



DPDK

DATA PLANE DEVELOPMENT KIT

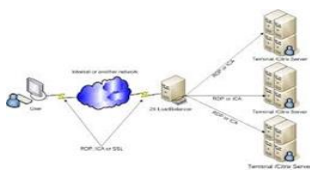
Userspace 2015 | Dublin



Realistic Traffic Generator

Current Situation

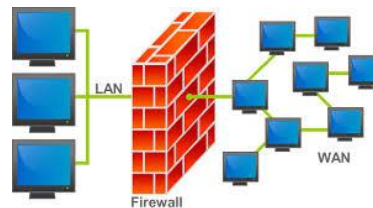
- Networks include complex L4-7 features, such as
 - Load Balancer, DPI/AVC, Firewall, NAT



LB



DPI/AVC



Firewall, NAT

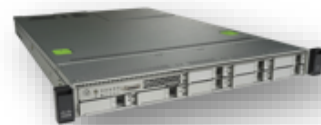
- Requires testing with stateful and realistic traffic mix

What problem is being solved?

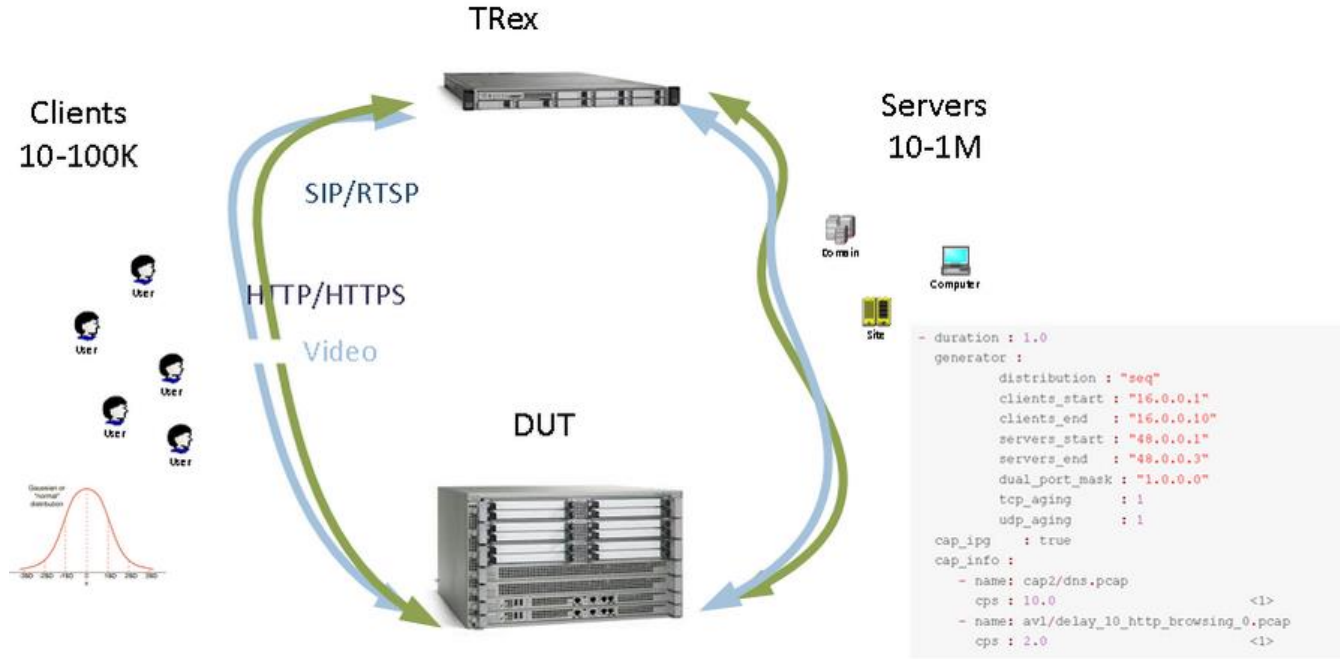
- Traffic generators for realistic traffic are
 - Expensive ~\$100-500K
 - Not scalable for high rates
 - Not flexible
- Implication
 - Limited and late testing
 - Different benchmarks and test methodologies
 - Real life bottlenecks and design issues

What is TRex?

- **Stateful traffic generator**
- Generates, manipulates and amplifies based on templates of real, captured flows – no TCP/IP stack
- **High performance:** up to 200 Gb/sec
- **Low cost:** C220M UCS-1RU, Cisco internal
 - Standard server hardware
- Flexible and Open Software - DPDK, ZMQ, Python libs
- Virtualization (VMXNET3/E1000)
- Easy installation and deployment

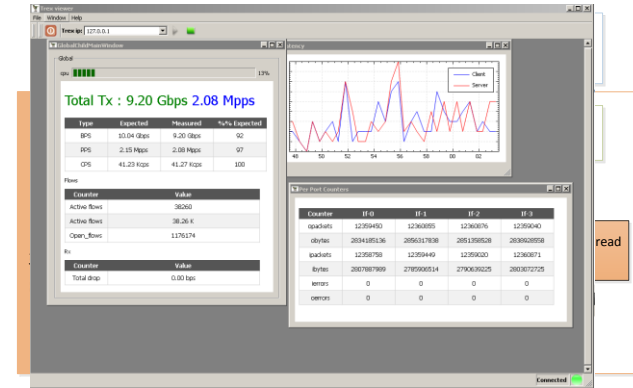


Stateful Traffic Generation Model



High level software architecture

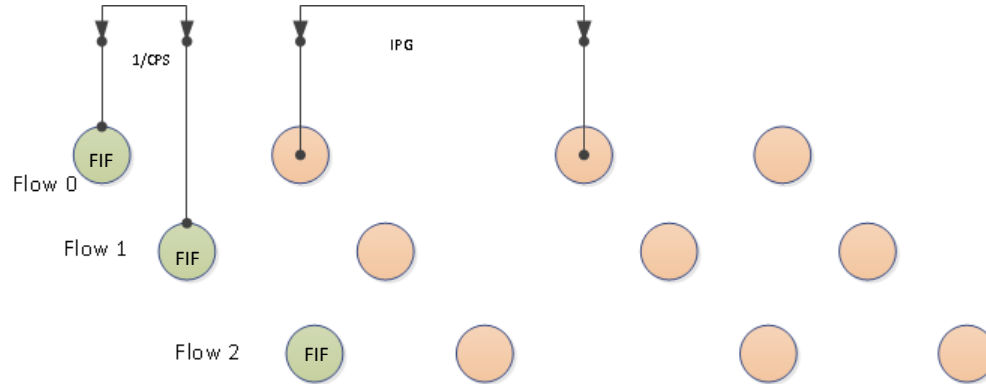
- **DPDK/Multi-Threaded**
 - Scales linearly
 - ~20 Gb/sec per core
 - Supports 1/10/40 Gb Intel NICs
- **Flow-based**
 - Fast event scheduler
 - Generates flow templates
 - Can support 1K templates
 - Scales up to 100K clients, 1M servers
- **Flexible**
 - Client/server generation models
 - Measures jitter/latency/flow order
 - NAT translation/IPv6/Tunnels



- **User Interface**
 - Python API
 - Benchmark automation
 - GUI

Flow Generation

- Example of one flow with four packets



$$\text{Total PPS} = \sum_{k=0}^n \text{CPS}_k \times \text{flow_pkts}_k$$

$$\text{Total CPS} = \sum_{k=0}^n \text{CPS}_k$$

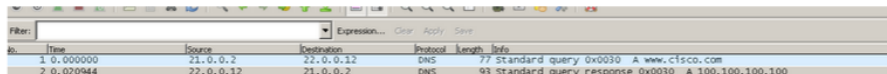
Concurrent flows

$$= \sum_{k=0}^n \text{CPS}_k \times \text{flow_duration}_k$$

DNS simple profile example

```
$more cap2/dns_test.yaml
- duration : 10.0
  generator :
    distribution : "seq"
    clients_start : "16.0.0.1"
    clients_end : "16.0.0.255"
    servers_start : "48.0.0.1"
    servers_end : "48.0.0.255"
    dual_port_mask : "1.0.0.0"
    tcp_aging : 1
    udp_aging : 1
  cap_info :
    - name: cap2/dns.pcap          <1>
      cps : 1.0                    <2>
```

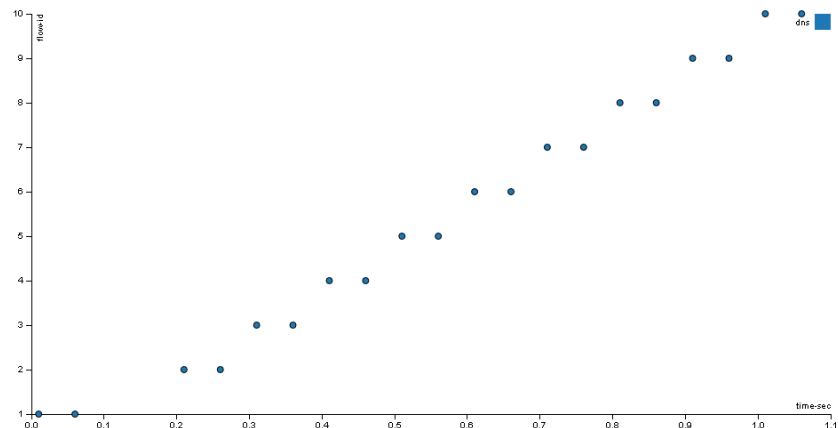
1. the pcap file that include DNS cap file that will be replicate
2. how many connection per second to generate, 1.0 means 1 connection per second



No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	21.0.0.2	22.0.0.12	DNS	77	Standard query 0x0030 A www.cisco.com
2	0.020944	22.0.0.12	21.0.0.2	DNS	93	Standard query response 0x0030 A 100.100.100.100

DNS output

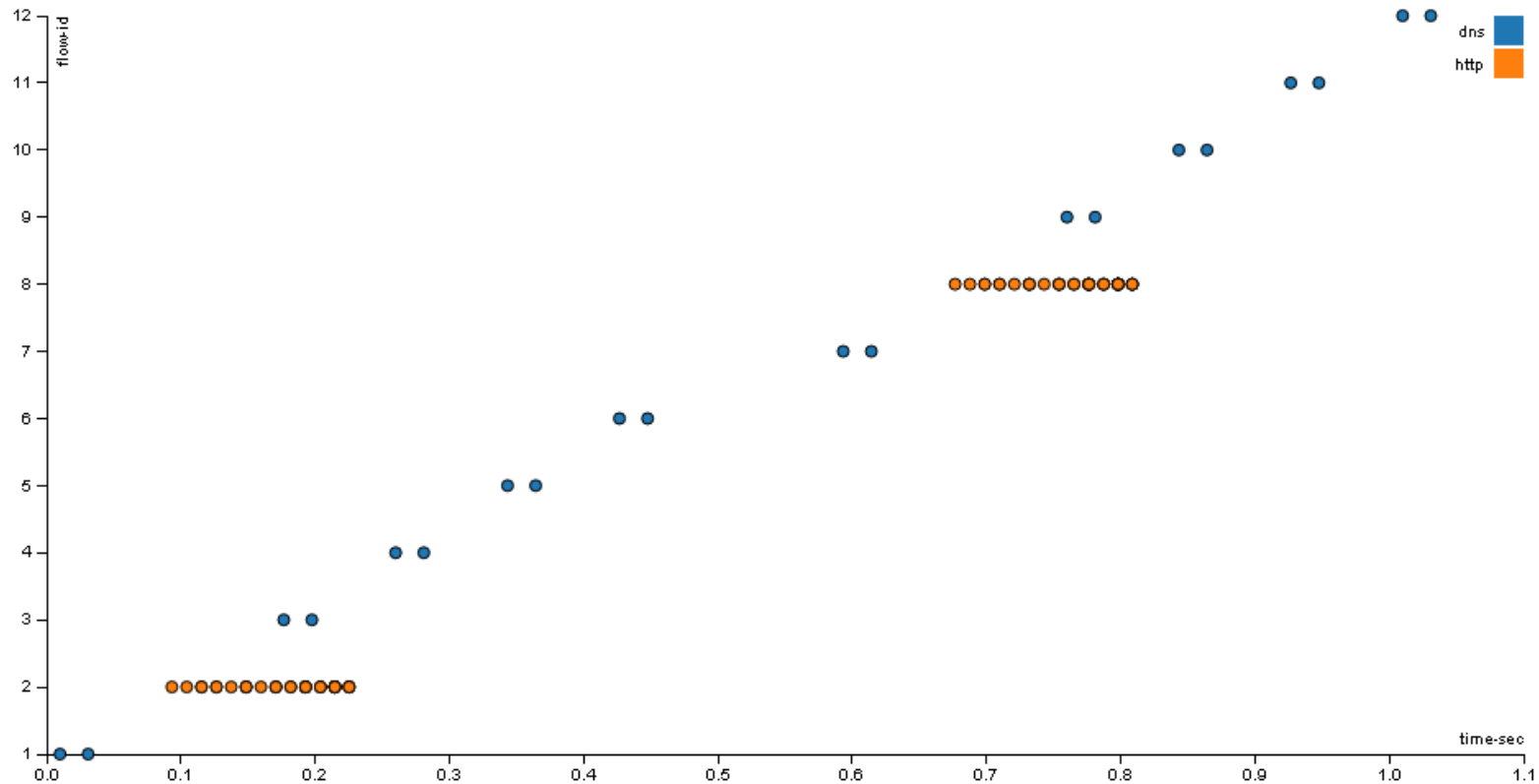
pkt	time sec	fid	flow- pkt- id	client_ip	client_port	server_ip	direction
1	0.010000	1	1	16.0.0.1	1024	48.0.0.1	→
2	0.020000	1	2	16.0.0.1	1024	48.0.0.1	←
3	2.010000	2	1	16.0.0.2	1024	48.0.0.2	→
4	2.020000	2	2	16.0.0.2	1024	48.0.0.2	←
5	3.010000	3	1	16.0.0.3	1024	48.0.0.3	→
6	3.020000	3	2	16.0.0.3	1024	48.0.0.3	←
7	4.010000	4	1	16.0.0.4	1024	48.0.0.4	→
8	4.020000	4	2	16.0.0.4	1024	48.0.0.4	←
9	5.010000	5	1	16.0.0.5	1024	48.0.0.5	→
10	5.020000	5	2	16.0.0.5	1024	48.0.0.5	←
11	6.010000	6	1	16.0.0.6	1024	48.0.0.6	→



HTTP & DNS

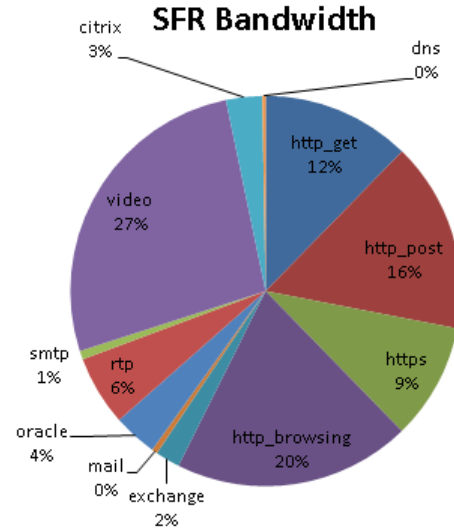
```
- duration : 1.0
  generator :
    distribution : "seq"
    clients_start : "16.0.0.1"
    clients_end : "16.0.0.10"
    servers_start : "48.0.0.1"
    servers_end : "48.0.0.3"
    dual_port_mask : "1.0.0.0"
    tcp_aging : 1
    udp_aging : 1
  cap_ipg : true
  cap_info :
    - name: cap2/dns.pcap
      cps : 10.0 <1>
    - name: avl/delay_10_http_browsing_0.pcap
      cps : 2.0 <1>
```

HTTP & DNS



Enterprise traffic profile

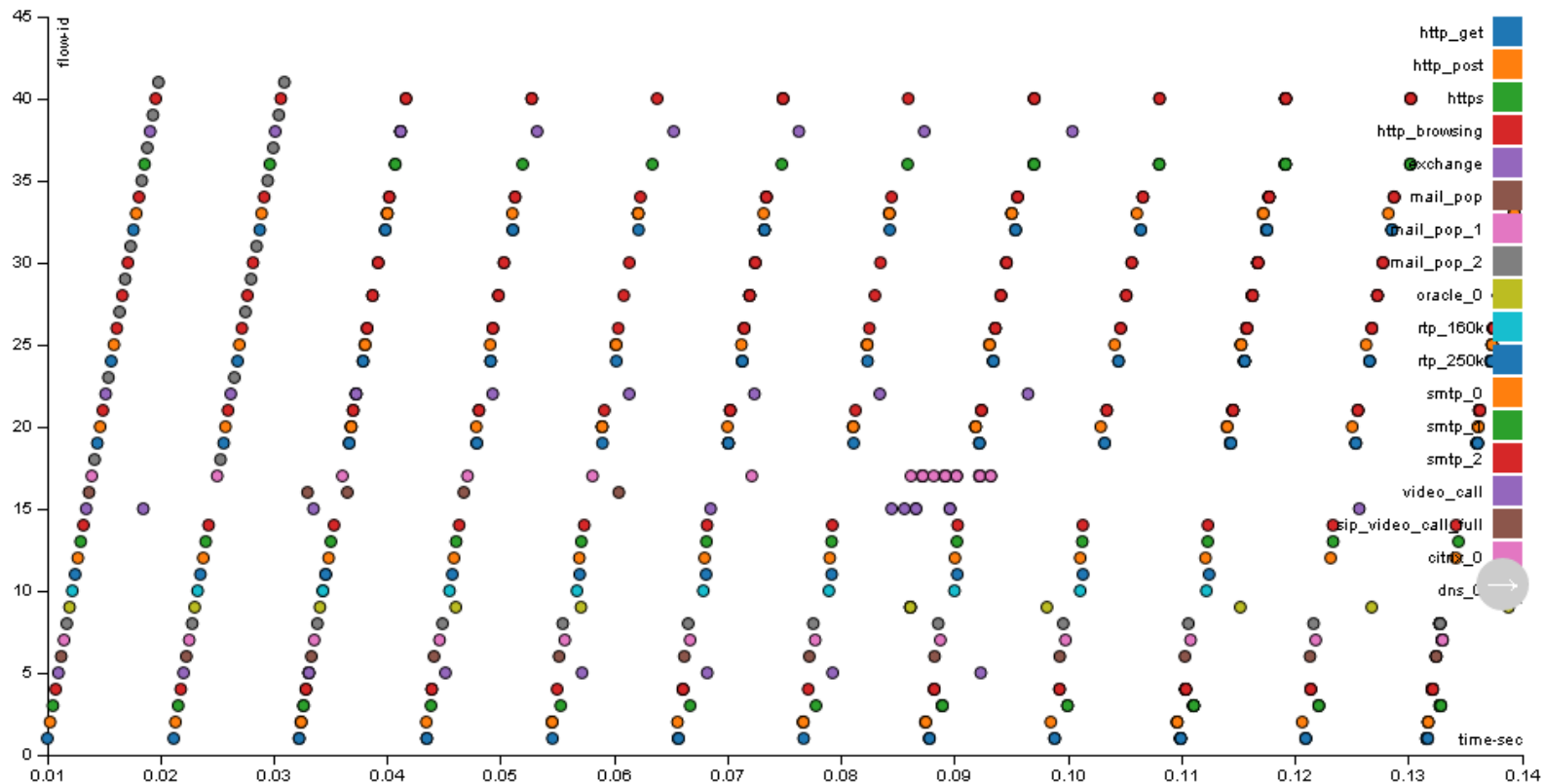
- Includes protocols with Control/Data dependency
 - SIP
 - RTSP



EMIX - YAML

```
- duration : 0.1
  generator :
    distribution : "seq"
    clients_start : "16.0.0.1"
    clients_end : "16.0.1.255"
    servers_start : "48.0.0.1"
    servers_end : "48.0.20.255"
    dual_port_mask : "1.0.0.0"
  cap_ipg : true
  cap_info :
    - name: avl/delay_10_http_get_0.pcap
      cps : 404.52
    - name: avl/delay_10_http_post_0.pcap
      cps : 404.52
    - name: avl/delay_10_https_0.pcap
      cps : 130.8745
    - name: avl/delay_10_http_browsing_0.pcap
      cps : 709.89
    - name: avl/delay_10_exchange_0.pcap
      cps : 253.81
    - name: avl/delay_10_mail_pop_2.pcap
      cps : 4.759
    - name: avl/delay_10_oracle_0.pcap
      cps : 79.3178
    - name: avl/delay_10_rtp_160k_full.pcap
      cps : 2.776
    - name: avl/delay_10_smtp_0.pcap
      cps : 7.3369
    - name: avl/delay_10_sip_video_call_full.pcap
      cps : 29.347
    - name: avl/delay_10_citrix_0.pcap
      cps : 43.6248
    - name: avl/delay_10_dns_0.pcap
      cps : 1975.015
```

EMIX



Demo routing

Cisco ASR 1013 ESP100 100Gb/sec
13RU - 4KW



UCS-220M2 32GB 2x8 cores 2Ghz
2x82559 NIC (4x10Gb/sec)
0.4KW 1RU , 2K\$



TRex

-Per port stats table

ports	0	1	2	3
opackets	71602327	82914082	71601627	82913259
obytes	23990692045	67783397687	23990683213	67783032819
ipackets	82914006	71602322	82913203	71601615
ibytes	67783068258	23986183633	67782693539	23986134949
Tx Bw	3.68 Gbps	8.84 Gbps	3.68 Gbps	8.84 Gbps

Cpu Utilization : 41.6 % 15.0 Gb/core

Platform_factor : 1.0

Total-Tx	:	25.04 Gbps	Nat_time_out	:	0
Total-Rx	:	25.03 Gbps	Nat_no_fid	:	0
Total-PPS	:	5.21 Mpps	Total_nat_active:		33
Total-CPS	:	103.16 Kcps	Total_nat_open	:	6697955

Active-flows	:	90502	Clients	:	248	Socket-util	:	0.5795 %			
Open-flows	:	6713475	Servers	:	5368	Socket	:	90502	Socket/Clients	:	364.9

-Latency stats enabled

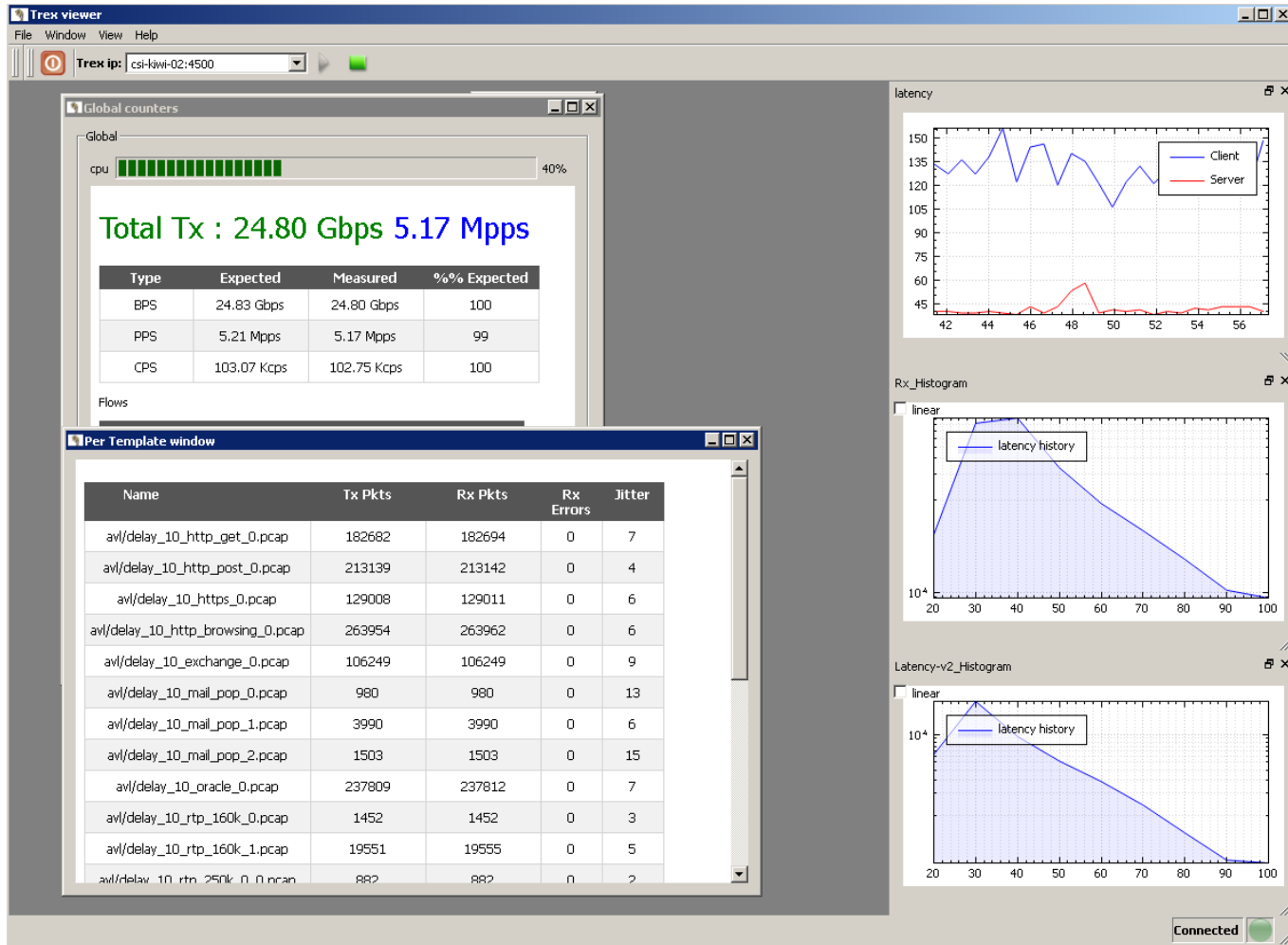
Cpu Utilization : 7.2 %

if	tx_ok	, rx_ok	, rx	,error,	average	, max	, Jitter	, max window
		, check,	, latency(usec),	latency (usec)	, (usec)	, ,		

0	65649,	65648,	647320,	0,	61	,	144,	13		111	130	138	107	127	110
1	65648,	65649,	552181,	0,	37	,	62,	3		42	42	43	39	38	39
2	65649,	65648,	660627,	0,	57	,	144,	11		103	139	130	97	126	
3	65648,	65649,	562860,	0,	37	,	55,	3		39	41	39	39	46	39

-Rx Check stats enabled

rx check:	avg/max/jitter latency,	63	,	176,	18		130	158	159	138	155	175	136
active flows:	647, fif:	52193,	drop:	0,	errors:	0							



Configure NAT & Firewall

-Global stats enabled

Cpu Utilization : 34.9 % 15.9 Gb/core

Platform_factor : 1.0

Total-Tx : 22.24 Gbps Nat_time_out : 3910462

Total-Rx : 22.24 Gbps Nat_no_fid : 735

Total-PPS : 4.87 Mpps Total_nat_active: 46

Total-CPS : 102.79 Kcps Total_nat_open : 11287417

Active-flows : 79813 Clients : 248 Socket-util : 0.5110 %

Open-flows : 11313545 Servers : 5368 Socket : 79813 Socket/Clients : 321.8

-Latency stats enabled

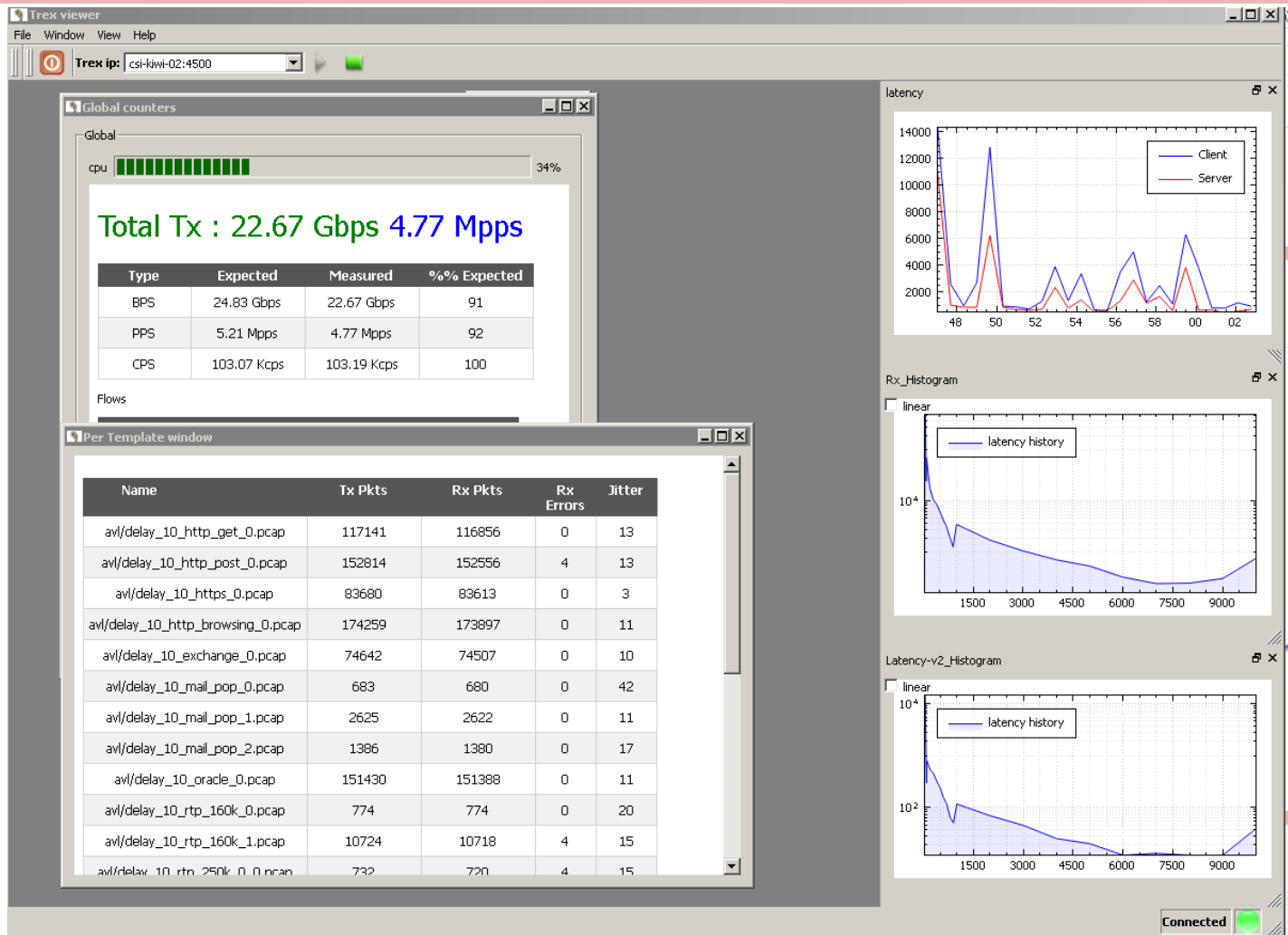
Cpu Utilization : 6.7 %

if| tx_ok , rx_ok , rx ,error, average , max , Jitter , max window
| , , check, , latency(usec),latency (usec) ,(usec) ,

```
--
0 | 110281, 110279, 714052, 0, 204 , 14313, 16 | 807 1276 3439 935 850 5175
1 | 110280, 110280, 644514, 0, 91 , 10907, 5 | 802 653 1344 717 701 3436
2 | 110281, 110280, 720630, 0, 201 , 14355, 14 | 808 1194 3357 972 822 5177
3 | 110280, 110281, 645768, 0, 90 , 10491, 3 | 800 642 1349 706 699 3279
```

-Rx Check stats enabled

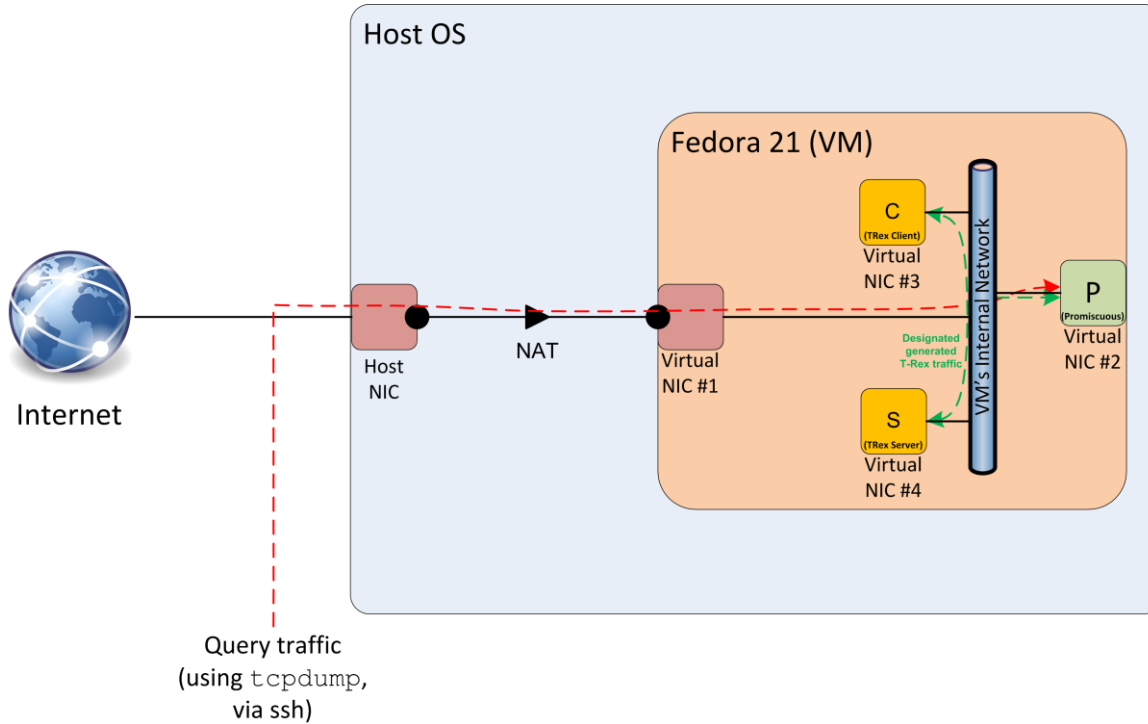
```
-----
rx check: avg/max/jitter latency, 180 , 14785, 407 | 2321 2546 4229 1627 1912 5275
active flows: 690, fif: 57593, drop: 14179, errors: 14552
-----
```



Roadmap

- RPC support
- Stateless support (Ostinato like)
 - Streams
 - Stats per stream
 - Any type of packet
 - GUI to build packet
 - Emulation
- Stateful
 - TCP stack
 - SDK for light application

TRex on your laptop (virtualbox)



Resources

- [Web](#)
- [GitHub](#)
- [Manual](#)
- [Presentation](#)





Thank you !