WAN Emulator Software Tool

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Introduction

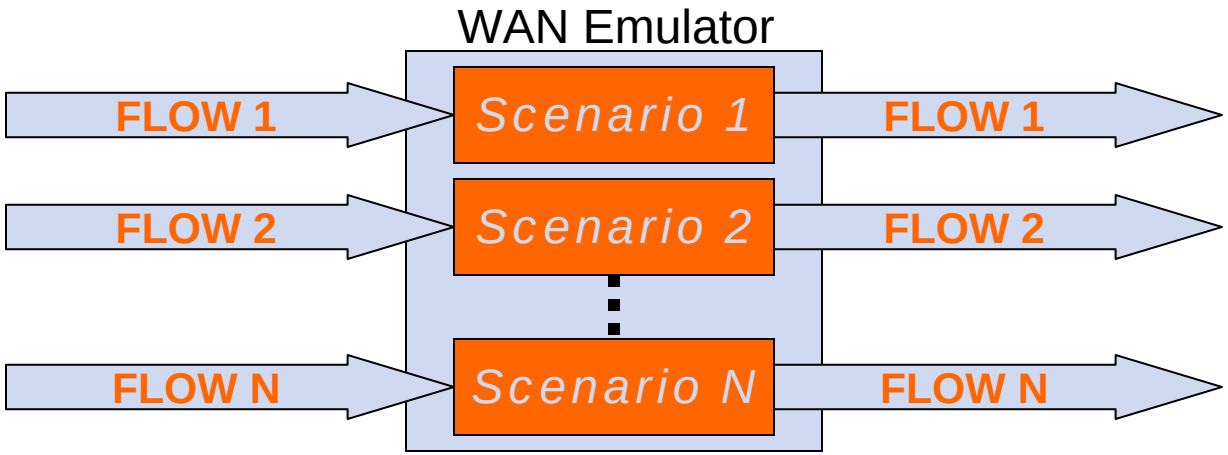
- Testing a protocol/ application in real life condition
  - is not an easy task
  - involves expensive hardware or proprietary solutions
- Linux offers a tool called NetEm
  - a component of `tc` with good performance but difficult to use

WAN Emulator capabilities (1/2)

- WANE *(WAN Emulator)*
  - has a friendly user interface, while maintaining the good performance in evaluations
- Emulated parameters:
  - delay, jitter, dropped packets and duplicate packets
  - Throughput from a minimum value up to the maximum hardware transfer rate

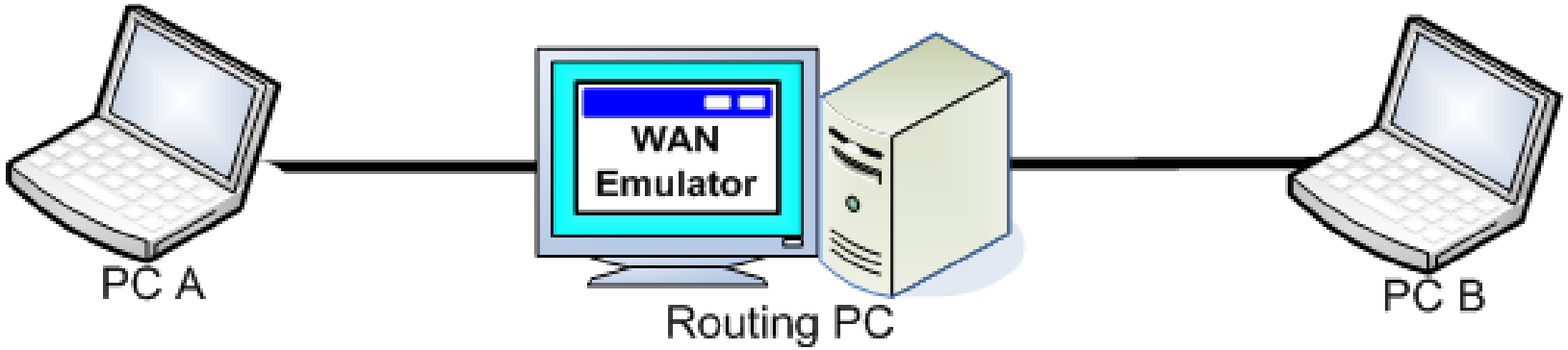
WAN Emulator capabilities (2/2)

- Emulate several scenarios in the same time for different data flows



- Flows are differentiated by:
  - source/destination IP address, mask and port
  - protocol (TCP, UDP or ICMP)

Testbed architecture



- Routing PC -> Linux machine with forwarding capabilities

Implementing a scenario

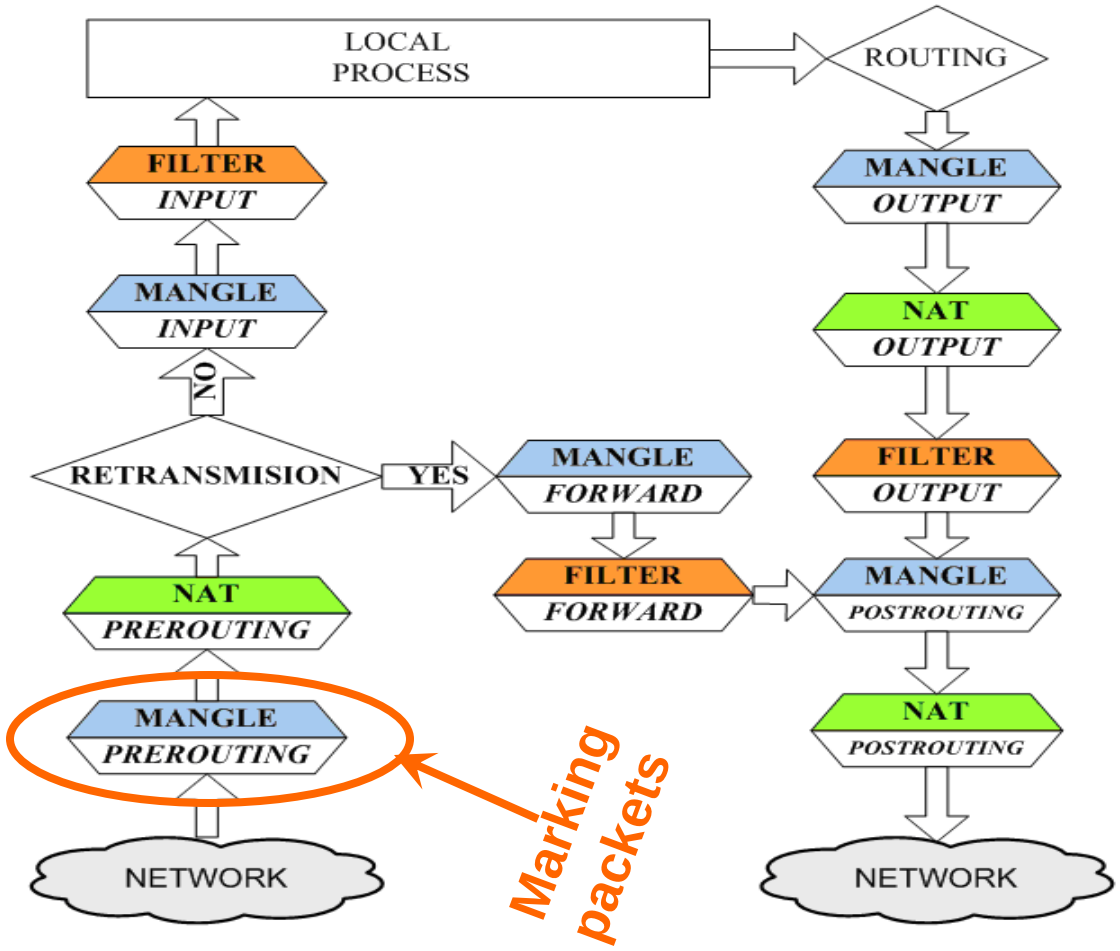
Steps covered by WANE when implementing a scenario

- *Marking* the specific traffic flow using iptables
- *Building the tc tree* composed by queuing disciplines with the tc tool
- *Filtering* the flows with a specific mark and sending them to a specific branch from the tc tree, using the filtering option of `tc`

iptables (1/2)

- Native packet filtering mechanism for the Linux 2.4 and above kernel series
  - filter packets
  - implement network address translation
  - mangle packets

iptables (2/2)

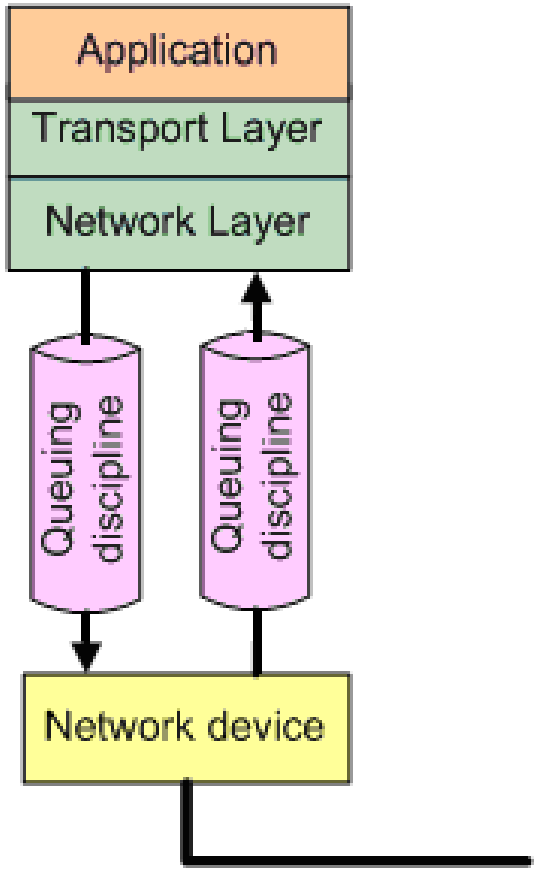


- Three tables:
  - filter
  - nat
  - mangle
- Five chains
  - PREROUTING
  - INPUT
  - OUTPUT
  - FORWARD
  - POSTROUTING

`tc` tool (1/2)

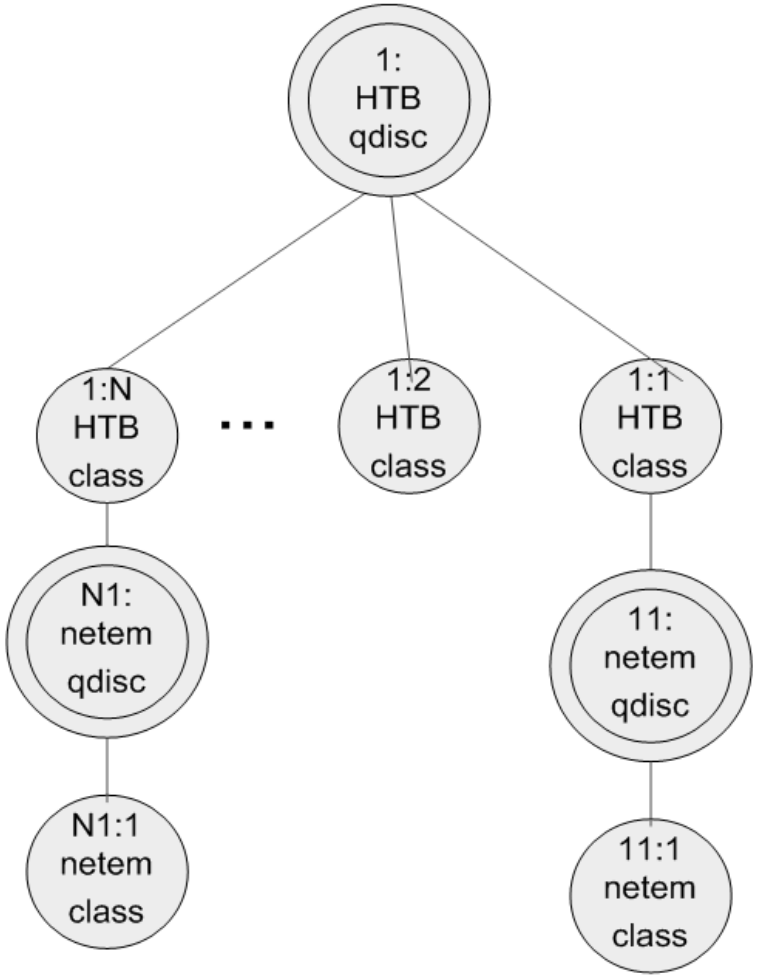
- Efficient and flexible software tool, implemented in Linux kernels
- Based on the concept of queue, where the binary data is stored, before being sent to the network interface
- DISADVANTAGES -> complex to work with

`tc` tool (2/2)



- Position of *tc* queuing disciplines within TCP/IP stack
- Types of queuing disciplines:
  - Classful
  - Classless

tc tree



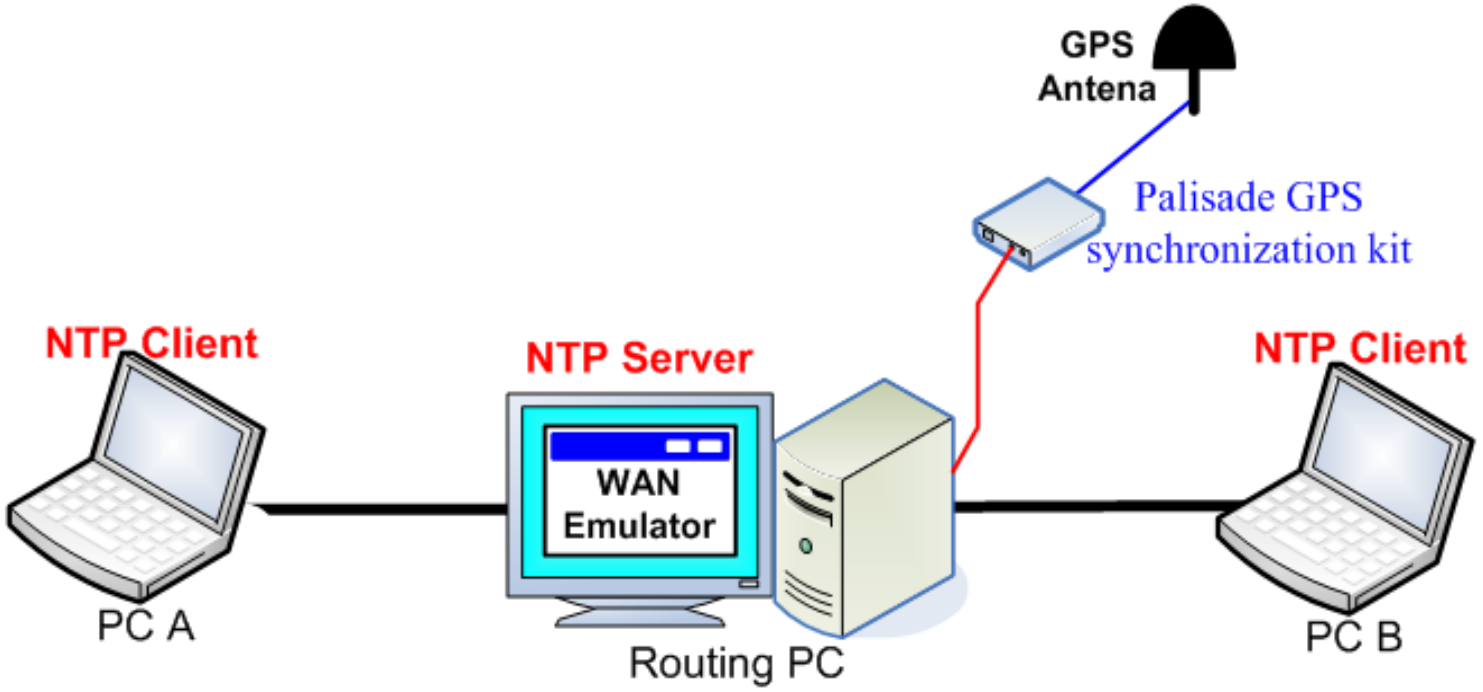
- HTB qdisc used to limit the maximum transfer rate for the data flow
- NetEm qdisc are emulating the IP traffic parameters like:
  - packet delays
  - dropped packets
  - duplicate packets

OWAMP Testing Tool (1/2)

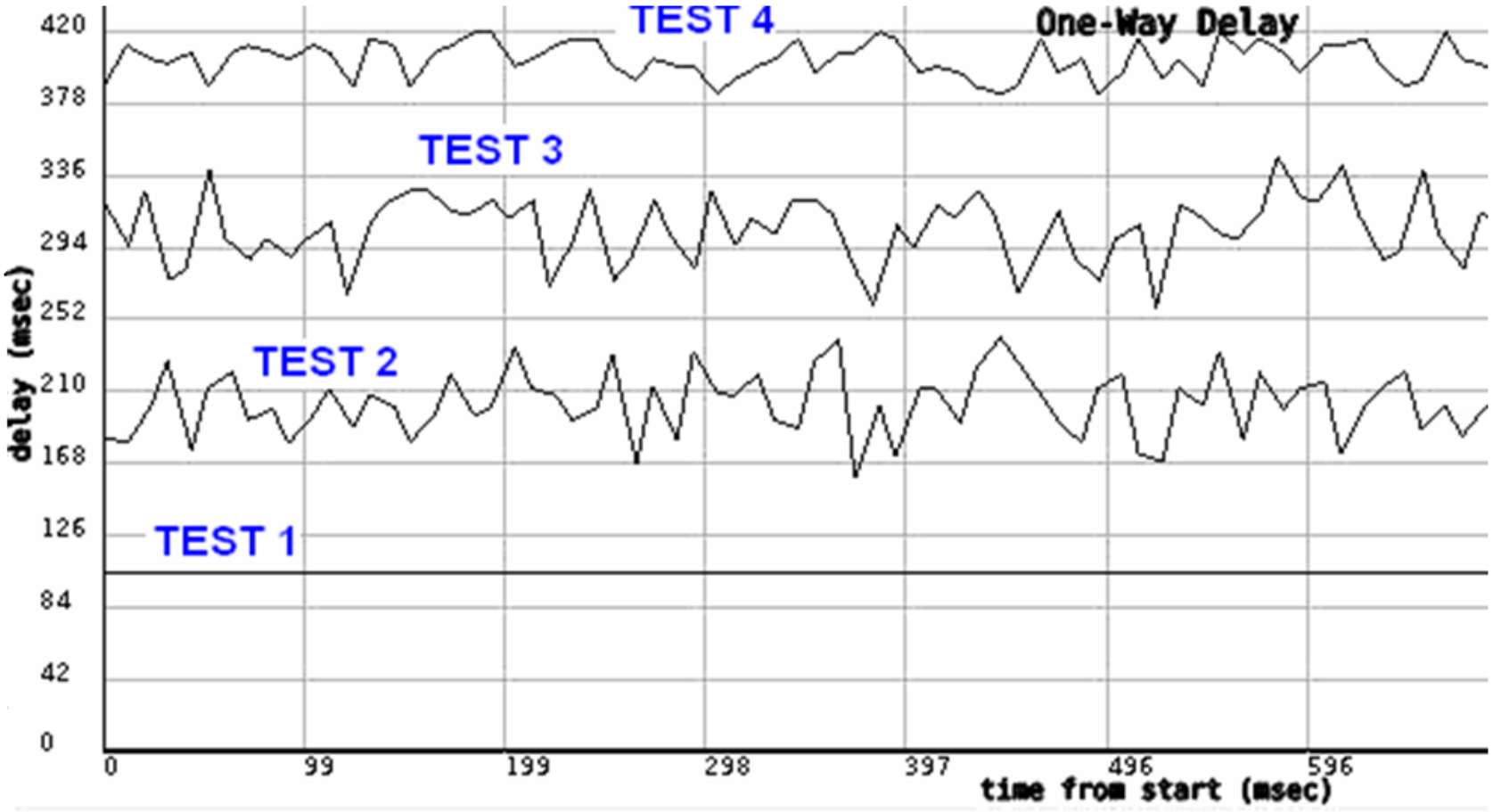
- Used to test the performance of WANE
- Measures unidirectional characteristics such as:
  - one-way delay
  - one-way loss
  - one-way duplications

OWAMP Testing Tool (1/2)

- High-precision measurement of these one-way IP performance metrics needed good time synchronization

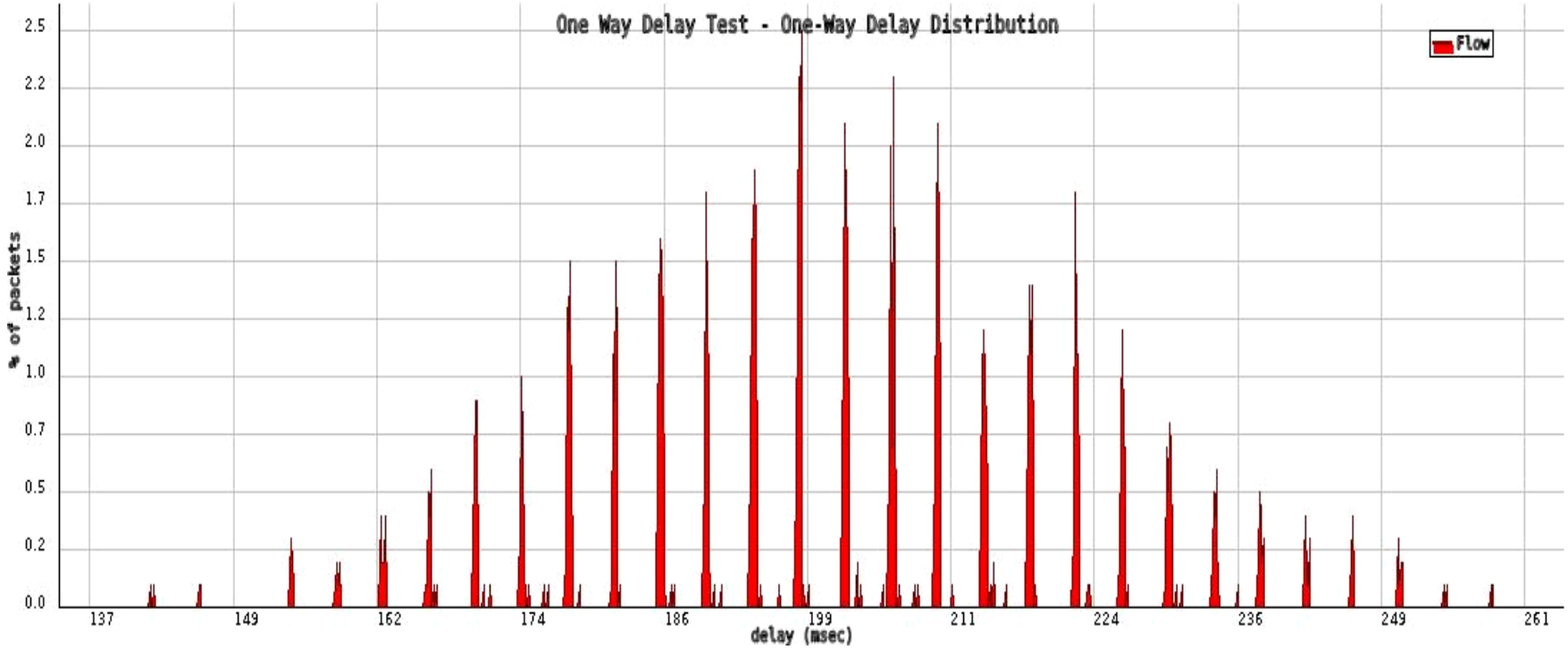


Tests and Results
Delay tests (1/3)



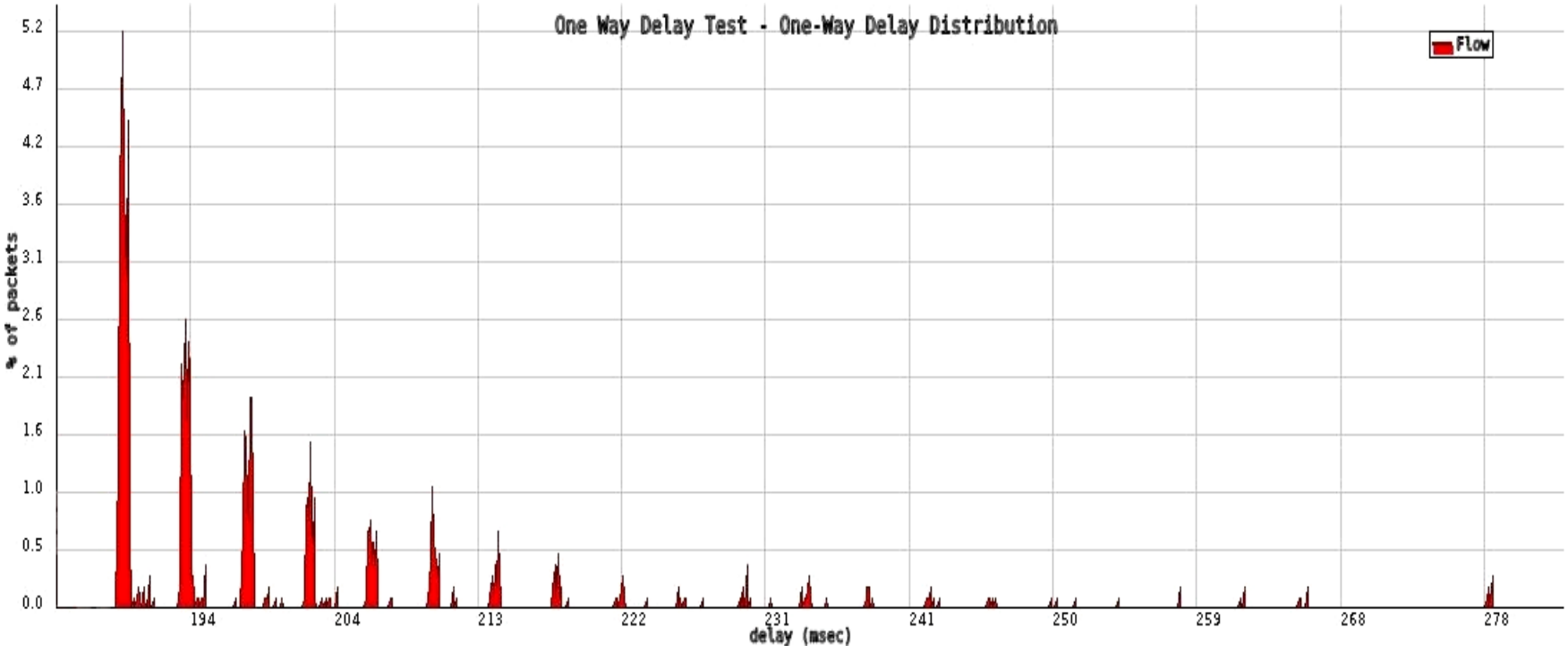
Tests and Results
Delay tests (2/3)

- Gaussian Distribution



Tests and Results
Delay tests (3/3)

- Pareto Distribution



Tests and Results
Packets Dropped

Value imposed by WANE [%]	Measured value at:			
	1kB/s [%]	10kB/s [%]	100kB/s [%]	1MB/s [%]
10	9.8	10.1	9.8	10.1
20	20.3	20.2	19.9	19.9
30	29.5	30.4	30.2	30.2
40	39.1	40.8	40.1	39.8
50	50.2	49.2	49.8	50.1
60	59.7	59.6	60.2	60.3
70	70.4	69.9	70.3	69.8
80	80.1	79.6	79.7	80.4
90	90.3	90.1	89.8	90

Difference between imposed values of dropped packets and the measured ones was **less** than **1%**

Tests and Results
Duplicate Packets

Value imposed by WANE [%]	Measured value at:			
	1kB/s [%]	10kB/s [%]	100kB/s [%]	1MB/s [%]
10	10.3	10.1	9.7	10.1
20	19.6	20	19.8	20.2
30	29.5	30.2	30.1	29.9
40	40.6	39.9	40.3	39.8
50	50.1	49.8	49.8	50.2
60	60.2	60.3	60.1	60.1
70	69.8	69.7	69.9	69.9
80	80.2	79.8	80.2	79.9
90	90.1	90.2	90.1	90.2

Difference between imposed values of duplicate packets and the measured ones was **less** than **1%**

Tests and Results
Maximum throughput

Maximum throughput imposed by WANE	Average throughput measured	Error [%]
10 [kbps]	9.59 [kbps]	4.10
50 [kbps]	48.06 [kbps]	3.89
100 [kbps]	97.33 [kbps]	2.67
500 [kbps]	479.17 [kbps]	4.17
1 [Mbps]	0.95 [Mbps]	5.00
5 [Mbps]	4.79 [Mbps]	4.20
10 [Mbps]	9.58 [Mbps]	4.20
50 [Mbps]	47.89 [Mbps]	4.22
100 [Mbps]	95.95 [Mbps]	4.05

Conclusions and Further Work

- WANE (WAN Emulator) made the job easier for the researchers because they will not have to bother with creating the tc tree, marking the specific traffic and filtering it.

- As future work, we want to improve WANE in order to support IPv6 traffic. Additionally we envisage an extra feature of the emulator to be able to corrupt packets and to test how this could influence the quality of the tested flow

Thank You