CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF ELECTRICAL ENGINEERING

DEPARTMENT OF TELECOMMUNICATION ENGINEERING

F-Tester

TCP/IP testing platform

We aren't packet generator

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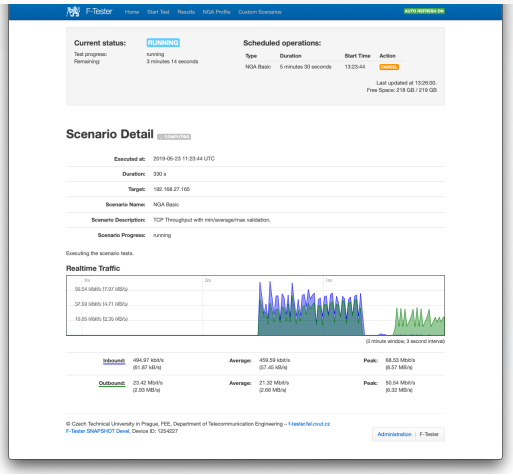
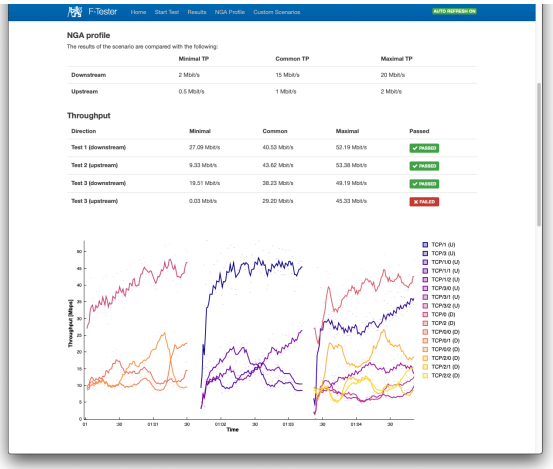
Activity Issues

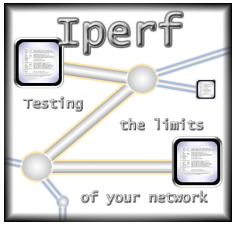
- Forms:
  - Analysis, Diagnosis and Testing
  - Research and development
  - Expert and consultant activity
  - Training and Courses
- Fields:
  - Data networks
  - Optical Networks
  - Access Networks (NGA)
  - Evaluation and measurement of QoS, QoE
  - Smart Grids, Internet of things, Industry 4.0
  - Cyber Security

F-Tester – Basic Description

- HW/SW Solution
  - Linux based system (OpenWRT)
  - Supported platforms – x86 (testing: MIPS, ARM)
  - Distribution
    - Network Device (PC Engines APU's)
    - Virtualization
  - HW modification
    - Ethernet 10/100/1000 – now
    - Mobile network – 3Q 2019
    - Wi-Fi network – 3Q 2019
    - 2.5/5/10G Ethernet – 1Q 2020
- Measurement tools
  - Iperf3
  - FlowPing
- Configuration
  - WEB Interface
  - JSON-RPC
  - CLI (SSH, Terminal)

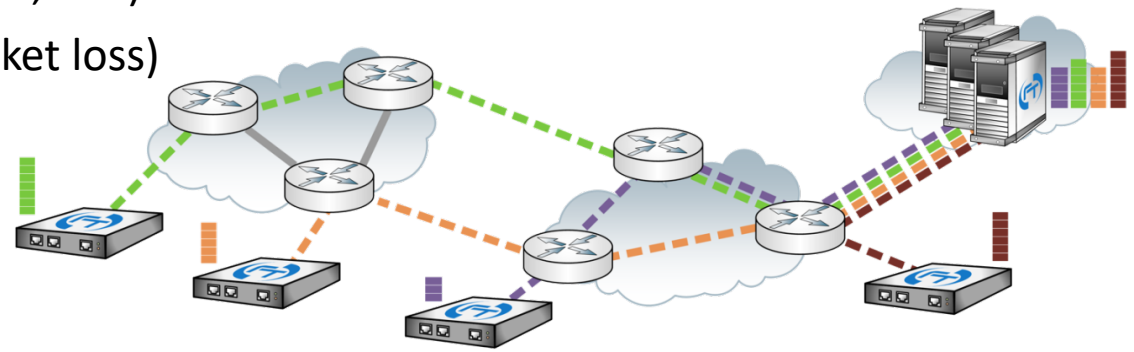






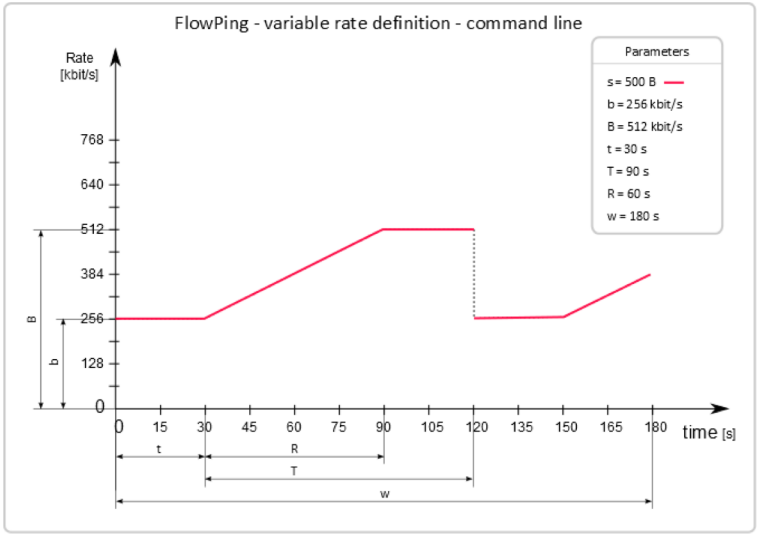
Clever Data Generator and Analyzer F-Tester

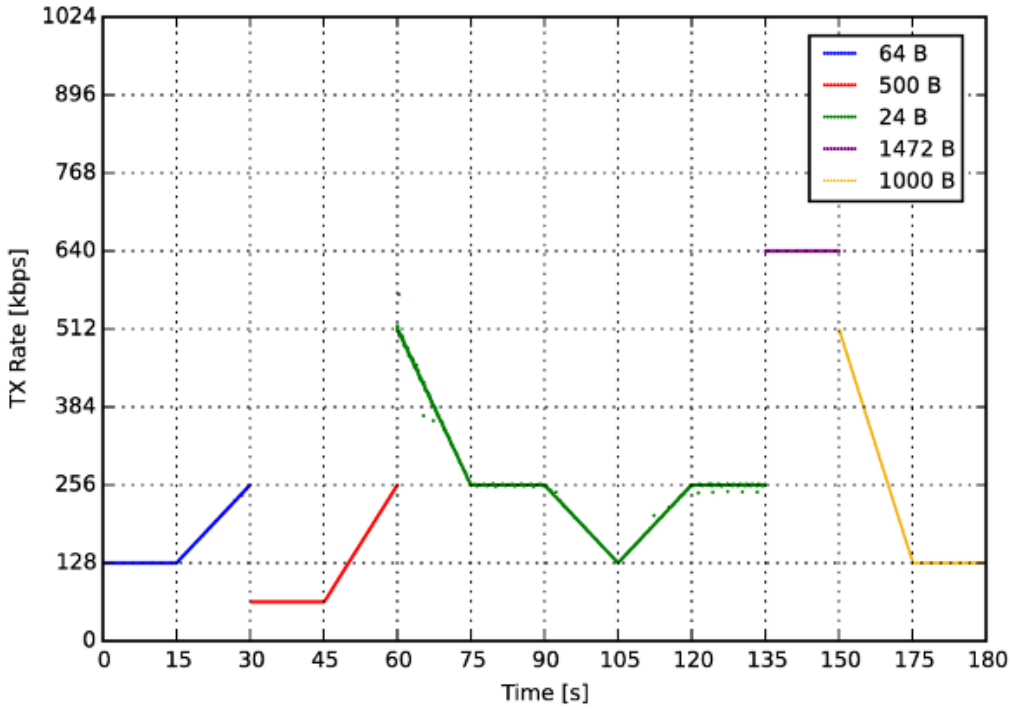
- Performance testing of communication networks
  - Stress test
  - Stability test
  - Protocol/service testing
- Network topology
  - Point-to-point (two F-Testers)
  - Point-to-Multipoint (server and many F-Testers)
  - Mesh (many F-Testers)
- Multi-data streams
  - TCP (true data throughput, RTT)
  - UDP (ramp test, RTT, packet loss)



Original Testing Tool - FlowPing

- UDP/IP based tool
- High variability of tests
  - data rates
  - packet size
  - timing of changes
  - symmetric/asymmetric stream





- License - GNU GPLv3
- https://flowping.fel.cvut.cz
- https://github.com/k13132/flowping

PLC (Power Line Communication)

Narrowband (PLC, NPL, NB-PLC)

- 4 bands by CENELEC 50065-1
- Units up to tens of kbps

Broadband (BPL)

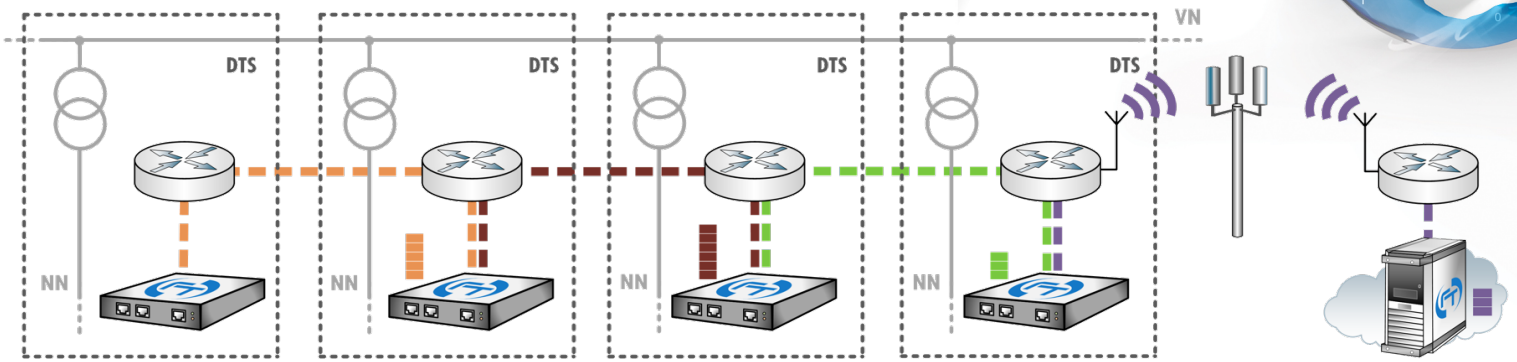
- Units up to tens of Mbps
- Mbps up to 1 Gbps

Outdoor/Indoor

Voltage level

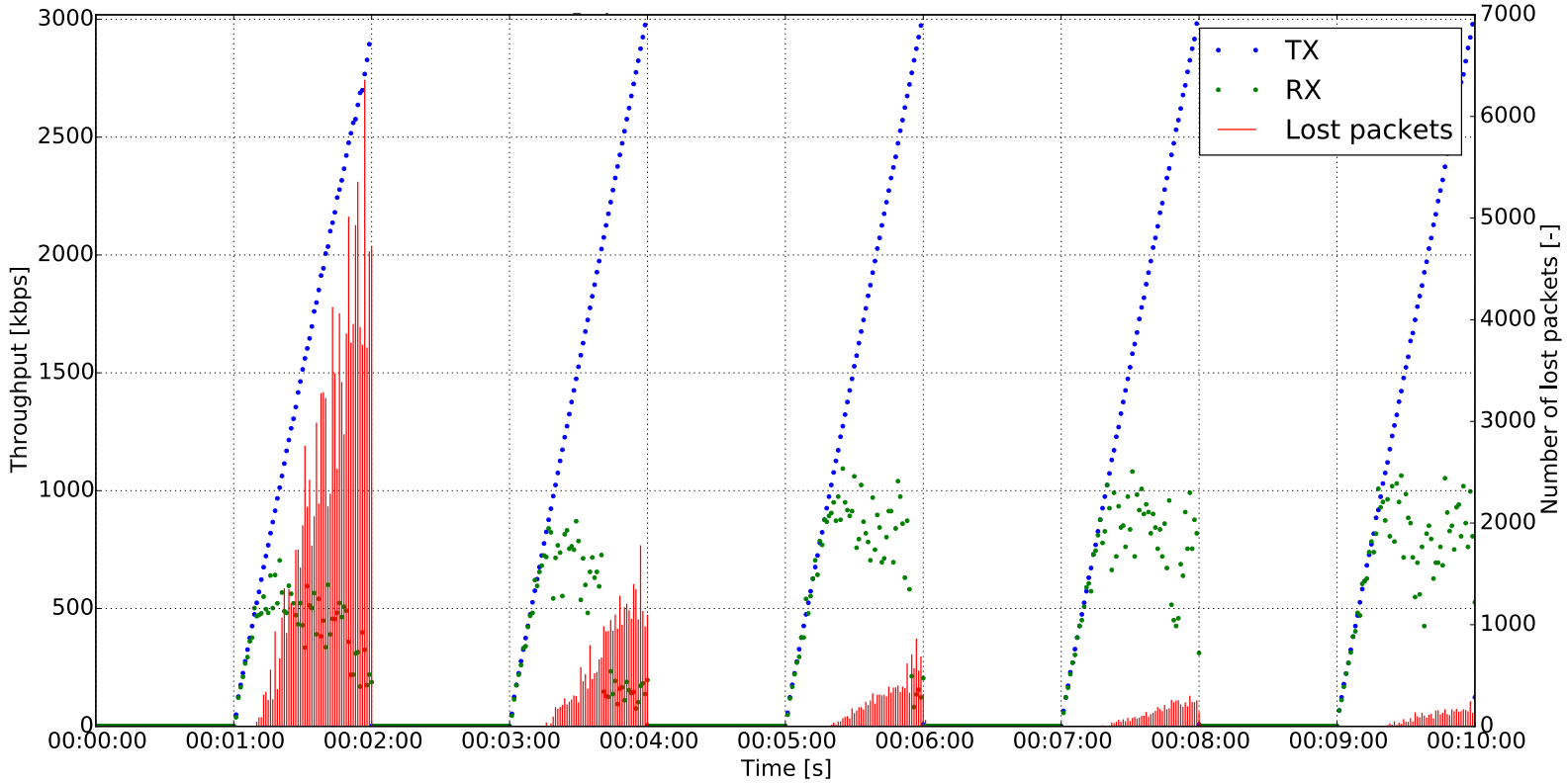
- LV – low voltage, LAN, power meter connection (AMM)
- MV/HV – signalization and commands

Testing of PLC Networks



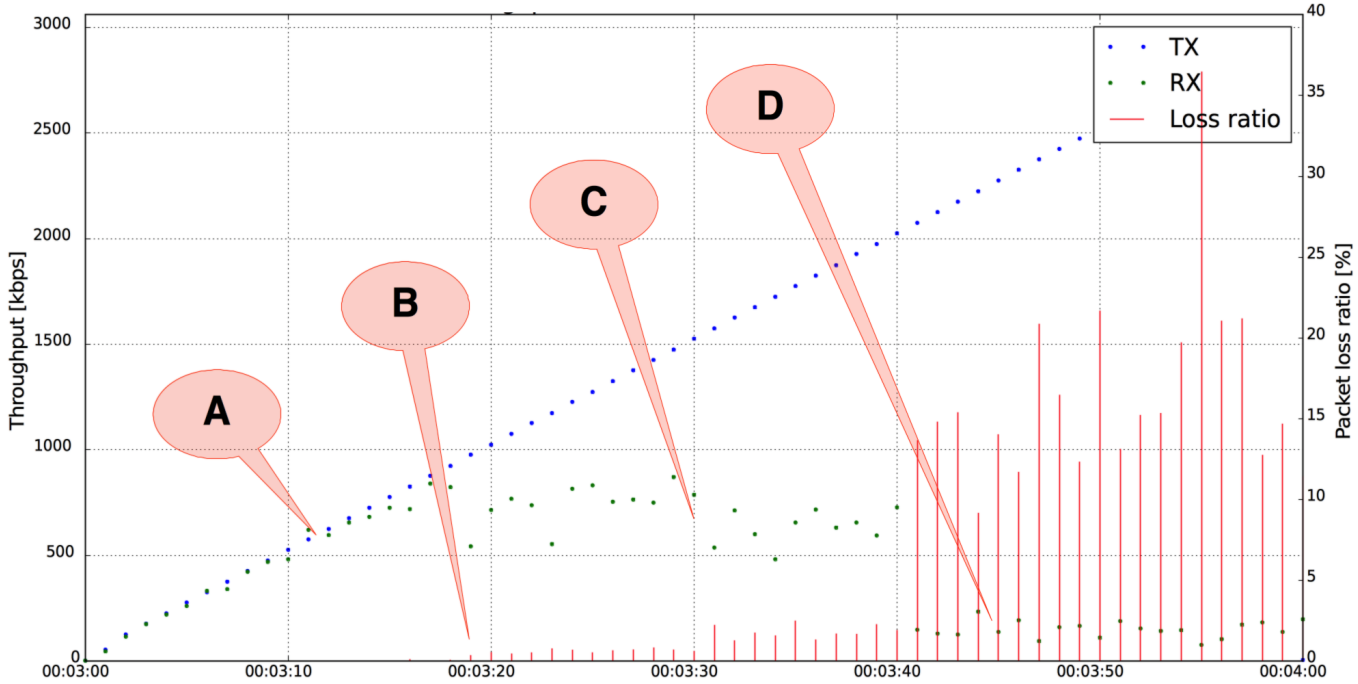
Testing process

- Stress test – Tooth SAW
  - Packet size: 64 B, 256 B, 512 B, 1024 B, 1400 B



Testing process

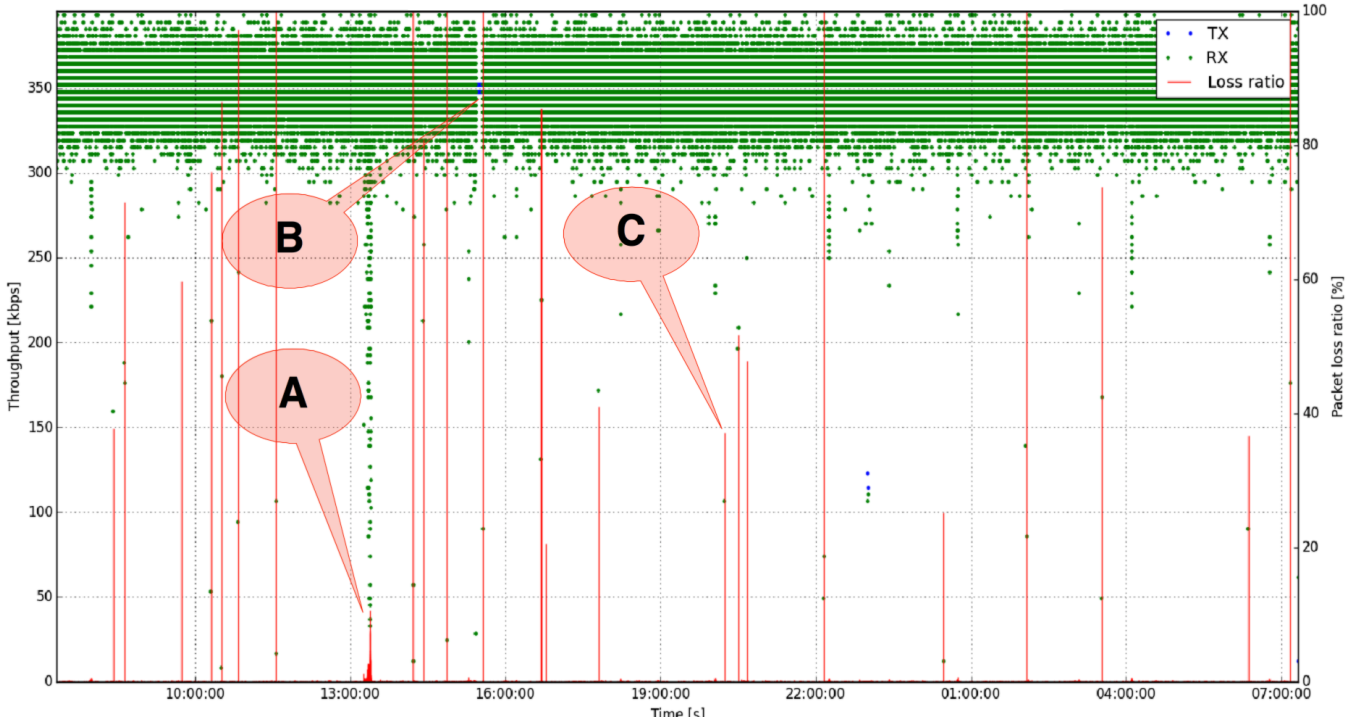
- Stress test – Tooth SAW detail



Point **A** indicates the area of initial saturation of the data link. Point **B** shows the moment of the first recorded loss of packet. Point **C** is in the area of maximum data link throughput before significant loss of packets begins. A heavily congested data link is the area around the **D** point.

Testing process

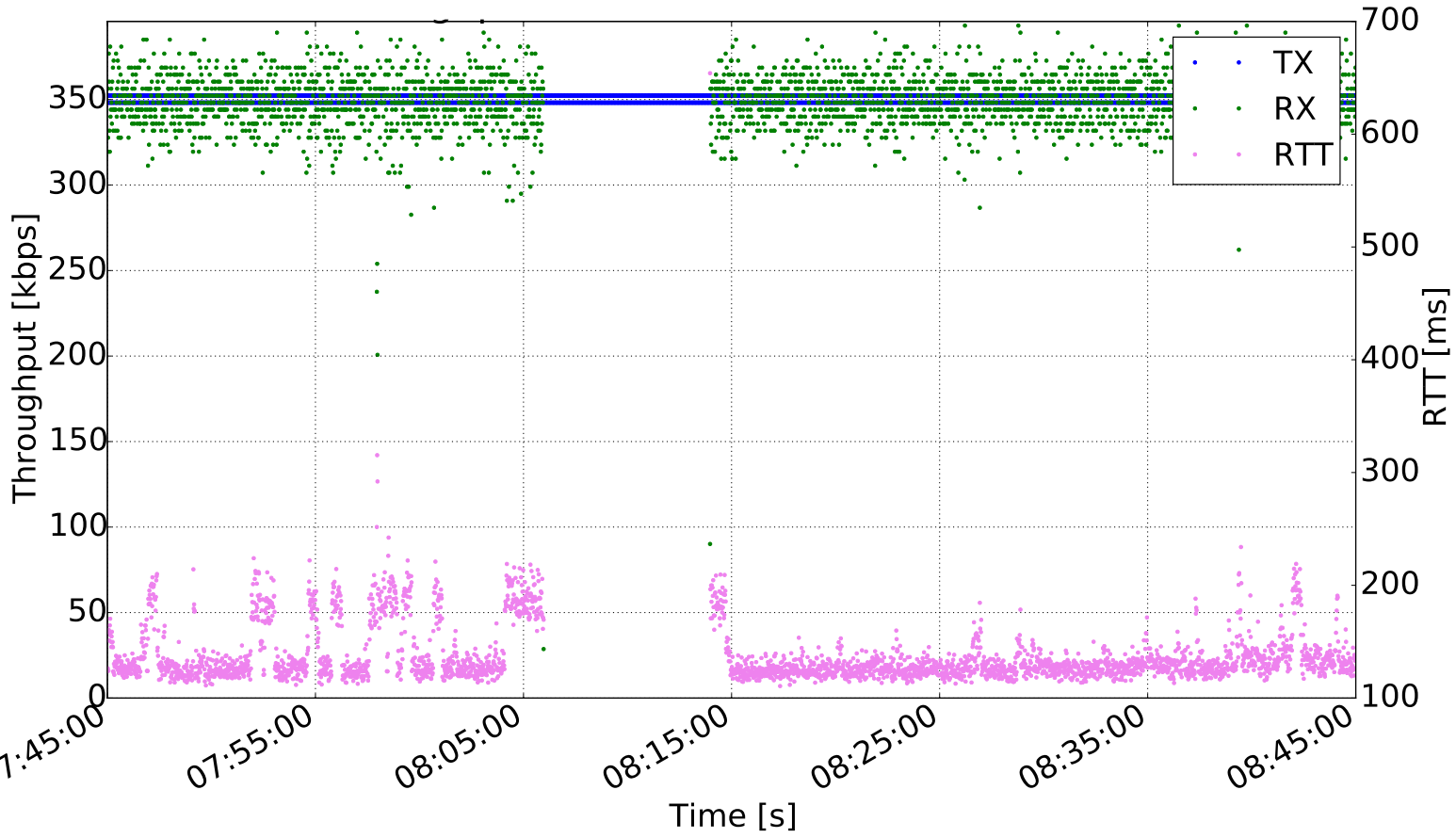
- Stability test by FlowPing
  - Utilisation of maximum 5 % of the nominal data rate
  - Testing in both directions with maximum packet size



At point **A**, there is a deterioration in the data link transfer properties leading to a decrease in bit rate and accumulation of loss. Point **B** indicates a more serious problem of interrupting communication in a few tens of minutes. Packet loss at point **C** is a brief deterioration of data link parameters over a few seconds.

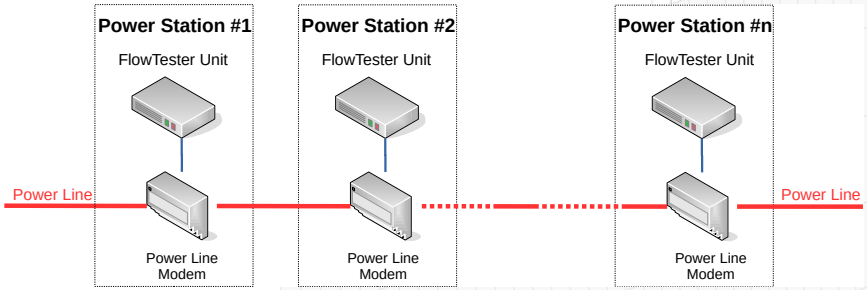
Testing process

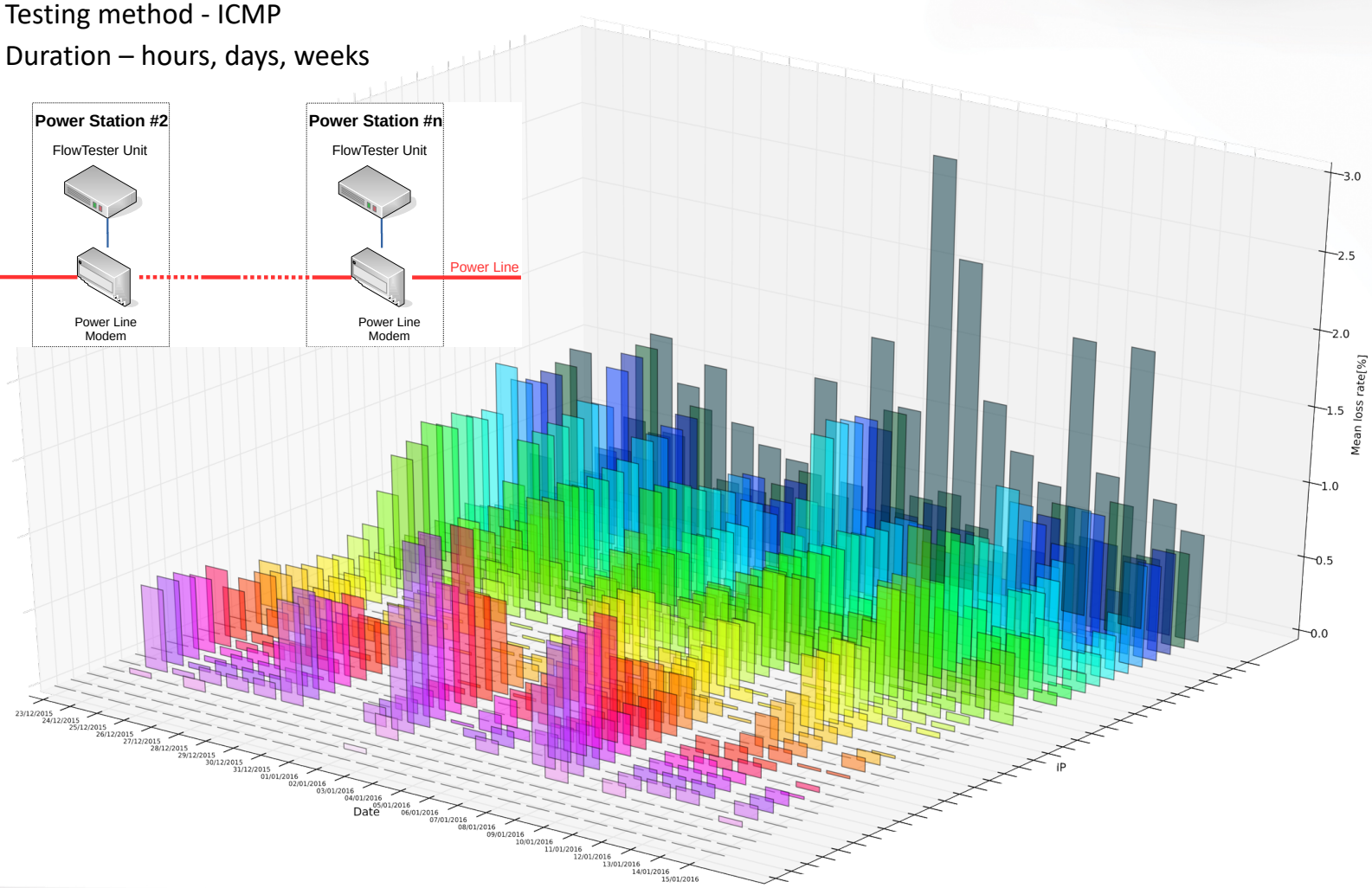
- Stability test - detail



Testing process

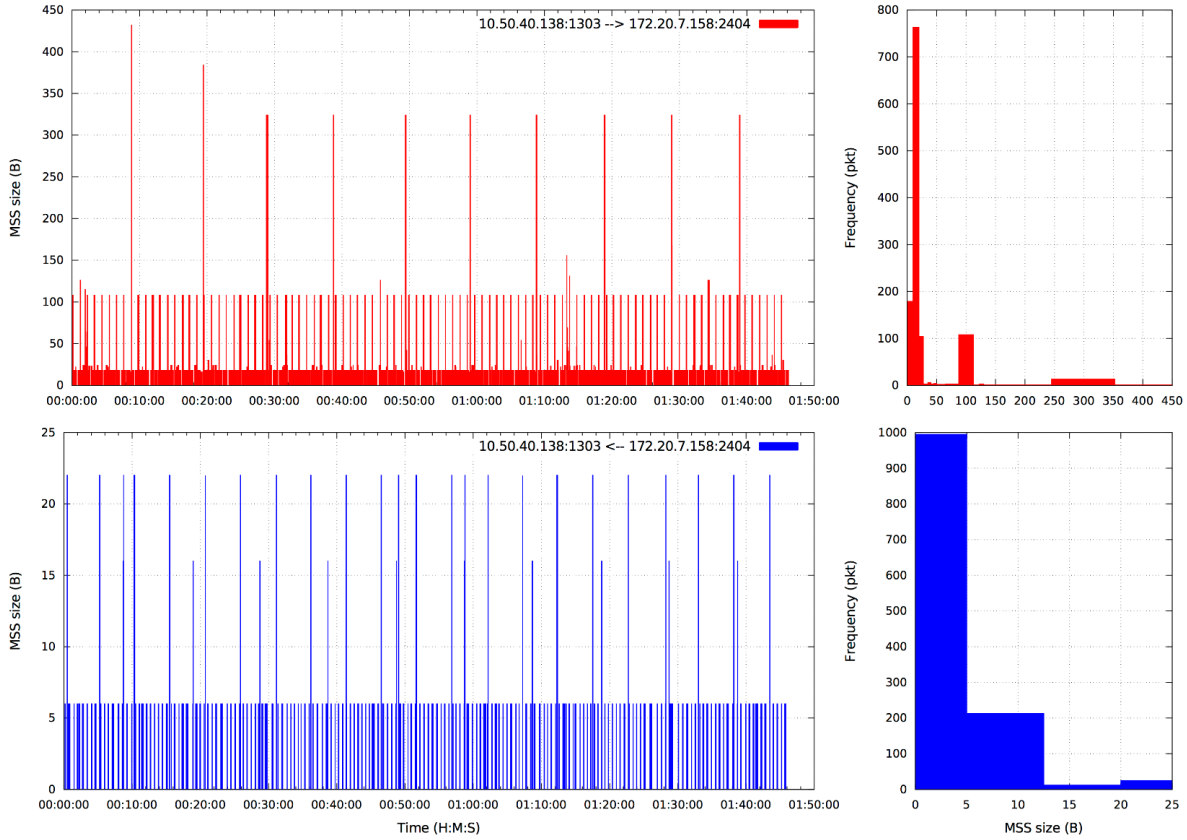
- Stability test - availability checking
  - Testing method - ICMP
  - Duration – hours, days, weeks





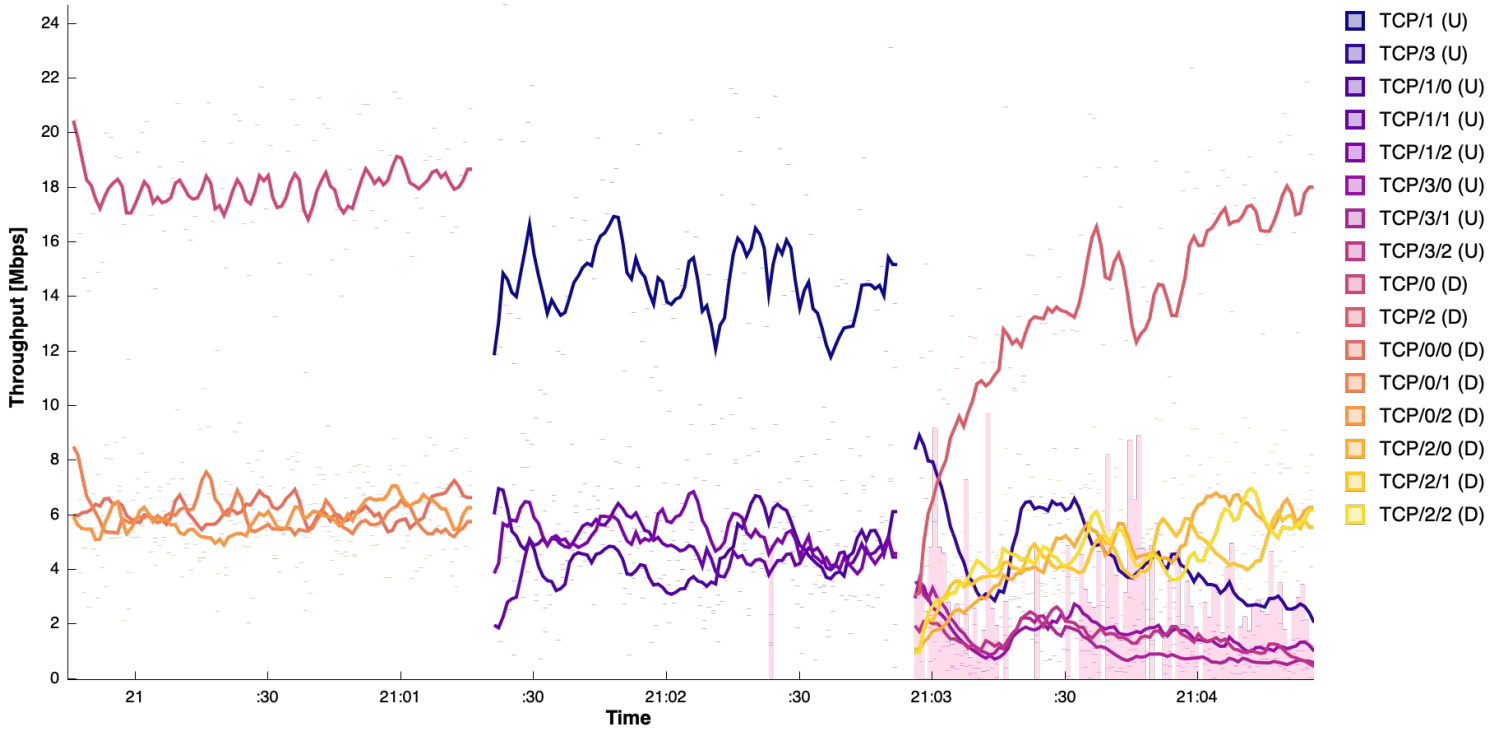
Testing process

- Protocol/service testing – by FlowPing
  - Real communication flow pattern
  - Example – IEC 60870-104 (SCADA) on wireless narrow band TCP/IP network



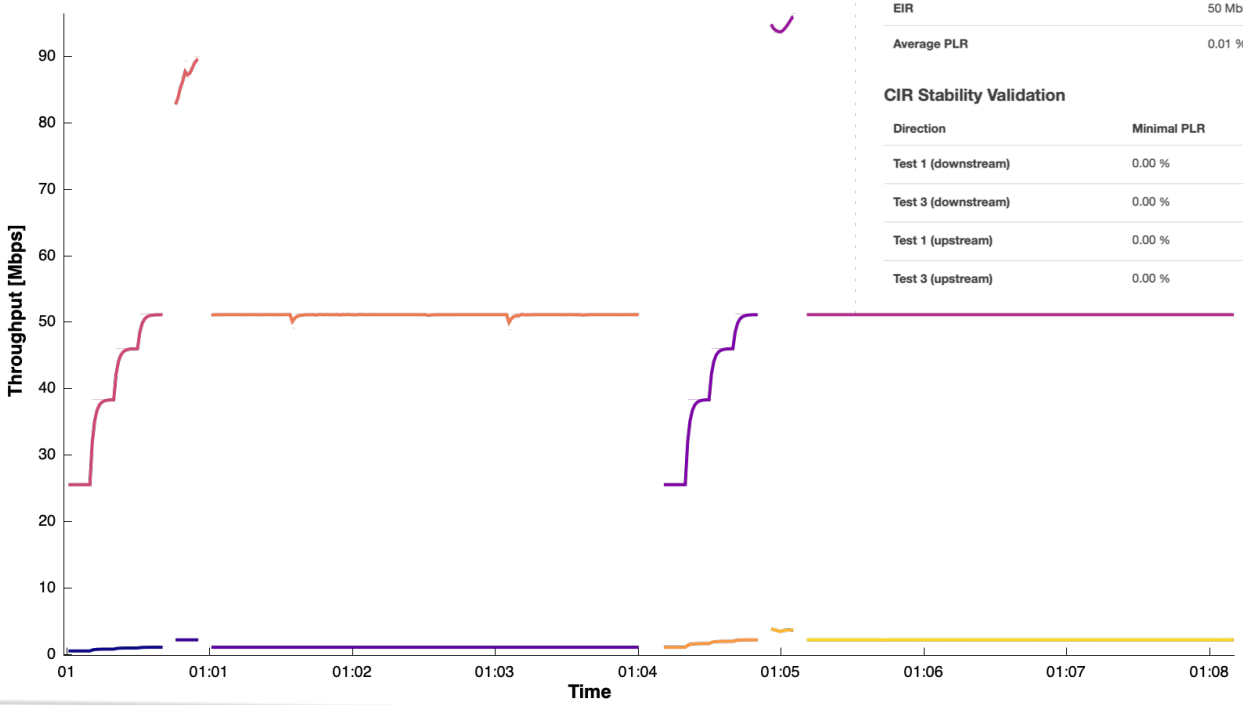
Example of NGA Basic Testing

- Next Generation Access networks measurement (TCP based)
  - Measurement with built-in evaluation (SLA)
  - Three sections of test (downstream, upstream, combined)
  - Multiple parallel TCP streams and summary of streams



Example of NGA Complementary Testing

- Next Generation Access networks measurement (UDP based)
  - Measurement with built-in evaluation (SLA)
  - Evaluation based on EtherSAM (ITU-T Y.1564)
  - Three sections of test (0.5, 0.75, 0.9 and 1 of CIR; CIR+EIR; CIR)



NGA profile

The results of the scenario are compared with the following:

	Downstream	Upstream
CIR	50 Mbit/s	50 Mbit/s
EIR	50 Mbit/s	50 Mbit/s
Average PLR	0.01 %	0.01 %

CIR Stability Validation

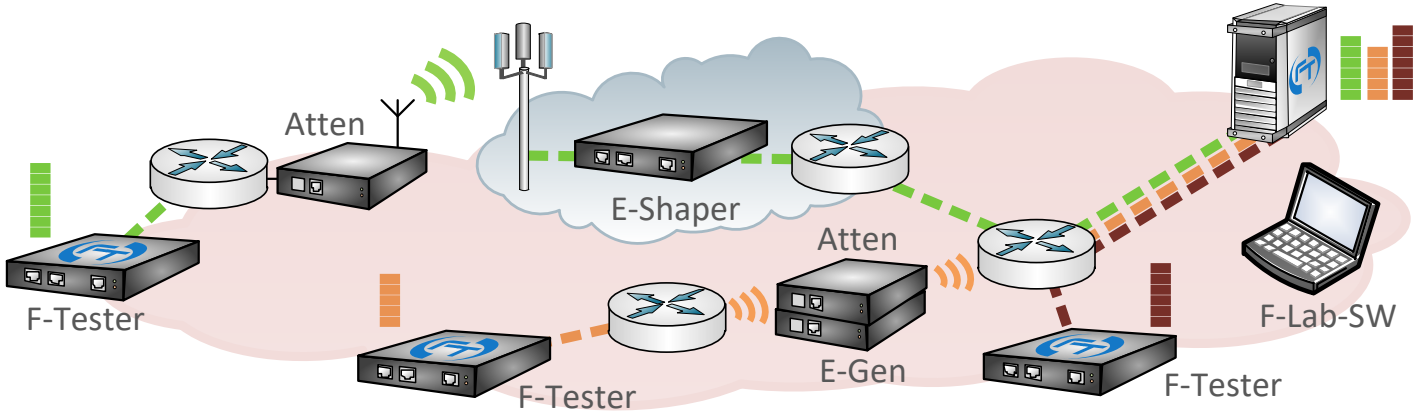
Direction	Minimal PLR	Average PLR	Maximal PLR	Passed
Test 1 (downstream)	0.00 %	0.00 %	0.00 %	PASSED
Test 3 (downstream)	0.00 %	0.05 %	4.60 %	FAILED
Test 1 (upstream)	0.00 %	0.00 %	0.09 %	PASSED
Test 3 (upstream)	0.00 %	0.02 %	1.84 %	FAILED

Complex Testing System „F-Lab“

Possible to emulate:

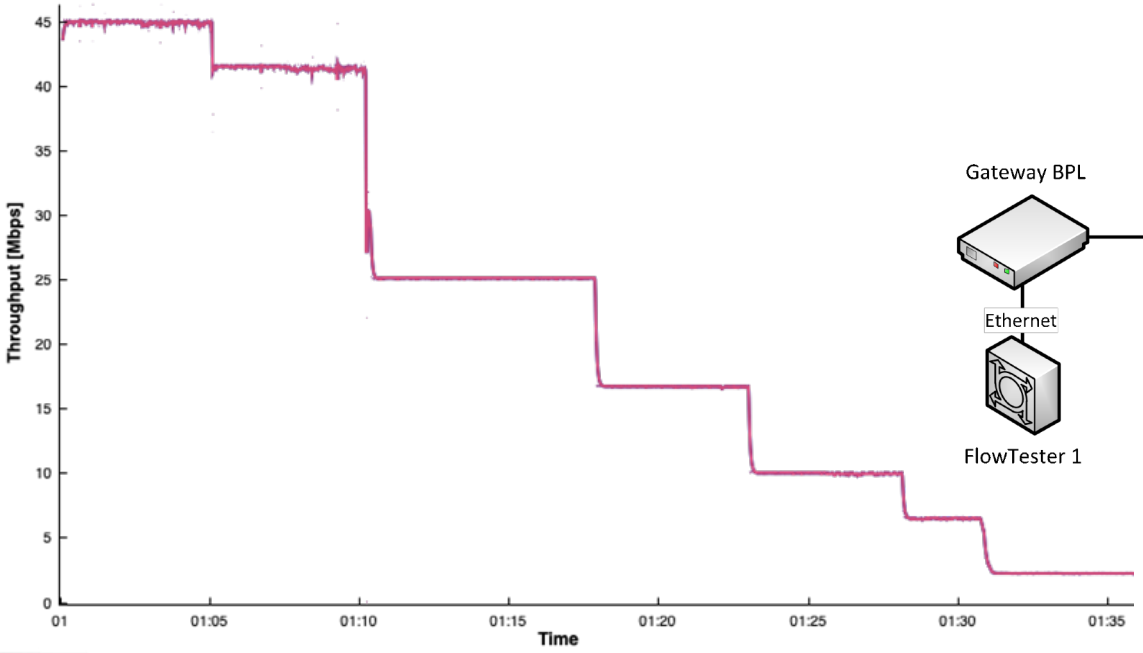
- **Analog environment** of communication channels
- **Parameters of complex IP data network** (delay, throughput, packet loss)
- **Network endpoint behaviour**

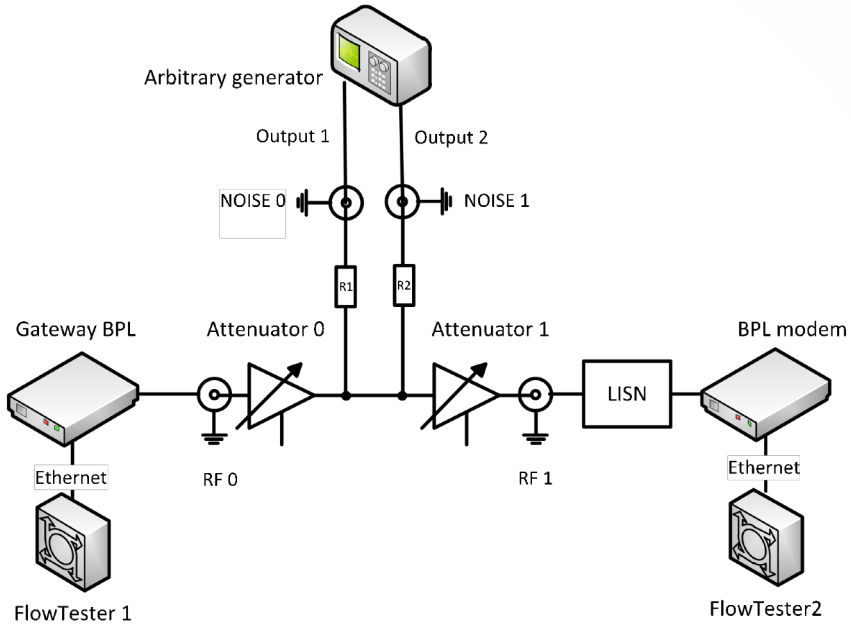
- **F-Tester** (FlowTester) – clever data generator and analyzer
- **E-Shaper** (Ethernet Shaper) - communication network emulator
- **F-Cap** (Flow Capture)
- **Atten** – remote-controlled attenuator with interference injection
- **E-Gen** (Signal Generator Controller) to add a defined noise to communication channel



Example of Smart Grid Testing

- Time dependence of TCP throughput
  - BPL transmission on MV line
  - For constant AWGN noise and step increase attenuation





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Thank you

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