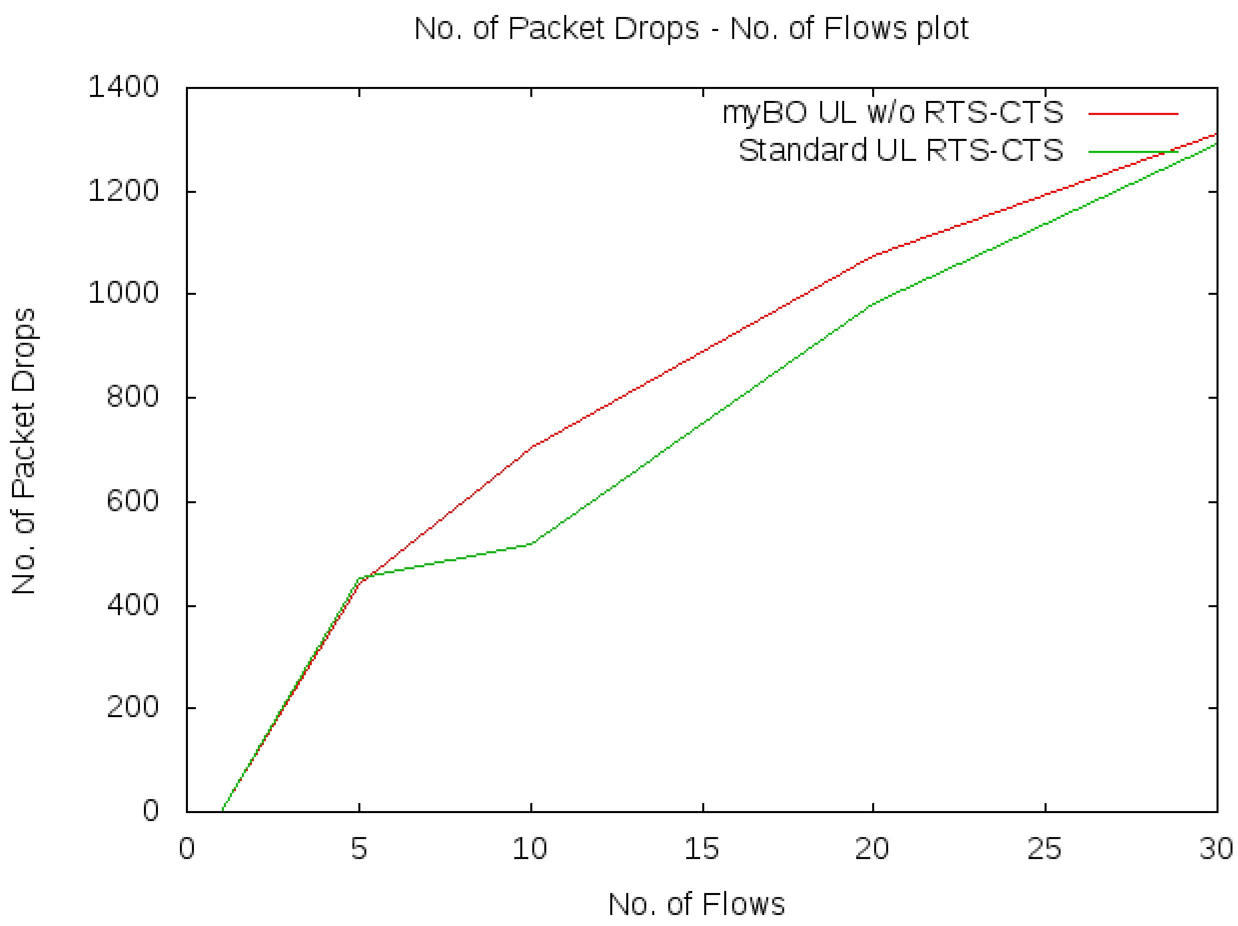
1. **Throughput**: myBO vs StandardBO



Observation:

- The throughput is improved by myBO on a particular no. Of flows as compared to StandardBO. e.g. flows # : 5, 10, 20.

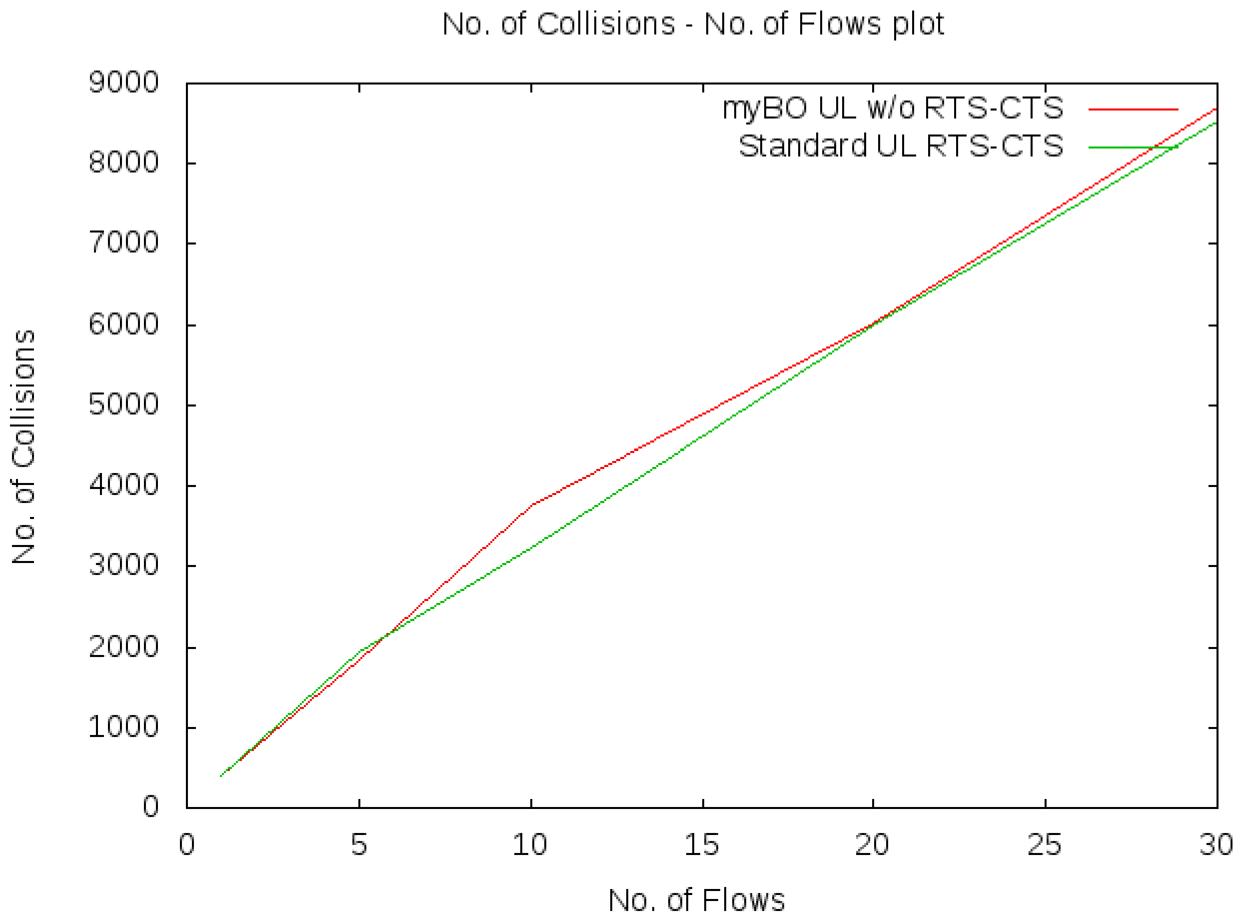
2. Packet Drop: myBO vs StandardBO



Observation:

- The packet drop is not improved by myBO as compared to StandardBO.

3. **Collision** : myBO vs StandardBO



Observation:

- The collisions are improved by myBO for a **high no. Of flows** as compared to StandardBO.

Problems :

a. Max PHY data rate supported by 11n in NS-3 ?
[].

b. Default Tx power levels of AP and STA nodes and Tx levels that you have set for scenarios 1 and 2?
[]. Default Tx power levels of AP and STA nodes is 1. No Tx levels is explicitly set in the experiment.

c. What is the path loss model used in expts and what are its configurable parameters?
[]. FriisPropagationLossModel is used in this experiment.
Frequency: The carrier frequency (in Hz) at which propagation occurs (default is 5.15 GHz).
SystemLoss: The system loss
MinLoss: The minimum value (dB) of the total loss, used at short ranges.
Lambda: The carrier wavelength.

NOTE:

The ns3::RangePropagationLossModel had an error of not interpreting cumulative TCP Ack from TCP-Server. Hence, TCP Client was re-transmitting packets again and again, whose Ack was not being handled properly by TCP Clientresulting in low throughput. Due to this, FriisPropagationLossModel was chosen for the experiment.

d. Which channel is used by AP for setting up BSS? Note that you could use either 2.4GHz or 5.2GHz bands with 802.11n ?
[]. Channel 1 (i.e Default Channel) is used by AP for setting up BSS.

e. What are the configurable parameters (attributes) of AP node in NS-3?
[]. Configurable parameters (attributes) of AP node in NS3:

1. BeaconGeneration,
2. BeaconInterval,
3. BeaconJitter,
4. EnableBeaconJitter,
5. EnableNonErpProtection.

Other parameters include:
1. Wifi Phy Standard: e.g. WIFI_PHY_STANDARD_80211n_5GHZ, WIFI_PHY_STANDARD_80211g, etc.
2. Rate Control Algorithm: e.g. AarfWifiManager, MinstrelWifiManager, OnoeWifiManager, etc.
3. Ssid of the AP.

NOTE: Used 2 out of 7 of the Slip days for the assignment.