

50 let

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techniky

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development
education

research

70



70 let

Fakulty
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CZECH
TECHNICAL
UNIVERSITY
IN PRAGUE

**FACULTY
OF ELECTRICAL ENGINEERING**

DEPARTMENT OF TELECOMMUNICATION ENGINEERING



F-Tester

TCP/IP testing platform



We aren't
packet generator

Zbyněk Kocur
Ondřej Vondrouš
Ondřej Votava

Activity Issues

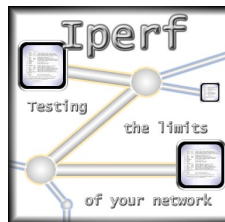
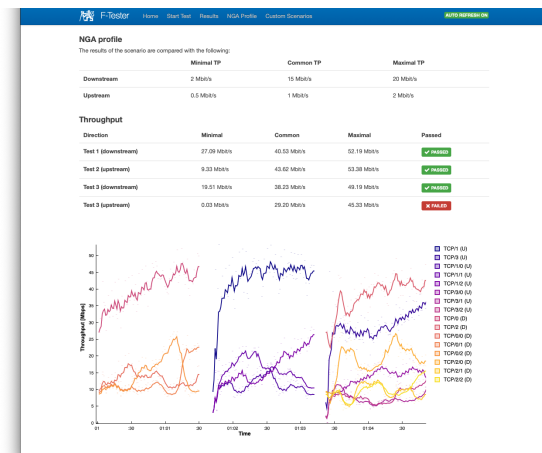
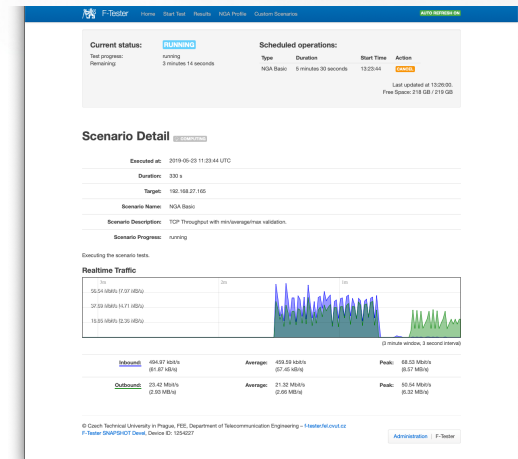


- Forms:
 - Analysis, Diagnosis and Testing
 - Research and development
 - Expert and consultant activity
 - Training and Courses
- Fields:
 - Data networks
 - Optical Networks
 - Access Networks (NGA)
 - Evaluation and measurement of QoS, QoE
 - Smart Grids, Internet of things, Industry 4.0
 - Cyber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

F-Tester – Basic Description



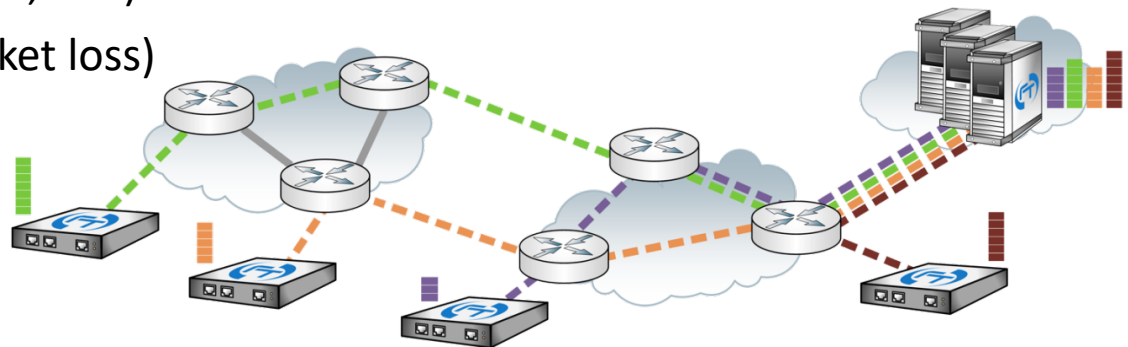
- HW/SW Solution
 - Linux based system (OpenWRT)
 - Supported platforms – x86 (testing: MIPS, ARM)
 - Distribution
 - Network Device (PC Engines APU's)
 - Virtualization
- HW modification
 - Ethernet 10/100/1000 – now
 - Mobile network – 3Q 2019
 - Wi-Fi network – 3Q 2019
 - 2.5/5/10G Ethernet – 1Q 2020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



Clever Data Generator and Analyzer F-Tester



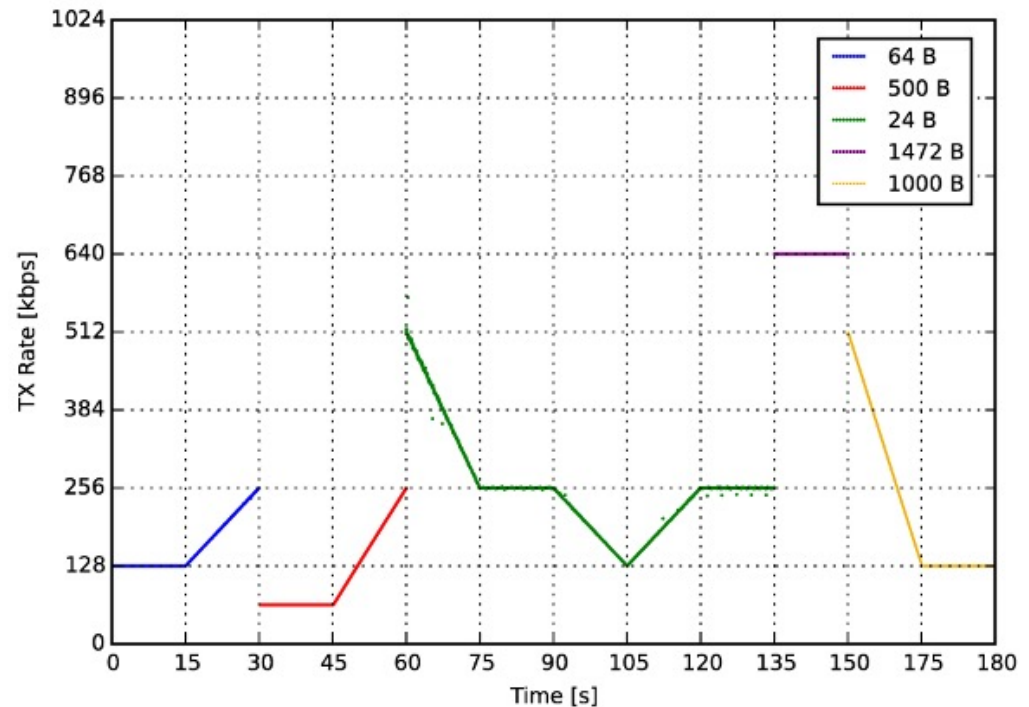
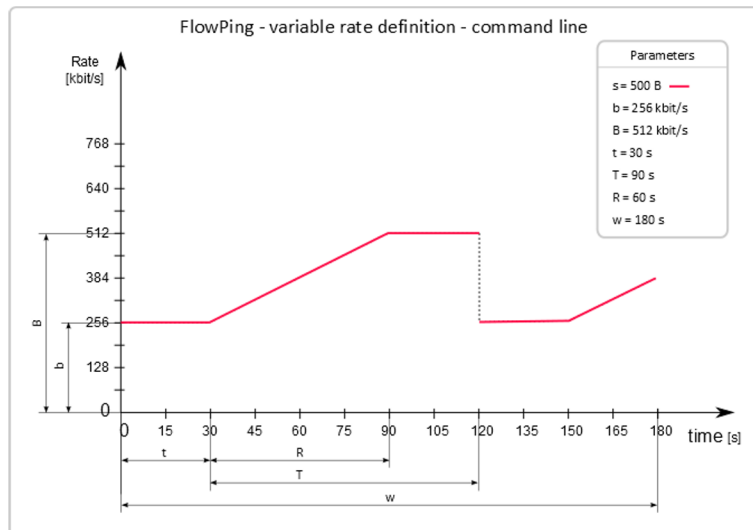
- Performance testing of communication networks
 - Stress test
 - Stability test
 - Protocol/service testing
- Network topology
 - Point-to-point (two F-Testers)
 - Point-to-Multipoint (server and many F-Testers)
 - Mesh (many F-Testers)
- Multi-data streams
 - TCP (true data throughput, RTT)
 - UDP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

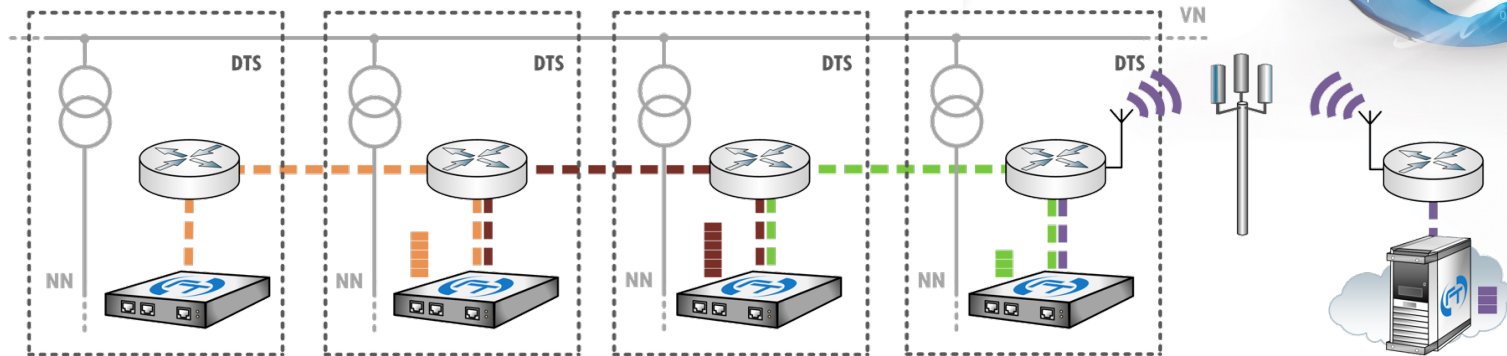
- ▶ Units up to tens of Mbps
- ▶ Mbps up to 1 Gbps

Outdoor/Indoor

Voltage level

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

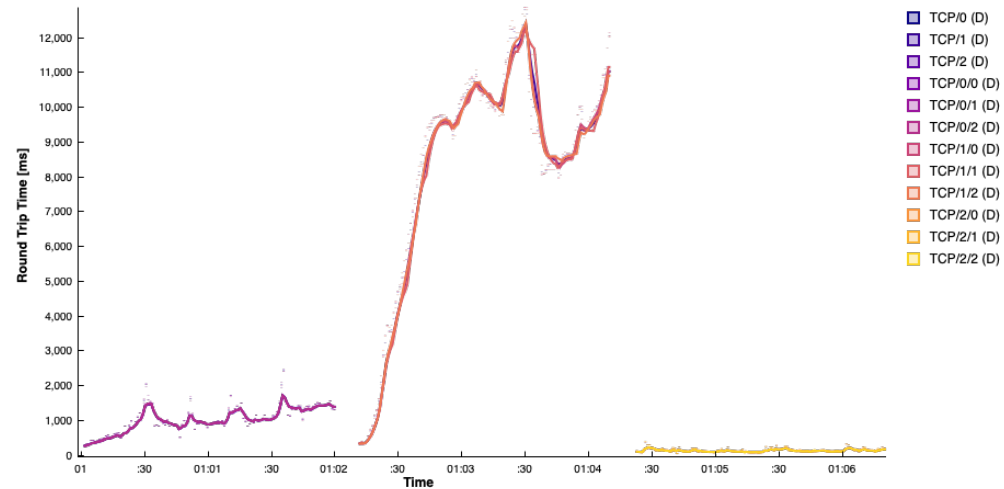
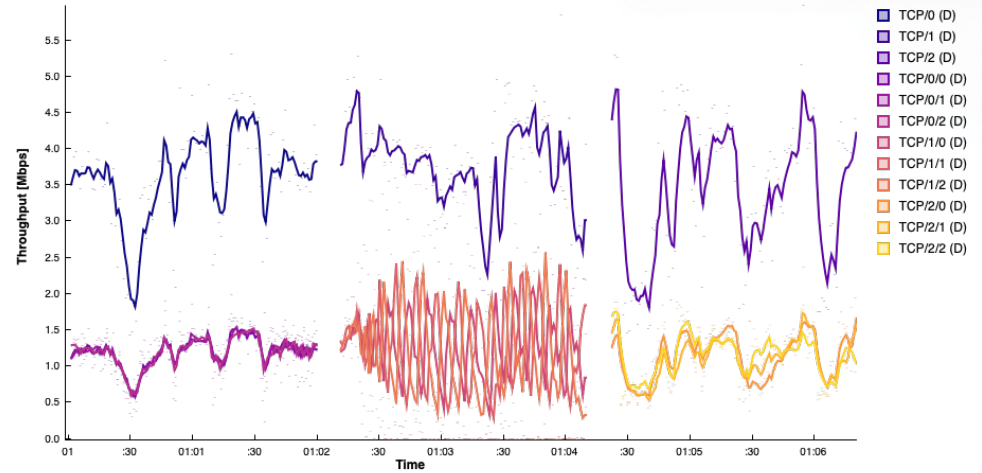
Testing of PLC Networks



Testing of Mobile Networks



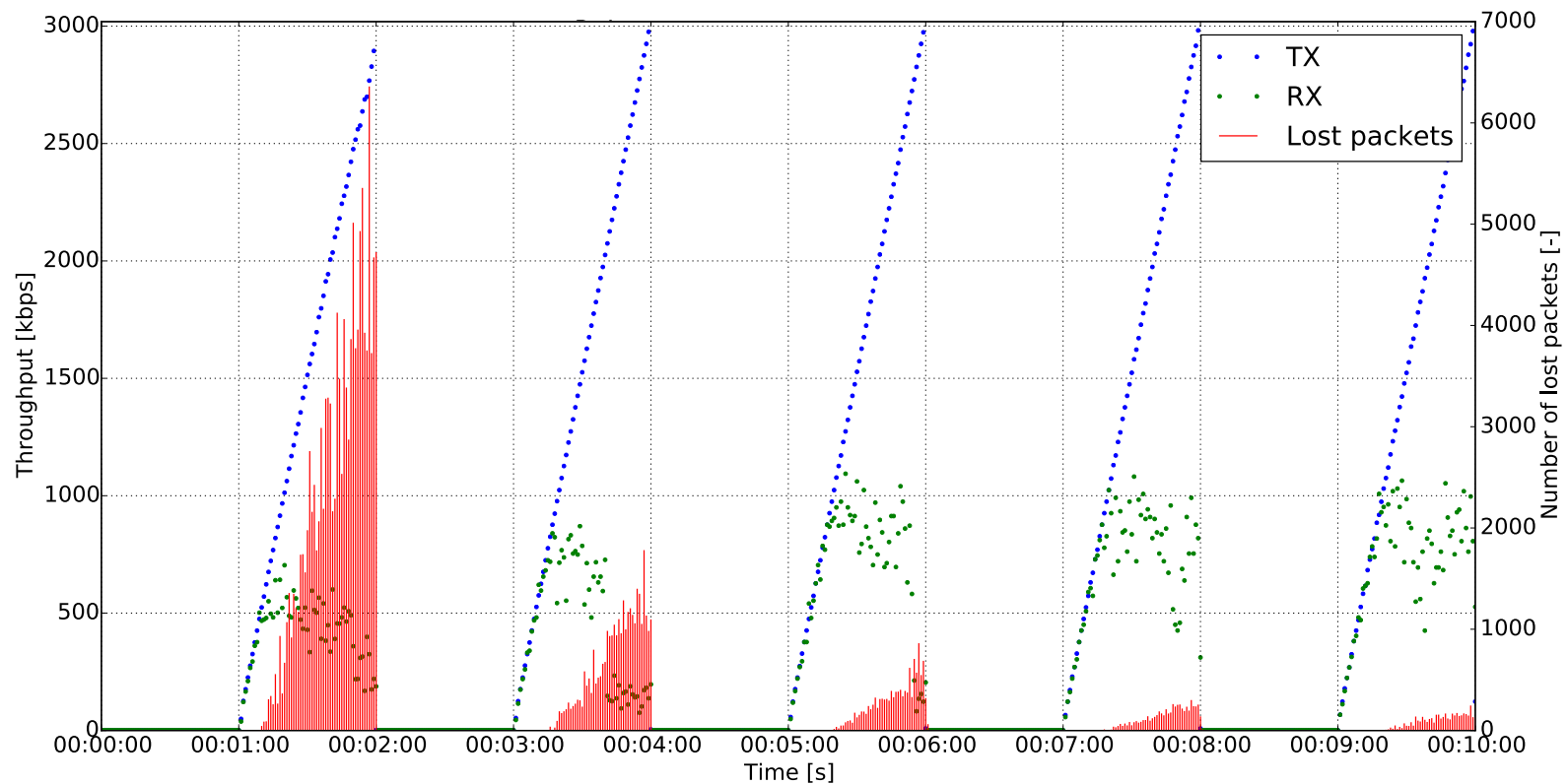
LTE: TCP Reno & TCP Cubic & TCP BBR



Testing process



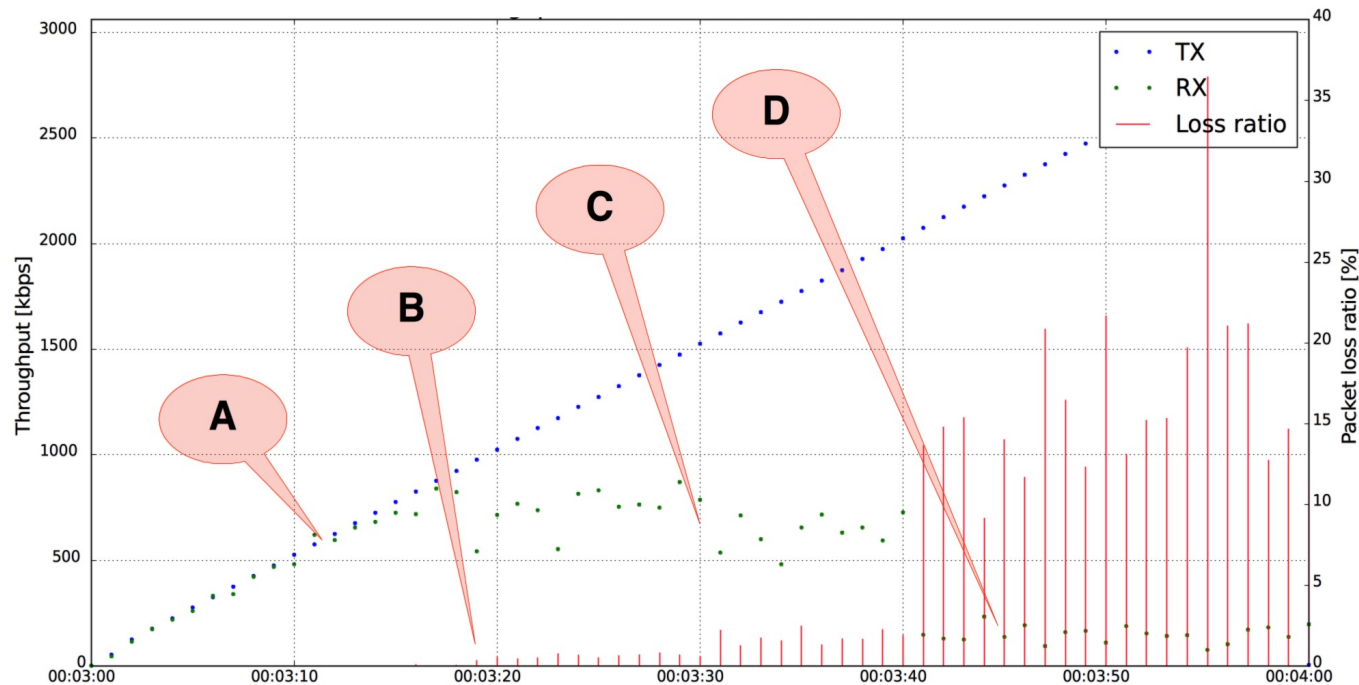
- Stress test – Tooth SAW
 - Packet size: 64 B, 256 B, 512 B, 1024 B, 1400 B



Testing process



- Stress test – Tooth SAW detail

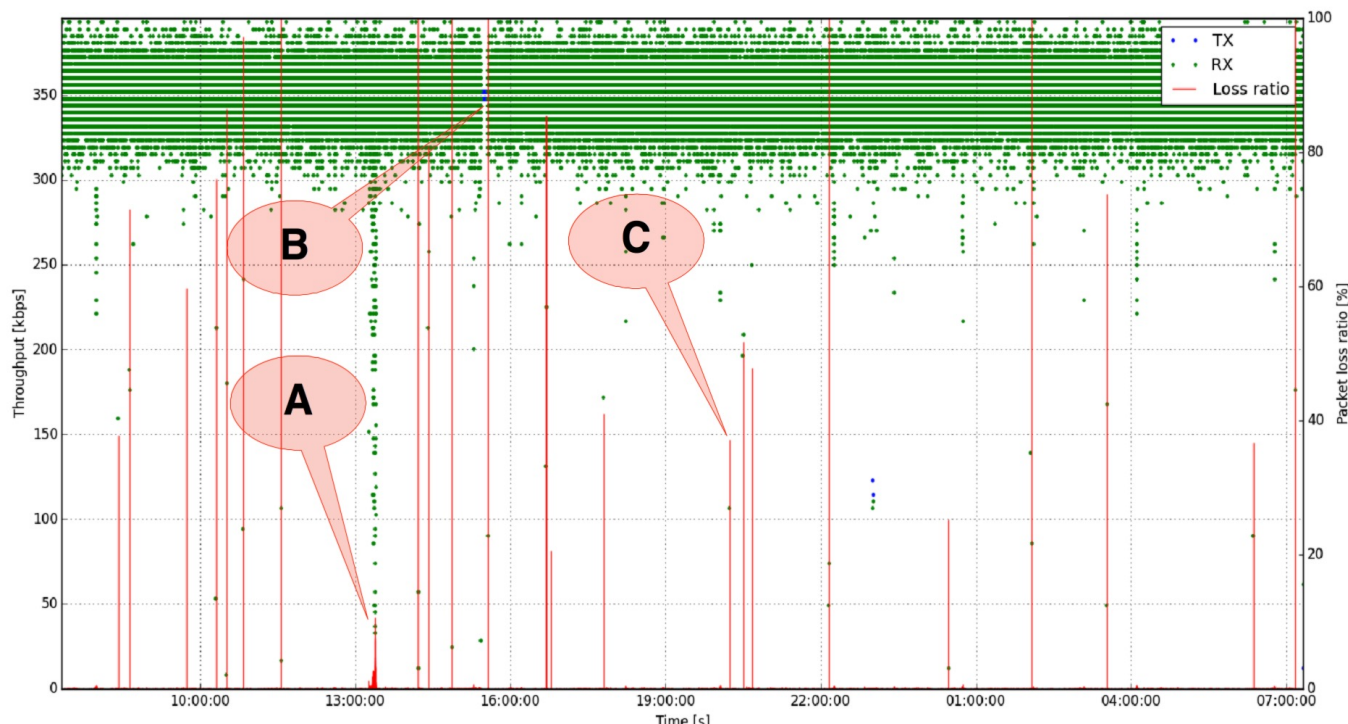


Point **A** indicates the area of initial saturation of the data link. Point **B** shows the moment of the first recorded loss of packet. Point **C** is in the area of maximum data link throughput before significant loss of packets begins. A heavily congested data link is the area around the **D** point.

Testing process



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

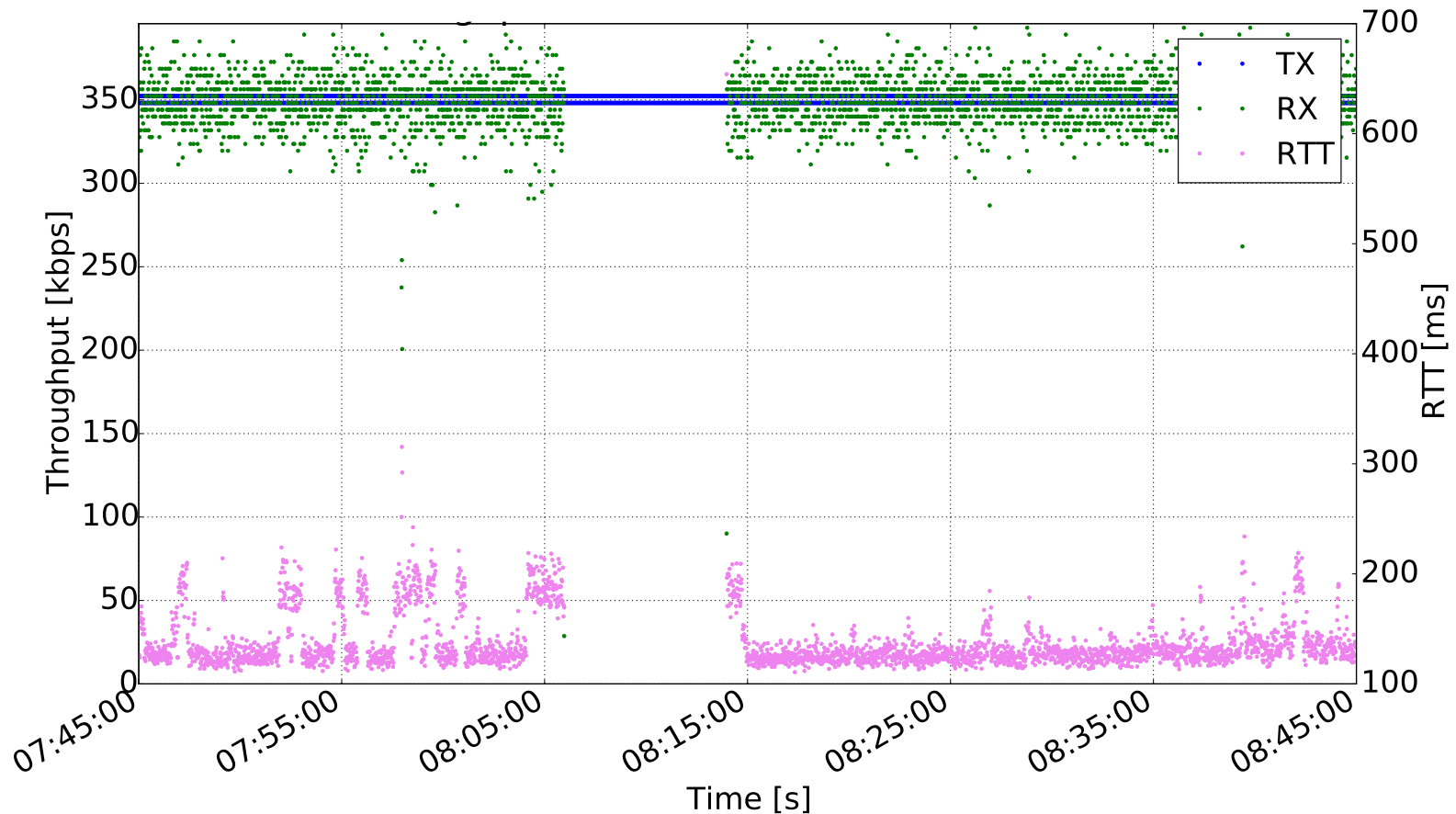


At point **A**, there is a deterioration in the data link transfer properties leading to a decrease in bit rate and accumulation of loss. Point **B** indicates a more serious problem of interrupting communication in a few tens of minutes. Packet loss at point **C** is a brief deterioration of data link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

Testing process



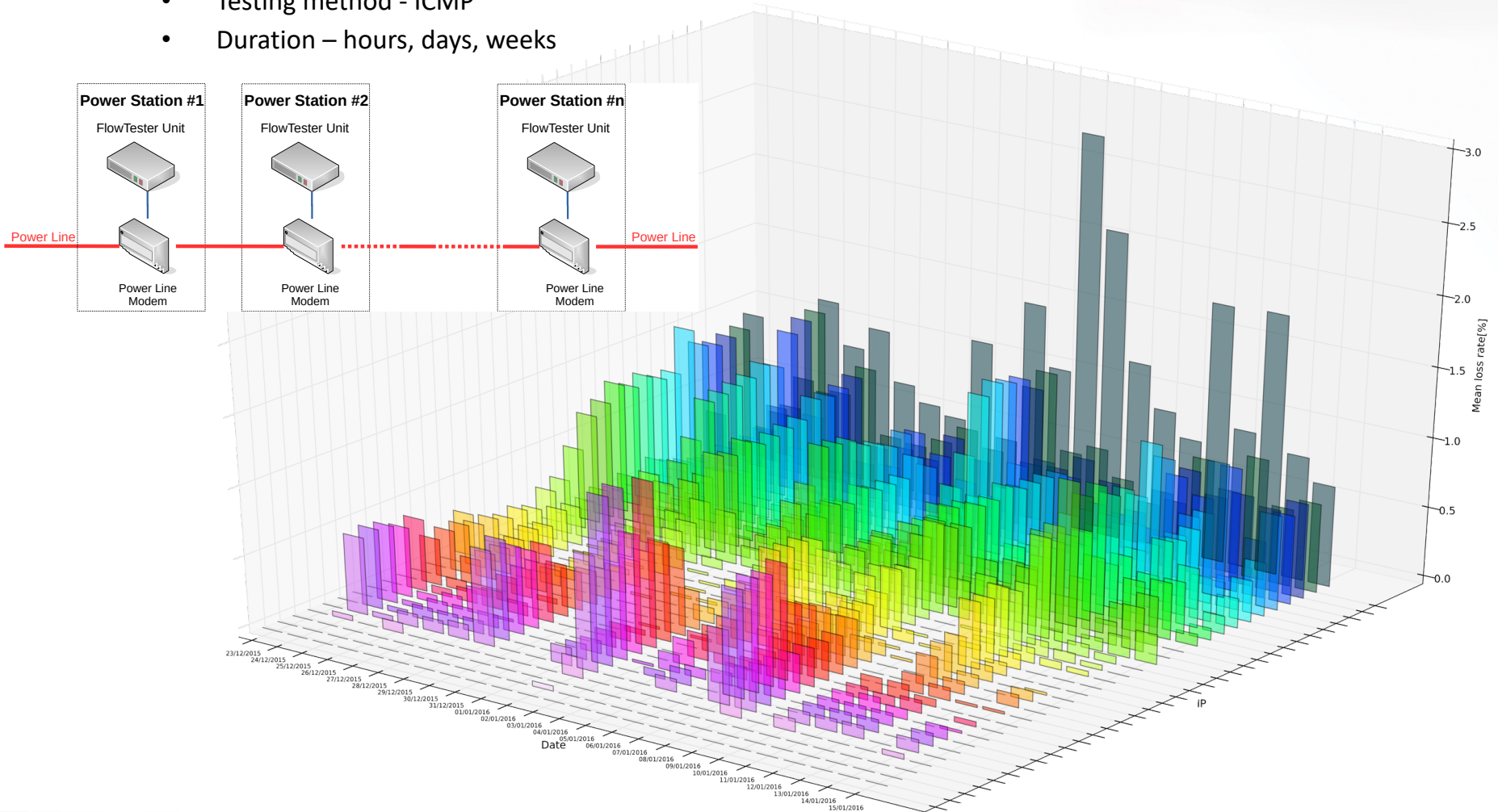
- Stability test - detail



Testing process



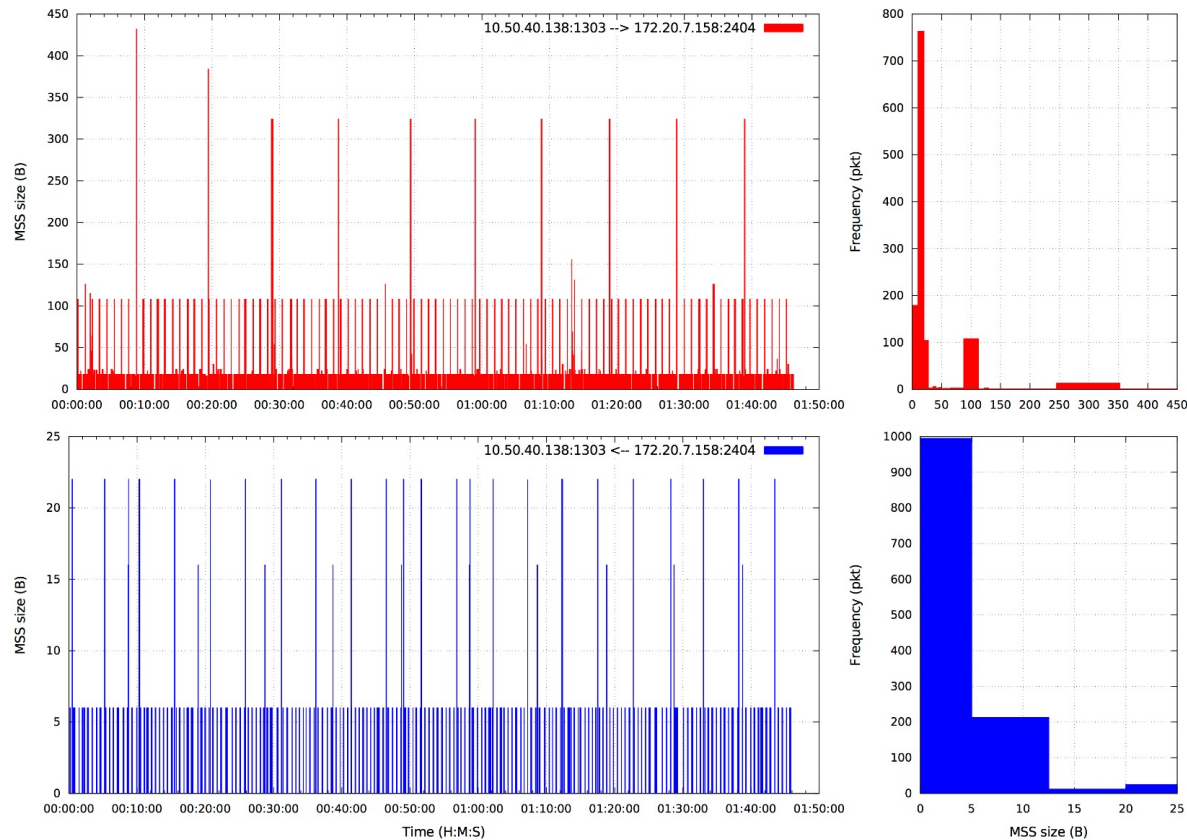
- Stability test - availability checking
 - Testing method - ICMP
 - Duration – hours, days, weeks



Testing process



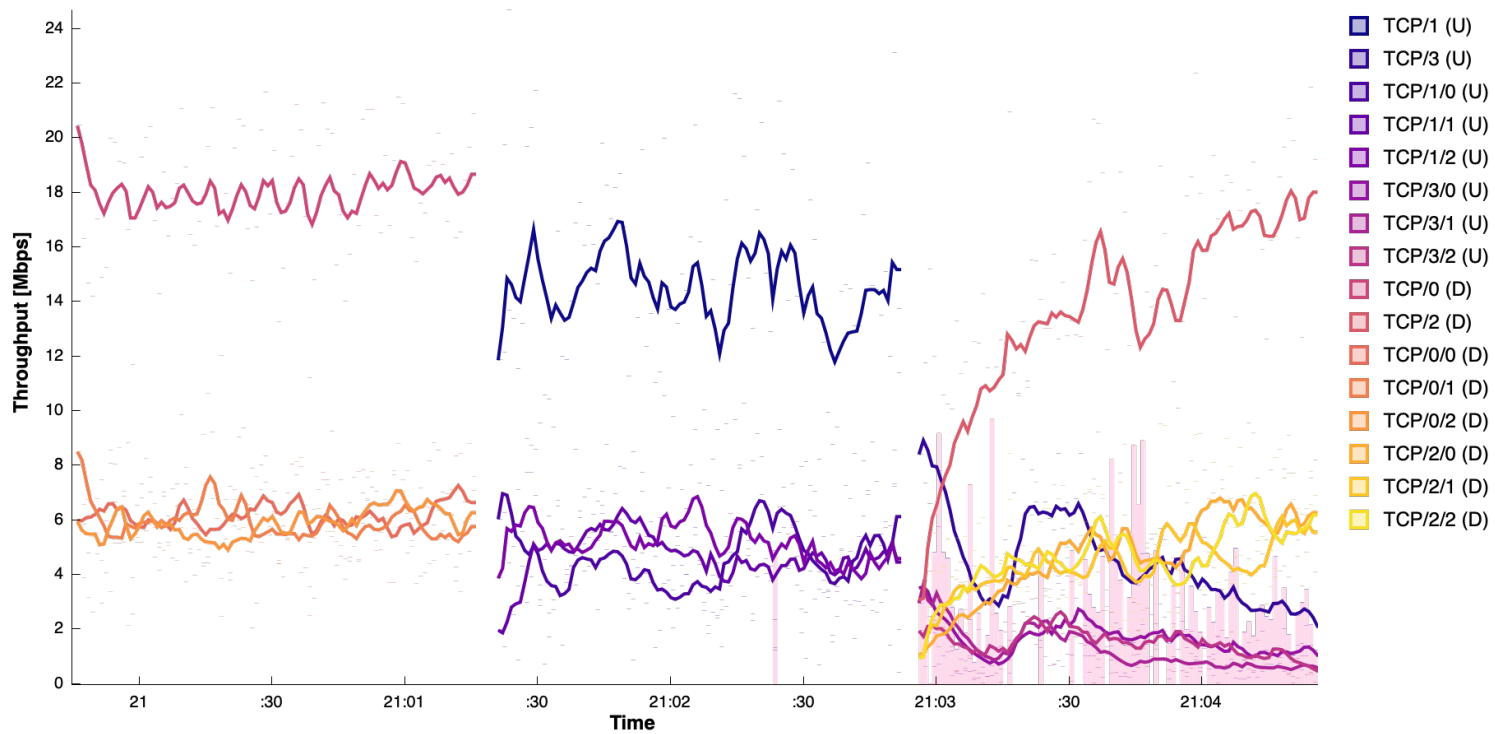
- Protocol/service testing – by FlowPing
 - Real communication flow pattern
 - Example – IEC 60870-104 (SCADA) on wireless narrow band TCP/IP network



Example of NGA Basic Testing



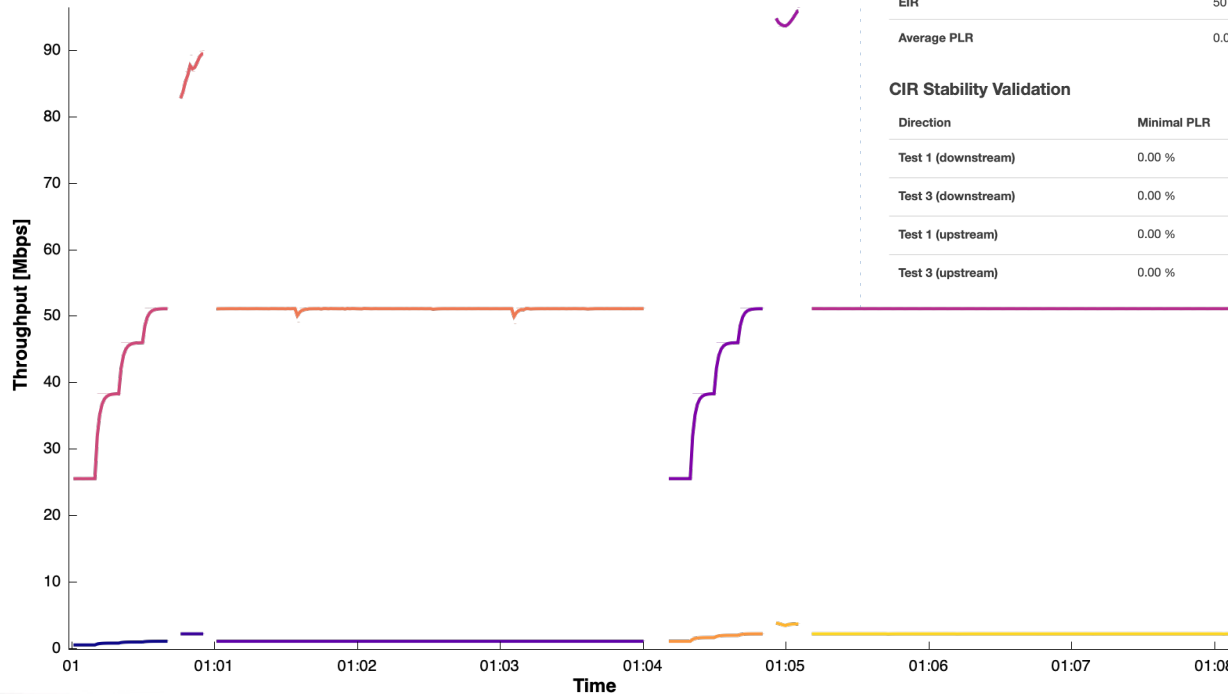
- Next Generation Access networks measurement (TCP based)
 - Measurement with built-in evaluation (SLA)
 - Three sections of test (downstream, upstream, combined)
 - Multiple parallel TCP streams and summary of streams



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

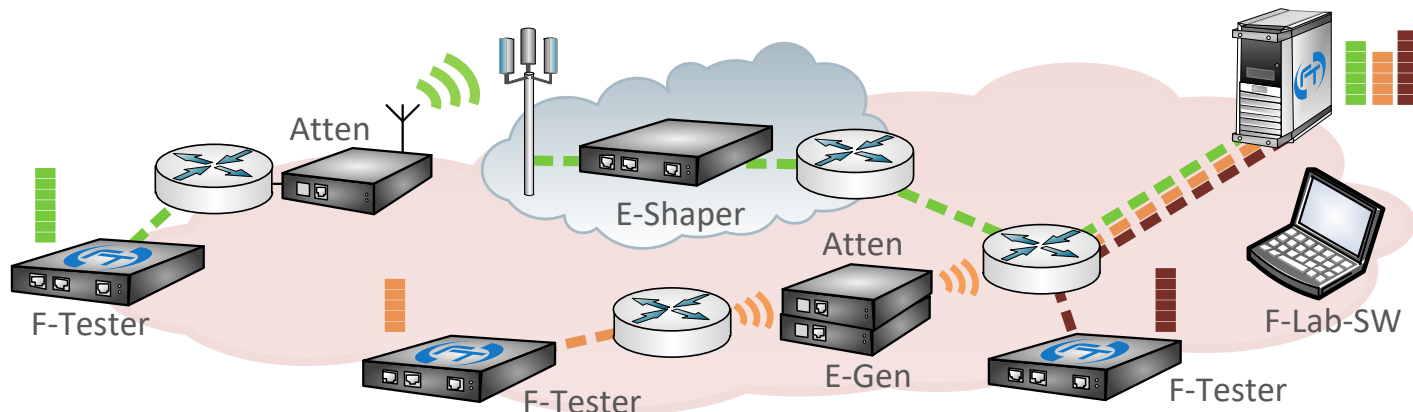
Direction	Minimal PLR	Average PLR	Maximal PLR	Passed
Test 1 (downstream)	0.00 %	0.00 %	0.00 %	✓ PASSED
Test 3 (downstream)	0.00 %	0.05 %	4.60 %	✗ FAILED
Test 1 (upstream)	0.00 %	0.00 %	0.09 %	✓ PASSED
Test 3 (upstream)	0.00 %	0.02 %	1.84 %	✗ FAILED

Complex Testing System „F-Lab“



Possible to emulate:

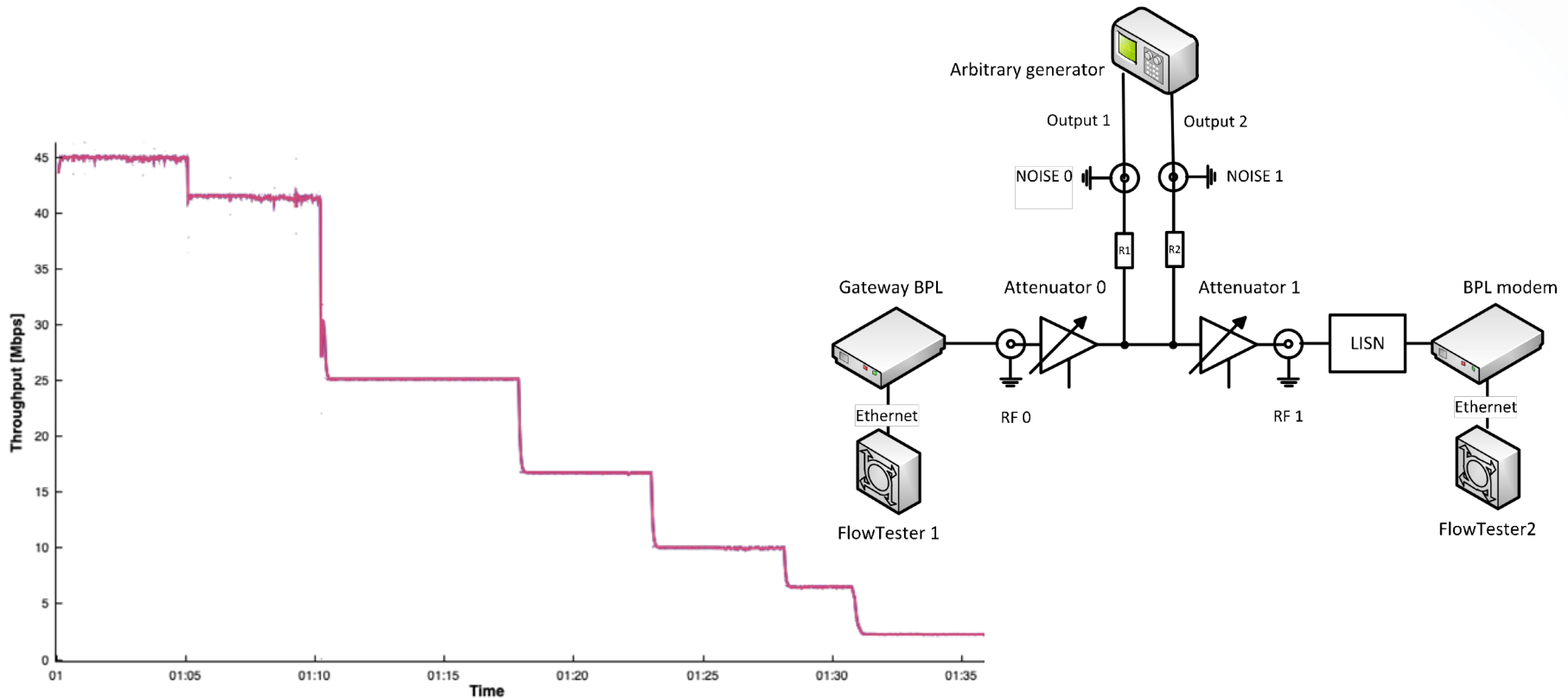
- **Analog environment** of communication channels
- **Parameters of complex IP data network** (delay, throughput, packet loss)
- **Network endpoint behaviour**
- **F-Tester** (FlowTester) – clever data generator and analyzer
- **E-Shaper** (Ethernet Shaper) - communication network emulator
- **F-Cap** (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



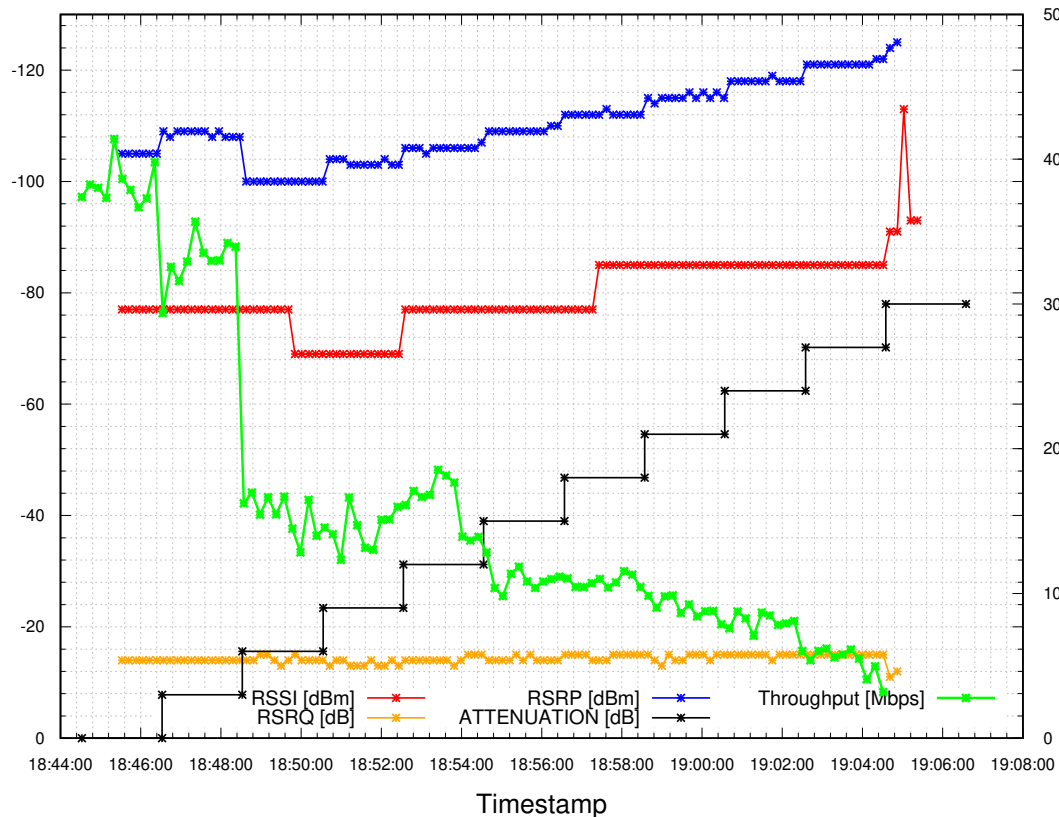
- Time dependence of TCP throughput
 - BPL transmission on MV line
 - For constant AWGN noise and step increase attenuation



Example of Mobile Network Testing



- Time dependence of TCP throughput
 - Measurement of LTE technology
 - Attenuation is increased during TCP downlink communication





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Thank you

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