NS-PROJECT

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1 Introduction

In this project we simulated different networks and measured different metrics on them. Also, we experimented with modification of different protocols. We simulated different networks, such as-

1. Wired network
2. Static WiFi network
3. Wired cum wireless network (Wired + Wifi)
4. Satellite network (Polar + Geo + Terminal)
5. LTE
6. WiMAX

We ran our modifications on wired and wifi network.

2 Wired Network

2.1 Topology

We generated the topology by randomly connecting two nodes.

2.2 Parameters

1. Number of nodes
2. Number of flows
3. Number of packets per second

2.3 Modifications

1. The Probability function that determines whether to discard a packet or not is as follows:
$$P = P_{max} * \frac{V_{avg} - T_{min}}{Th_{max} - T_{min}} \tag{1}$$
However, This linear function of is better approximated if we remove the linearity and introduce some slowly growing function as logarithm. So, we might expect this to perform better.
$$P = P_{max} * \frac{\ln V_{avg} - \ln T_{min}}{\ln T_{max} - \ln T_{min}} \tag{2}$$

2. Another linear but better approximation is predicted by this equation which was also brought into as a modification in cpp.

$$P = \begin{cases} P_{max} * \frac{1.2*V_{avg} - T_{min}}{Th_{max} - T_{min}} & V_{avg} \leq \frac{T_{max}+T_{min}}{2} \\ \\ P_{max} * \frac{1.2*Vavg}{T_{max} - T_{min}} - \frac{0.2*T_{max}+T_{min}}{T_{max} - T_{min}} & V_{avg} > \frac{T_{max}+T_{min}}{2} \end{cases}$$

2.4 Result

We simulated the network and generated graphs for each performance metric vs parameter under variation. In figure 1 the graphs for the network with no modification are shown. In figure 2 and figure 3 the graphs for the network with modification 1 and modification 2 are shown respectively.

2.5 Findings

By checking the equations for change in performance . we can see that it affects the performance metrics. In some of them, it improves, while some performance metric shows degradation.

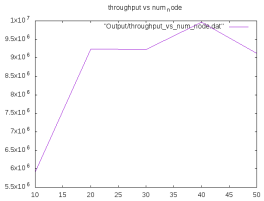
3 Static WiFi Network

3.1 Topology

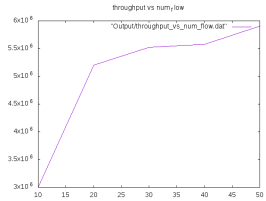
All the nodes were arranged in a grid. [There is an option to arrange the nodes randomly in the *tcl* file, but that was not used to generate the results]

3.2 Parameters

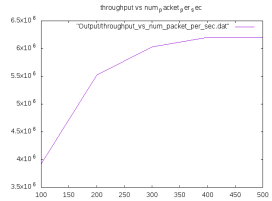
1. Number of nodes
2. Number of flows



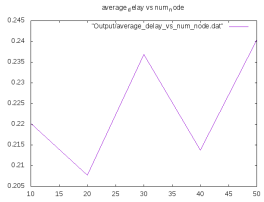
(a) Throughput vs Number of nodes



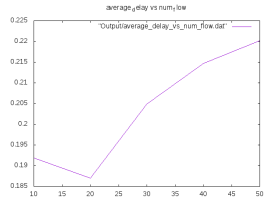
(b) Throughput vs Number of flows



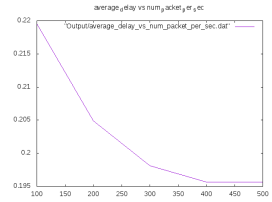
(c) Throughput vs Number of packets per second



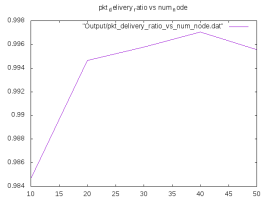
(d) Average delay vs Number of nodes



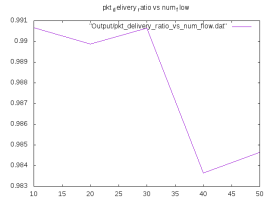
(e) Average delay vs Number of flows



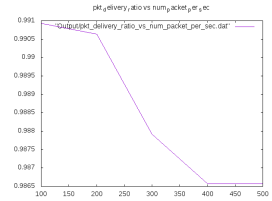
(f) Average delay vs Number of packets per second



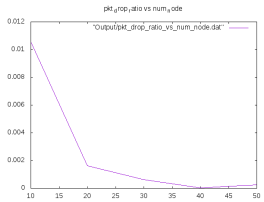
(g) Packet delivery ratio vs Number of nodes



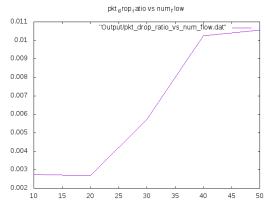
(h) Packet delivery ratio vs Number of flows



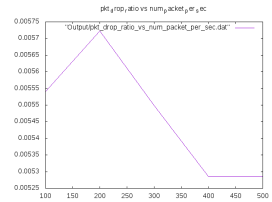
(i) Packet delivery ratio vs Number of packets per second



(j) Packet drop ratio vs Number of nodes

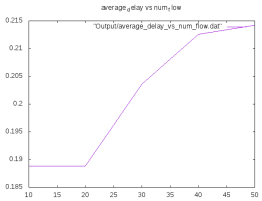


(k) Packet drop ratio vs Number of flows

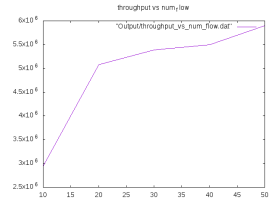


(l) Packet drop ratio vs Number of packets per second

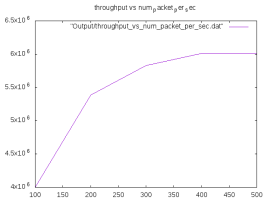
Figure 1: Graphs generated for Wired network with no modification



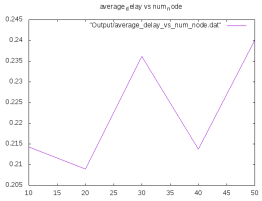
(a) Throughput vs Number of nodes



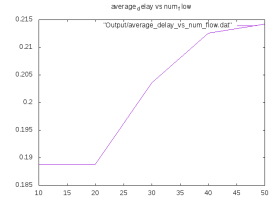
(b) Throughput vs Number of flows



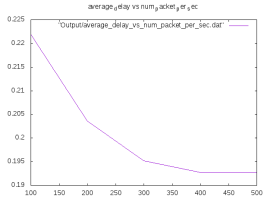
(c) Throughput vs Number of packets per second



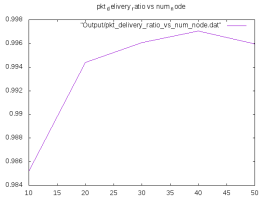
(d) Average delay vs Number of nodes



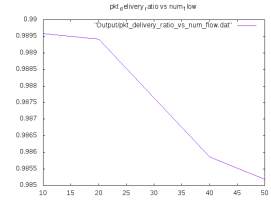
(e) Average delay vs Number of flows



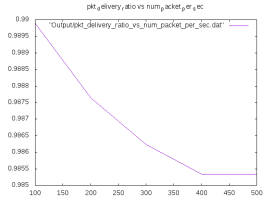
(f) Average delay vs Number of packets per second



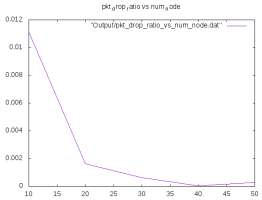
(g) Packet delivery ratio vs Number of nodes



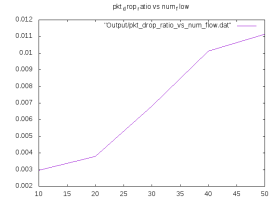
(h) Packet delivery ratio vs Number of flows



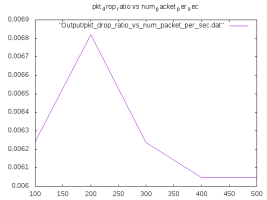
(i) Packet delivery ratio vs Number of packets per second



(j) Packet drop ratio vs Number of nodes

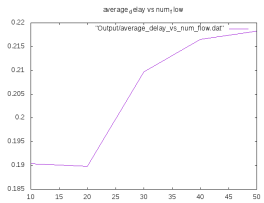


(k) Packet drop ratio vs Number of flows

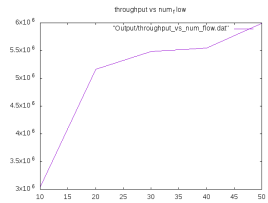


(l) Packet drop ratio vs Number of packets per second

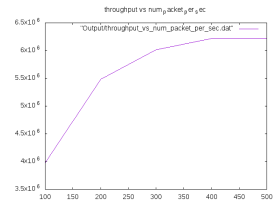
Figure 2: Graphs generated for Wired network with modification 1



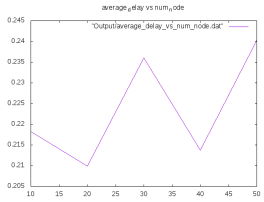
(a) Throughput vs Number of nodes



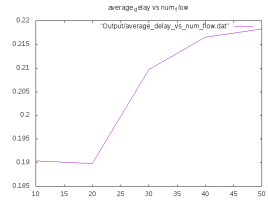
(b) Throughput vs Number of flows



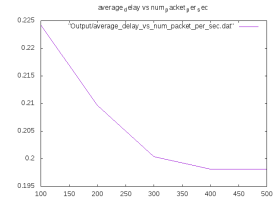
(c) Throughput vs Number of packets per second



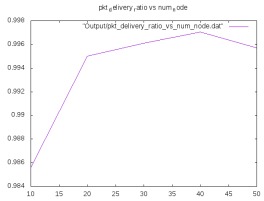
(d) Average delay vs Number of nodes



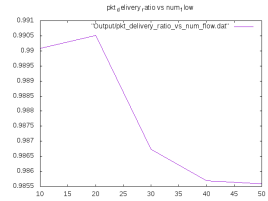
(e) Average delay vs Number of flows



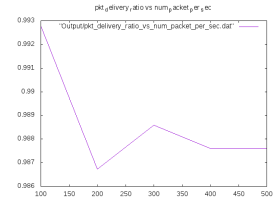
(f) Average delay vs Number of packets per second



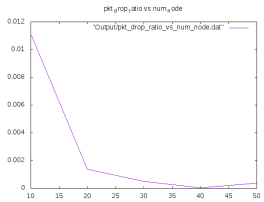
(g) Packet delivery ratio vs Number of nodes



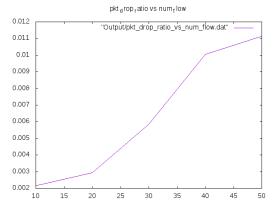
(h) Packet delivery ratio vs Number of flows



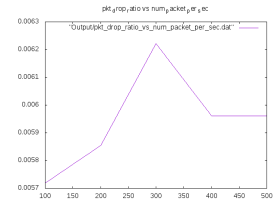
(i) Packet delivery ratio vs Number of packets per second



(j) Packet drop ratio vs Number of nodes



(k) Packet drop ratio vs Number of flows



(l) Packet drop ratio vs Number of packets per second

Figure 3: Graphs generated for Wired network with modification 2

3. Number of packets per second

4. Transmission range

3.3 Modifications

1. The Modification Process conducted here is a modified machanism to calculate RTT(Round Trip Time) and RTT variation and RTO(TimeOut). The classical apporach is as follows:

$$srtt_{new} = (1-\alpha) * srtt_{old} + \alpha * rtt_{sample}[where, \alpha = \frac{1}{8}] \tag{3}$$

$$rttvar_{new} = (1-\alpha) * rttvar_{old} + \alpha * rttvar_{sample}[where, \alpha = \frac{1}{4}] \tag{4}$$

$$rto_{new} = srtt_{new} + 4 * rttvar_{new} \tag{5}$$

The classical Equation is not dynamic rather static. So, to modify the mechanism, lets bring another set of equations as follows.

$$DELTA_E = RTT_{sample} - SRTT_E \tag{6}$$

$$FLIGHT_E = MAX(SSTHRESHOLD, \frac{CWND}{2}) + 1 \tag{7}$$

$$GAIN_E = \frac{1}{FLIGHT_E} \tag{8}$$

$$\bar{GAIN}_E = \begin{cases} GAIN_E & when(DELTA_E - RTTVAR_E) \geq 0 \\ \\ GAIN_E^2 & when(DELTA_E - RTTVAR_E) < 0 \end{cases}$$

$$SRTT_E = SRTT_E + DELTA_E * GAIN_E \tag{9}$$

$$RTTVAR_E = \begin{cases} RTTVAR_E & when, DELTA_E < 0 \\ \\ RTTVAR_E + \bar{GAIN}_E * (DELTA_E - RTTVAR_E) & when, DELTA_E < 0 \end{cases}$$

$$RTO_E = MAX(SRTT_E + \frac{RTTVAR_E}{GAIN_E}, 2 + RTT_{sample}) \tag{10}$$

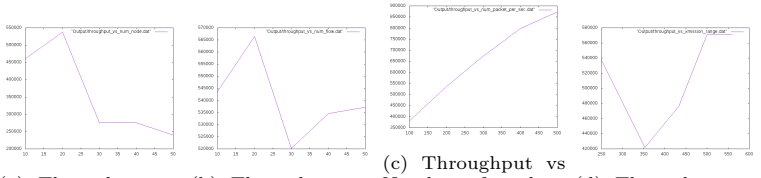
So, this hectic algorithm does the pretty job of accommodating network state while evaluating timeout functions.

3.4 Result

We simulated the network and generated graphs for each performance metric vs parameter under variation. In figure 4 the graphs for the network with no modification are shown. In figure 5 the graphs for the network with modification are shown.

3.5 Findings

From simulation we can see the dynamism in choosing RTTVAR and RTO results in slightly better performance than static algorithm used in default NS library.

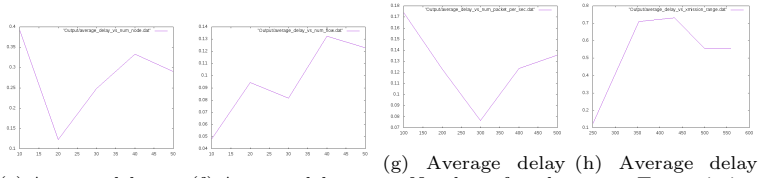


(a) Throughput vs Number of nodes

(b) Throughput vs Number of flows

(c) Throughput vs Number of packets per second

(d) Throughput vs Transmission range

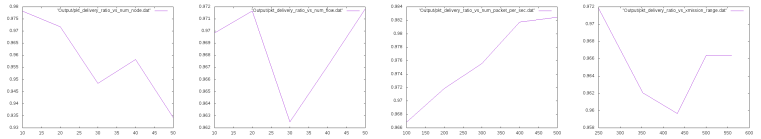


(e) Average delay vs Number of nodes

(f) Average delay vs Number of flows

(g) Average delay vs Number of packets per second

(h) Average delay vs Transmission range

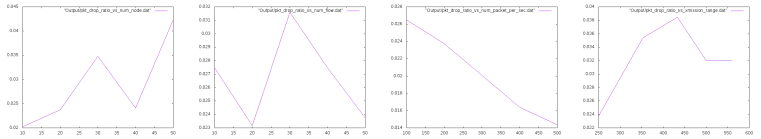


(i) Packet delivery ratio vs Number of nodes

(j) Packet delivery ratio vs Number of flows

(k) Packet delivery ratio vs Number of packets per second

(l) Packet delivery ratio vs Transmission range

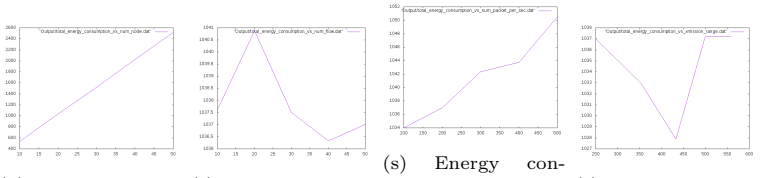


(m) Packet drop ratio vs Number of nodes

(n) Packet drop ratio vs Number of flows

(o) Packet drop ratio vs Number of packets per second

(p) Packet drop ratio vs Transmission range

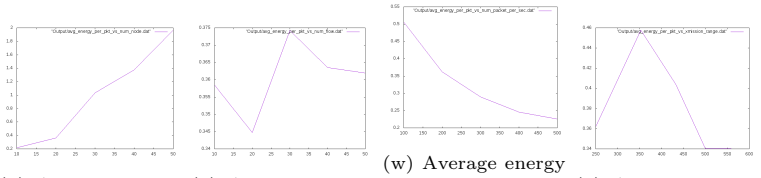


(q) Energy consumption vs Number of nodes

(r) Energy consumption vs Number of flows

(s) Energy consumption vs Number of packets per second

(t) Energy consumption vs Transmission range



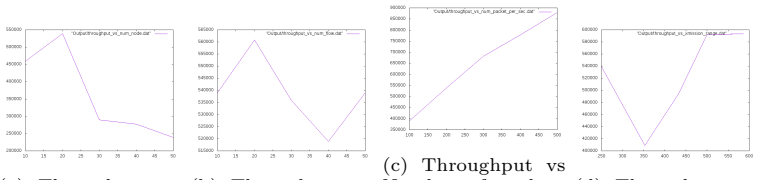
(u) Average energy per packet vs Number of nodes

(v) Average energy per packet vs Number of flows

(w) Average energy per packet vs Number of packets per second

(x) Average energy per packet vs Transmission range

Figure 4: Graphs generated for static WiFi network with no modification

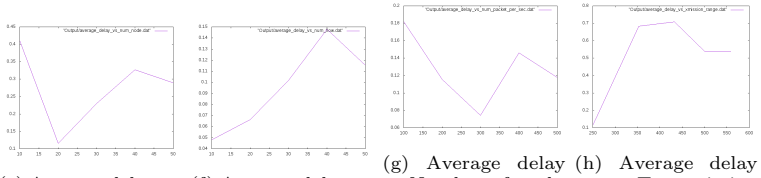


(a) Throughput vs Number of nodes

(b) Throughput vs Number of flows

(c) Throughput vs Number of packets per second

(d) Throughput vs Transmission range

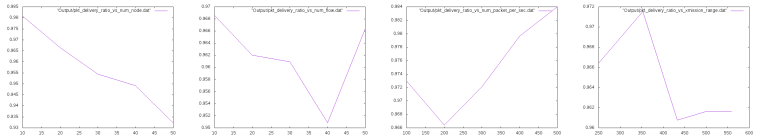


(e) Average delay vs Number of nodes

(f) Average delay vs Number of flows

(g) Average delay vs Number of packets per second

(h) Average delay vs Transmission range

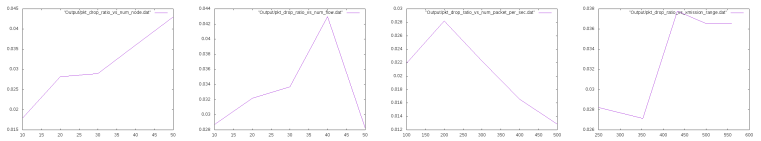


(i) Packet delivery ratio vs Number of nodes

(j) Packet delivery ratio vs Number of flows

(k) Packet delivery ratio vs Number of packets per second

(l) Packet delivery ratio vs Transmission range

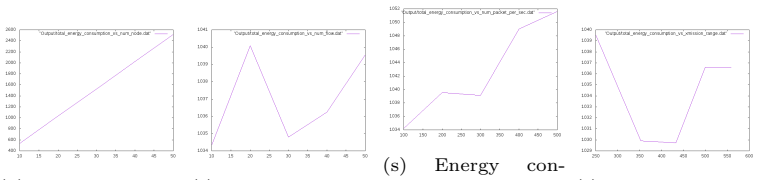


(m) Packet drop ratio vs Number of nodes

(n) Packet drop ratio vs Number of flows

(o) Packet drop ratio vs Number of packets per second

(p) Packet drop ratio vs Transmission range

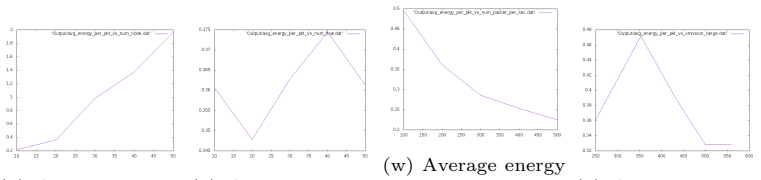


(q) Energy consumption vs Number of nodes

(r) Energy consumption vs Number of flows

(s) Energy consumption vs Number of packets per second

(t) Energy consumption vs Transmission range



(u) Average energy per packet vs Number of nodes

(v) Average energy per packet vs Number of flows

(w) Average energy per packet vs Number of packets per second

(x) Average energy per packet vs Transmission range

Figure 5: Graphs generated for static WiFi network with specified modification