UPLB Network Queue Simulator (UNQS): Analyzing Network Performance for Internet Bandwidth Management

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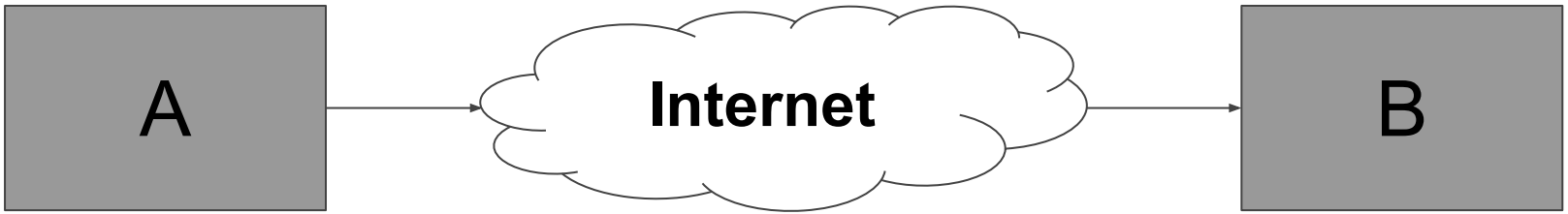
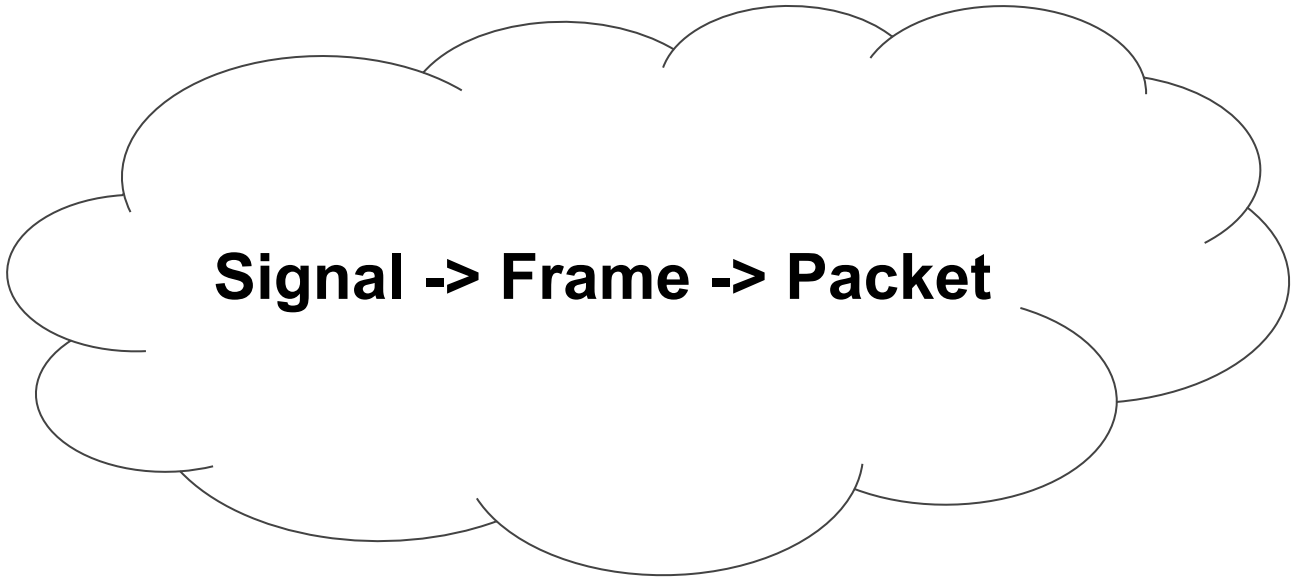
June 1, 2018

Introduction

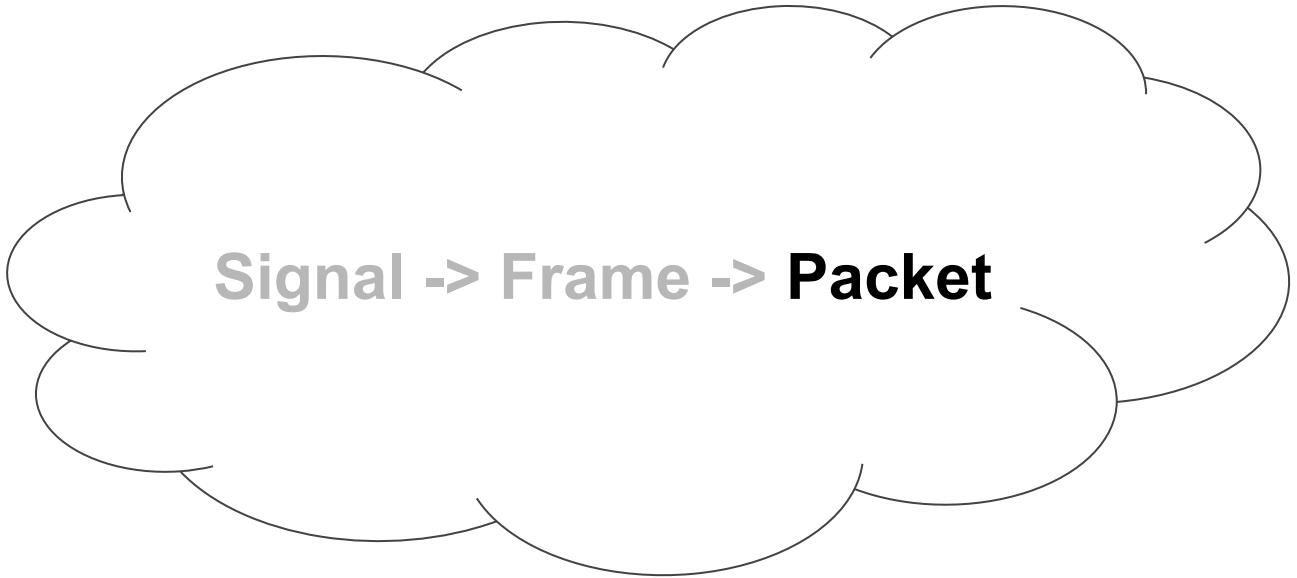
Flow of traffic data



Flow of traffic data (zoomed in to Internet)



Flow of traffic data (Network layer: packet)



Packet switching

Flow

The network link between a source IP address and a destination IP address where packet data is transfered.

Traffic engineering

Evaluating network performance and optimizing it.

D. Awduche, A. Chiu, A. Elwalid, and X. Xiao, “Overview and principles of internet traffic engineering,” The Internet Society, 2002.

Traffic engineering

Route Selection Algorithms

Bandwidth Management

Traffic engineering

Route Selection Algorithms

Bandwidth Management

Bandwidth Management

Allocation of available bandwidth depending on network traffic and client/service priority.

R. Kanu, S. Kuyoro, S. Ogunlere, and A. Adegbenjo, “Management and control of bandwidth in computer networks,” International Journal of Computer Networks and Wireless Communications, vol. 2, no. 3, pp. 342–348, 2012.

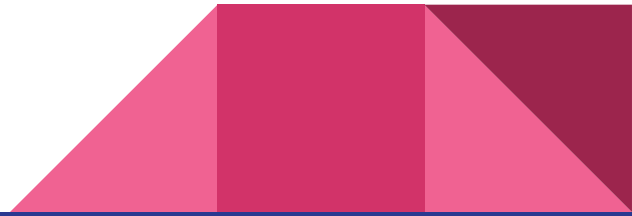
Main Objective

Simulate UPLB network traffic by identifying the most optimal bandwidth setting using the resulting network performance parameters, namely, *duration*, *throughput*, and *flow loss*.

Methodology

Methodology

1. Collect traffic data using *ntopng*.
2. Simulate the data using different bandwidth rates.
3. Compute the network performance metrics.
4. Observe the trend across varying bandwidth settings, compare them, and identify the optimal bandwidth rate.



Collect traffic data

Collect traffic data: *ntopng* configuration file

```
--pid-path=/var/tmp/ntopng.pid
--daemon
--interface=eth1
--http-port=3000
--local-networks="10.0.0.0/8, 172.16.0.0/16, 202.92.144.0/22"
--dns-mode=1
--data-dir=/var/tmp/ntopng
--community
--hw-timestamp-mode=ixia
--user="lmlawas"
--dump-flows="mysql;localhost;ntopng;flowsv4;root;<password>"
--dump-hosts=remote
```

Collect traffic data: running *ntopng*

```
sudo service ntopng start
```

or

```
ntopng /etc/ntopng/ntopng.conf
```

Simulate traffic data

First-In First-Out (FIFO)

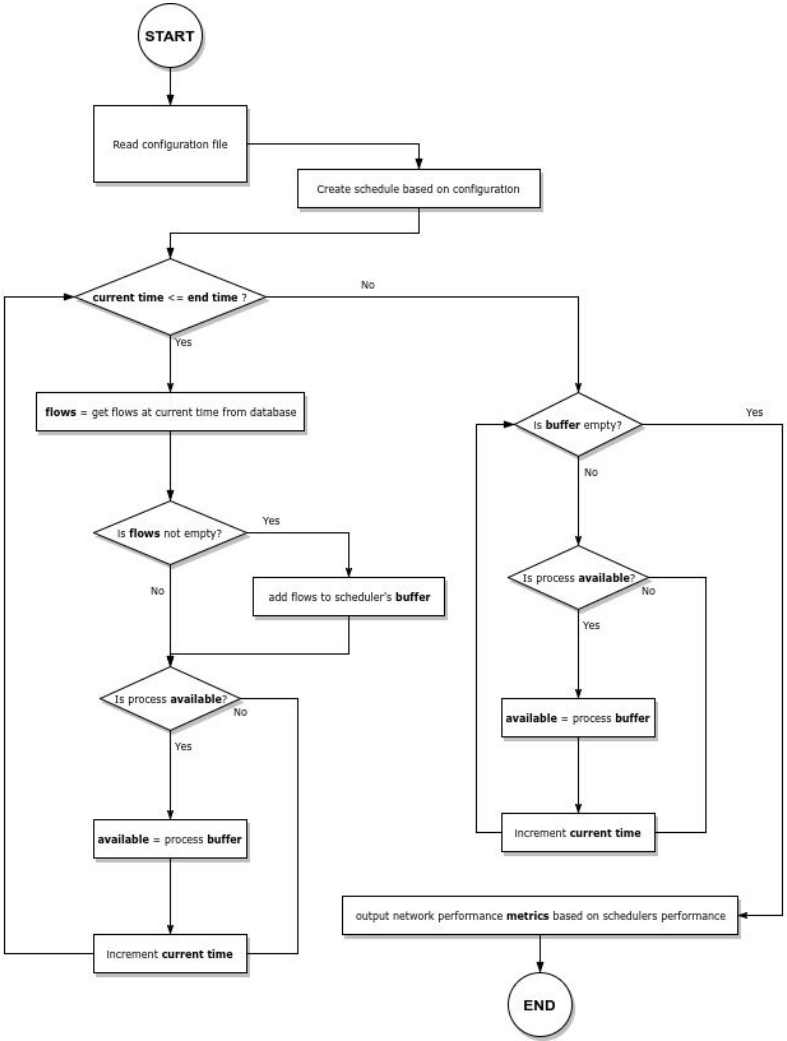
Simplest queueing technique

First In-First Out (FIFO)

The buffer accepts flows by arrival time *t* and services them in chronological fashion.

UNQS Main Program Logic

Flow chart



UNQS Main Program Logic

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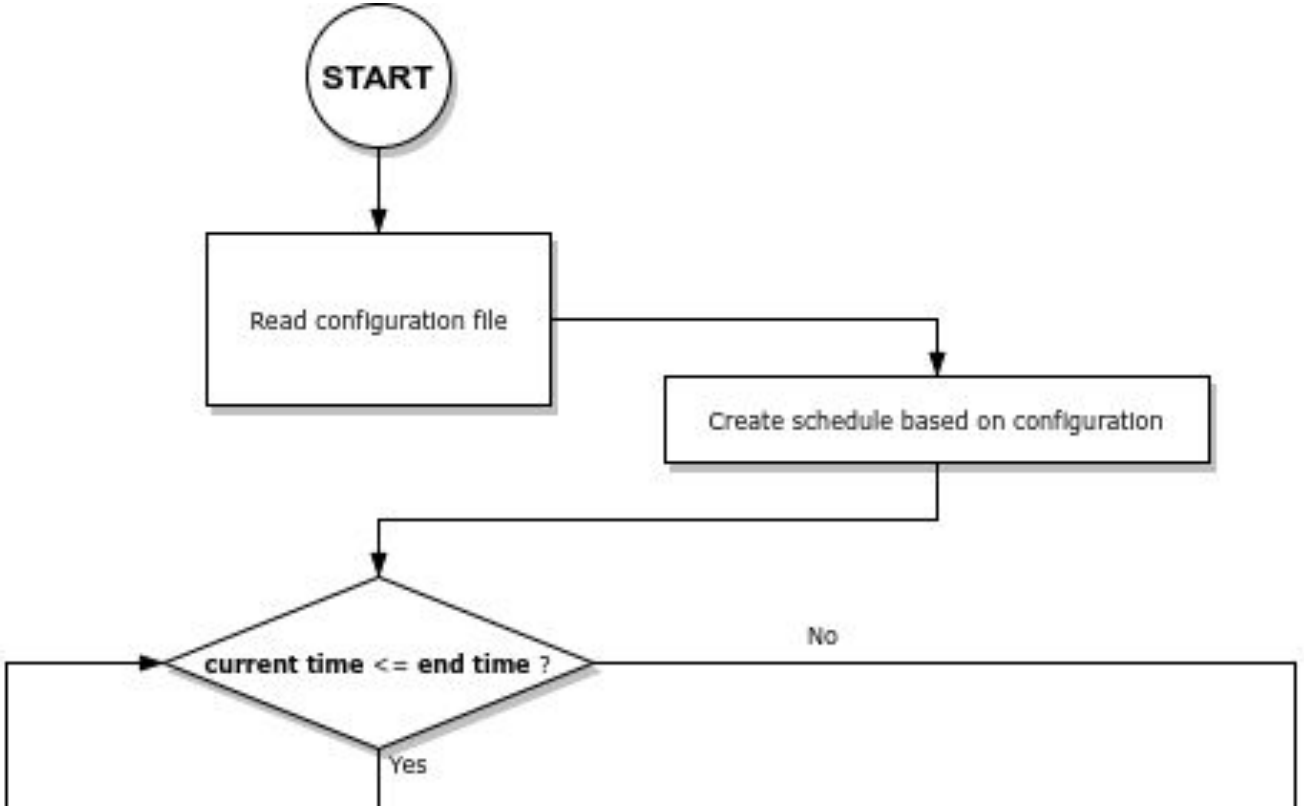
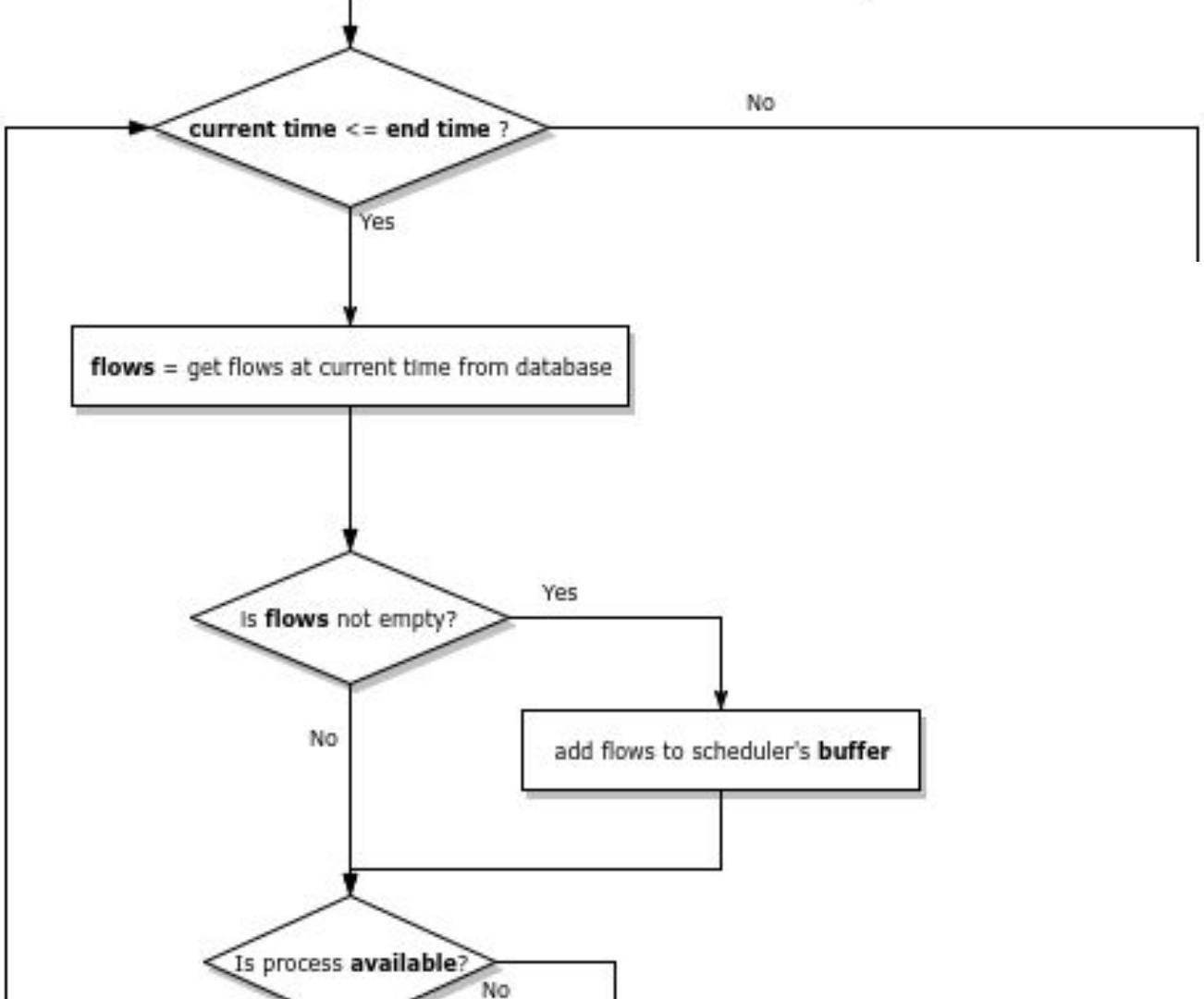
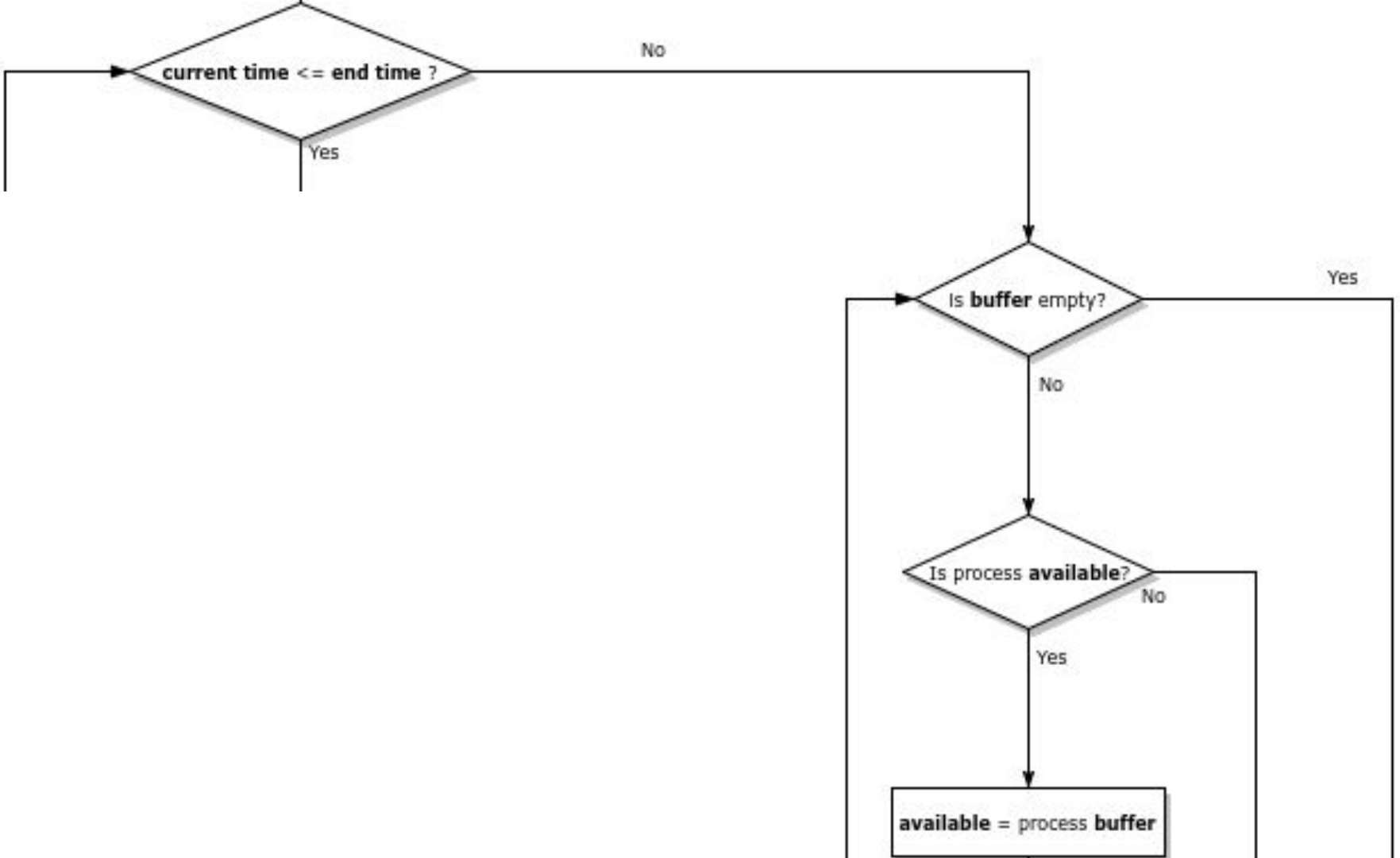
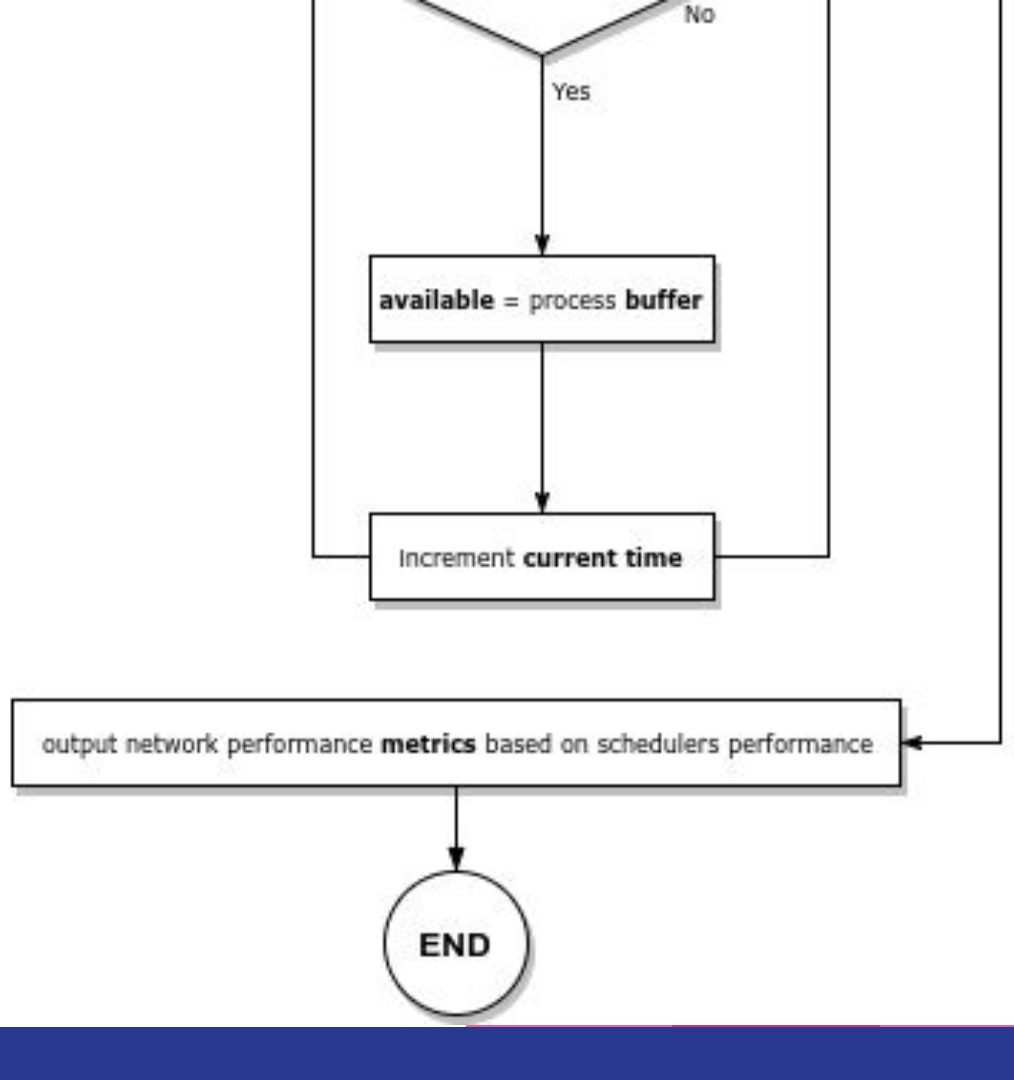



current time <= end time ?
No
Yes
flows = get flows at current time from database
Is flows not empty?
Yes
No
add flows to scheduler's buffer
Is process available?
No


Is **flows** not empty?
Yes
No
add flows to scheduler's **buffer**
Is process **available**?
No
Yes
available = process **buffer**
Increment **current time**


current time <= end time ?
No
Yes
Is buffer empty?
Yes
No
Is process available?
No
Yes
available = process buffer


No
Yes
available = process buffer
Increment current time
output network performance metrics based on schedulers performance
END

Compute network performance metrics

Compute network performance metric: Duration (s)

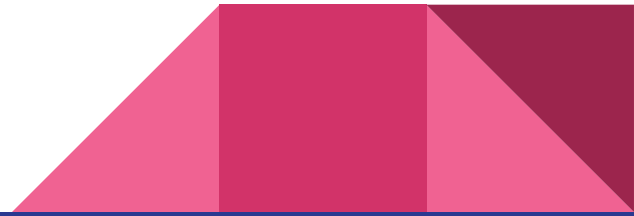
Duration = finish time - start time

Compute network performance metric: Throughput (bps)

Throughput = total switched flows / duration

Compute network performance metric: Flow loss (%)

Flow loss = [total dropped flows / (dropped flows + switched flows)] x 100



Determine most optimal bandwidth

Results and Discussion

Results and Discussion: Bandwidth per unit time

	per UNIT TIME		
	per DAY	**per HOUR**	**per SECOND**
BANDWIDTH (bits)	297,975,842,700.91	12,415,660,112.54	3,448,794.48

*note – divisor for per day = 7.71, for per hour = 7.71x24, for per second = 7.71x24x60x60

Results and Discussion: Top Out-Flows

DESTINATION (# of flows)	TOTAL BYTES	% TOTAL
KDDI CORPORATION (1)	62,409,079,786	60.6
MULTICAST (3)	12,310,903,701	11.9
Google LLC (3)	5,202,456,530	5.0
Facebook, Inc. (1)	2,771,346,197	2.7
Apple Inc. (1)	1,054,547,100	1.0

Results and Discussion: Top In-Flows

SOURCE (# of flows)	TOTAL BYTES	% TOTAL
KDDI CORPORATION(1)	79,135,454,093	43.0
Google LLC(3)	27,958,817,762	15.2
WorldStream B.V.(1)	3,426,880,570	1.9
M247 Ltd(2)	4,286,472,241	2.3
Converge ICT Solutions Inc.(2)	3,967,550,023	2.2

Results and Discussion: Top Applications

PORT NUMBER	PROTOCOL	TOTAL FLOWS	% TOTAL
443	HTTPS	65,088	11.7
53	DNS	60,765	11.0
1900	SSDP	52,579	9.5
5060	SIP	43,101	7.8
445	MS-DS	28,746	5.2
80	HTTP	18,485	3.3
5355	LLMNR	17,090	3.1
0	Reserved	15,732	2.8
7437	Faximum	13,734	2.5
161	SNMP	9,142	1.6
67	Boostrap Protocol Server	8,602	1.6

Results and Discussion: Simulation results per bandwidth

	BANDWIDTH (Mbps)			
METRICS	**32.5**	**35.0**	**37.5**	**40.0**
flows_dropped_size (Gb)	72.59	18.87	0	0
flows_dropped_cnt	36	9	0	0
flows_switched_size (Gb)	866.46	920.18	939.05	939.05
flows_switched_cnt	554,356	554,383	554,392	554,392
duration (days)	8.22	8.22	8.22	8.22
throughput (Mbps)	1.2	1.3	1.3	1.3

DEMO

UNQS program

Conclusion

37.5Mbps

Optimal bandwidth constraint with 0 flow loss

Recommendation/s

Based on collected data

Block Untagged Ports

...by the firewall, like ports 0 and 7437, which have potential to receive harmful traffic data.

Maintain and use Internal DNS Server

...to further reduce external DNS traffic.

Turn off MS-DS traffic

...that consumes a large amount of the out-bound bandwidth.

Mirror Linux, Microsoft and Apple traffic

...to monitor possible intrusions and unnecessary traffic within the network in order to formulate and enforce policies to block and limit such traffic.

Future Works

Implement other Queueing Techniques

...like PQ and WFQ which could further improve the network performance.

Collect more data

...over a longer time period to discover a pattern in network traffic behavior depending on certain periods of time, such as peak season during enrollment period, etc.

Thank you.