Regulatory perspective and technical tools and platforms to measure QoS

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Český telekomunikační úřad

Legal framework - QoS

1. **Act on Electronic Communications** – the guaranteed level of QoS is one of the particulars of the contract for provision of the publicly available electronic communications service
2. **Act on consumer protection -** basic rules for consumer contracts
3. **Recommendation „Management of data traffic, parameters of QoS“** – selected parameters for monitoring QoS – download, upload and delay

Only the minimum service quality level is presented by operators and the real speed is swapped with the maximal one which should be different.

Legal framework - customer protection

Complex analyses of contractual documentation

- CTU has performed number of complex analyses of contractual documentation
- Individual operators are presented with results of analyses and called to correct deficiencies
- Based on results of analysis and on the continuous dialogue with the operators, many contractual documents have been remedied

- CTU prefers initial consulting and negotiating with operators to repression and sanctions, because it proved more effective

Legal framework - customer protection

Recommendation on Consumer Contracts

- CTU has issued guidelines, in which points out and generalizes findings arising in aforementioned analyses – chapter about QoS included
- Main Target - to inform both consumers (mainly on their rights) and operators (mainly on their duties) in order to achieve, fair, comprehensive, certain and simple consumer contracts

Legal framework – LTE coverage

Radio parameters

- LTE: RSRP + SINR
- UMTS: RSCP + Ec/Io
  (correction for indoor and antenna height)

Data transmission speed (DL)

- Min. 2 Mb/s / 5 Mb/s
- Stationary measurement (priority)
- Drive test - Method of square 100 x 100 m

Legal framework – NGA access

Definition of support conditions

- Open access
- Downlink speed min. 30 Mbit/s (upgradable up to 100 Mbit/s)
- Asymmetrical link – downlink vs. uplink → not worse than 3:1
- Data, IPTV, VoIP services ready

Verification of NGA access

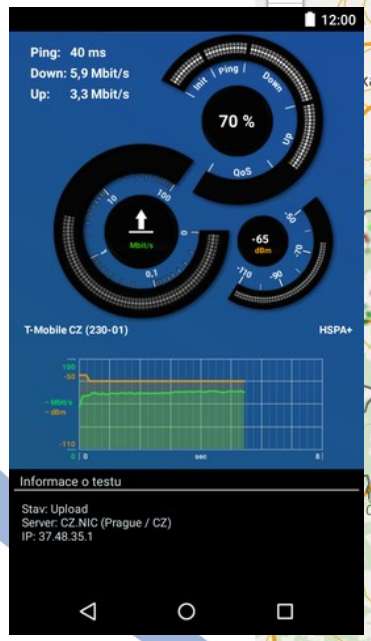
- Measurement methodology - L2/3/4, traffic shaping, statistical value
- Activation test (ITU-T Y.1564)
- Customer complain verification (IETF RFC6349)

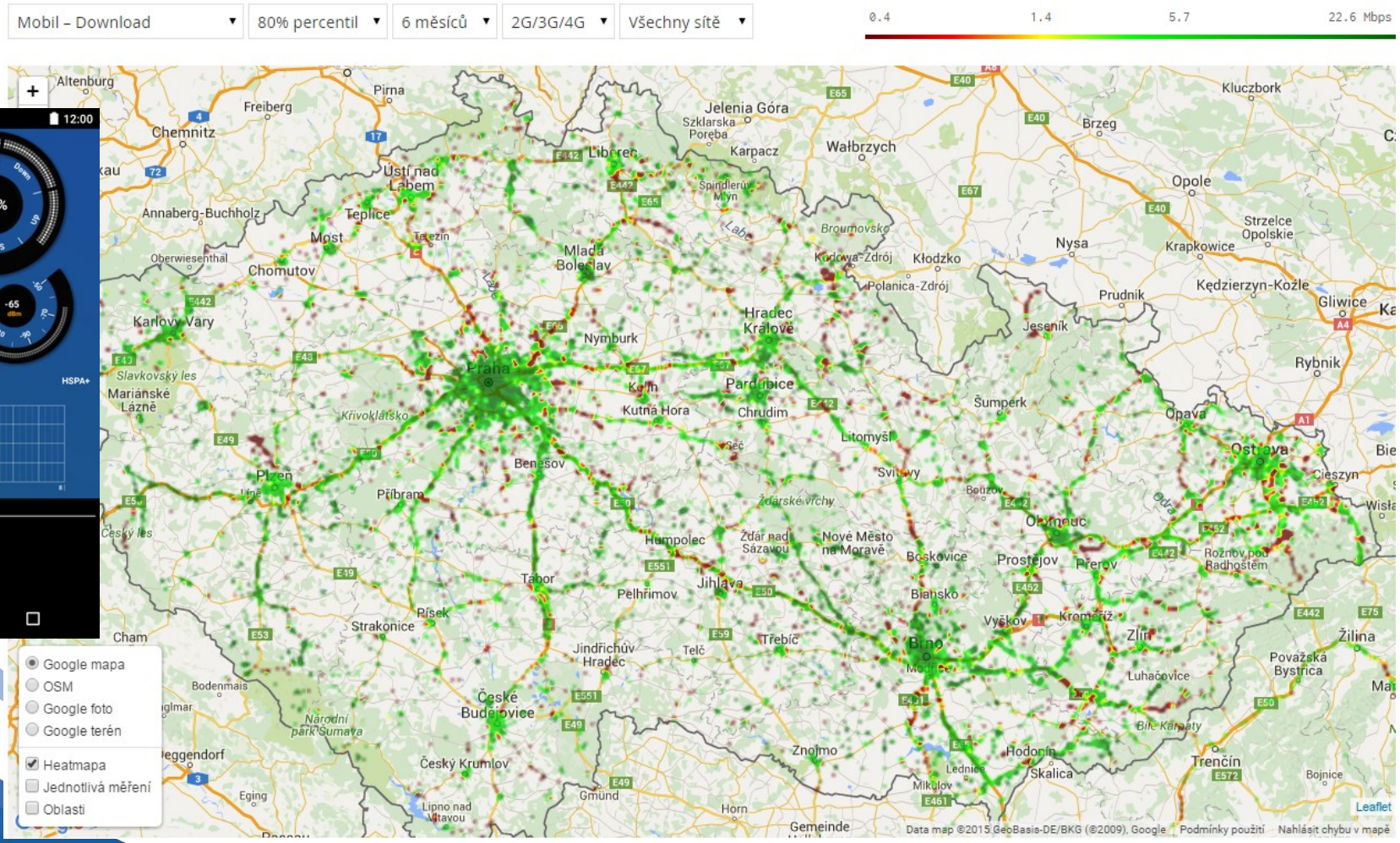
Conceptions of QoS measurement

How QoS can be measured and verified?

1. **Crowdsourcing**
   - Customer experience sharing – how to share them?
     → Speedometers - CTO: NetMetr.cz
   - Advantages:
     - Lot of people → low cost, rapid deployment
     - Large number of measurement
   - Disadvantages:
     - Large deviation of measurement (variance)
     - Question of data aggregation
     - Solution
       a) maximization criterion (percentile – 80%, 50%) in combination with proper data filtering
       b) Monitor and restrict customer terminal parameters

Custommer measurement - NetMetr.cz





Result January 2015 – November 2015
Czech Republic

NetMetr.cz

Current status of project

1. **Pilot (test) operation by CTO employees**
   - Almost 10.000 measurement in January 2015
2. **Test operation by Czech mobile operators**
3. **Discussion about quality of application and data aggregation**
   - How to obtain representative data measurements?
     a) Parametric evaluation of terminals → hard
     b) Statistics (percentile – 80%, 50% ; filtering) → easy
4. **Audit of proper function - Specure**
   - Audit of platforms
   - Checking of measurements data
   - Identifying bottlenecks x suggesting filters
   - New version – end of 2015

Conceptions of QoS measurement

How QoS can be measured and verified?

2. Professional measurement

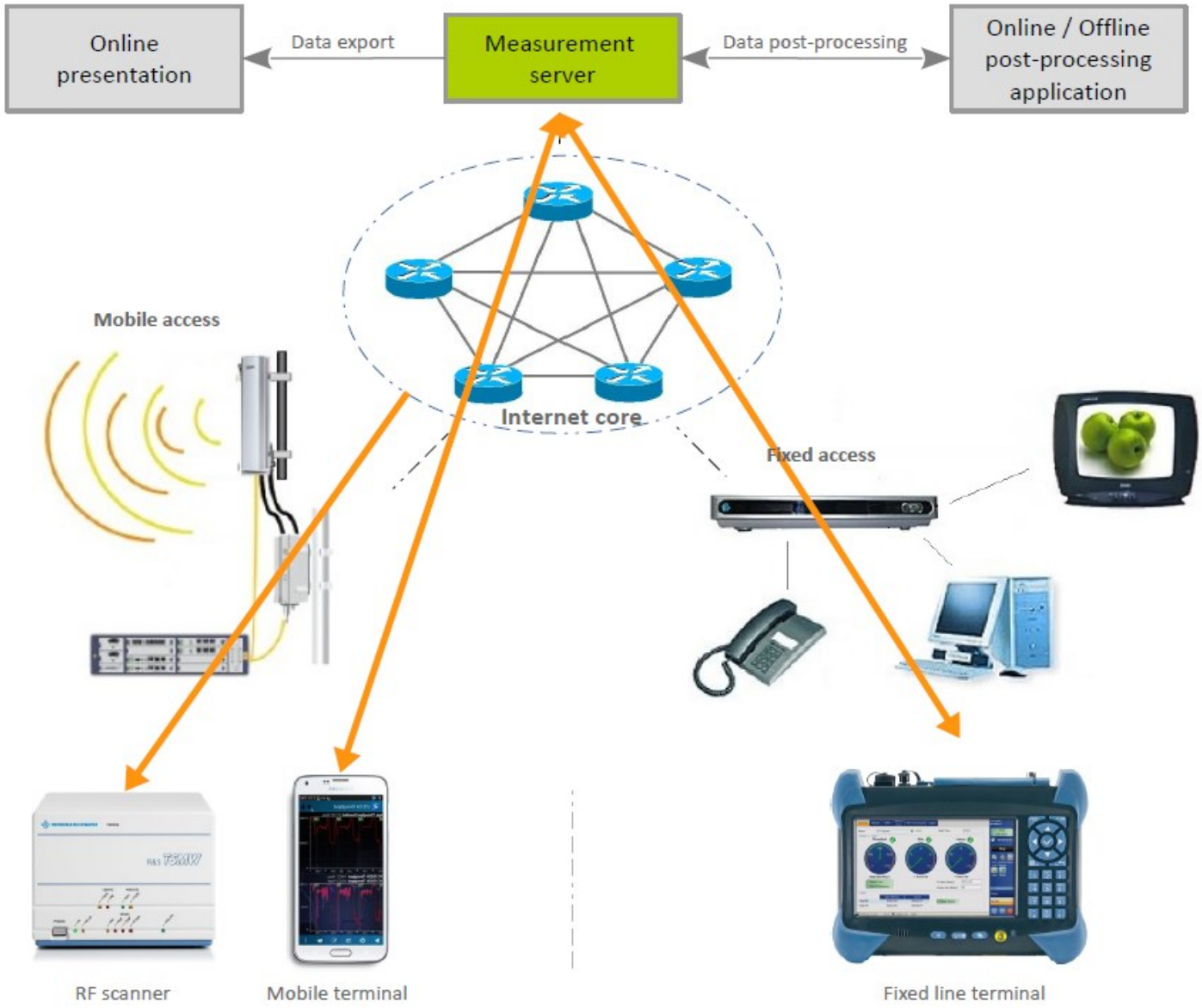
- Used to meet legal obligations of CTO
- Conditions to meet quality requirements:
  - Guaranteed measurement server and terminal parameters
  - Guaranteed, independent and dedicated national and transit connectivity
  - Uniform measurement methodology of QoS on L4 layer (IETF RFC 6349) – enables to compare technologies
- Measurement types (correspondent with terminal):
  - Mobile networks – GSM, UMTS, HSPA, LTE, LTE-A, etc.
    - Stationary – time diversity, statistical amount of data
    - Drivetest – rectangular network, coverage calculation
  - Fixed lines – xDSL, ETH (metallic, opto), xPON, Ex

QoS measurement methodology

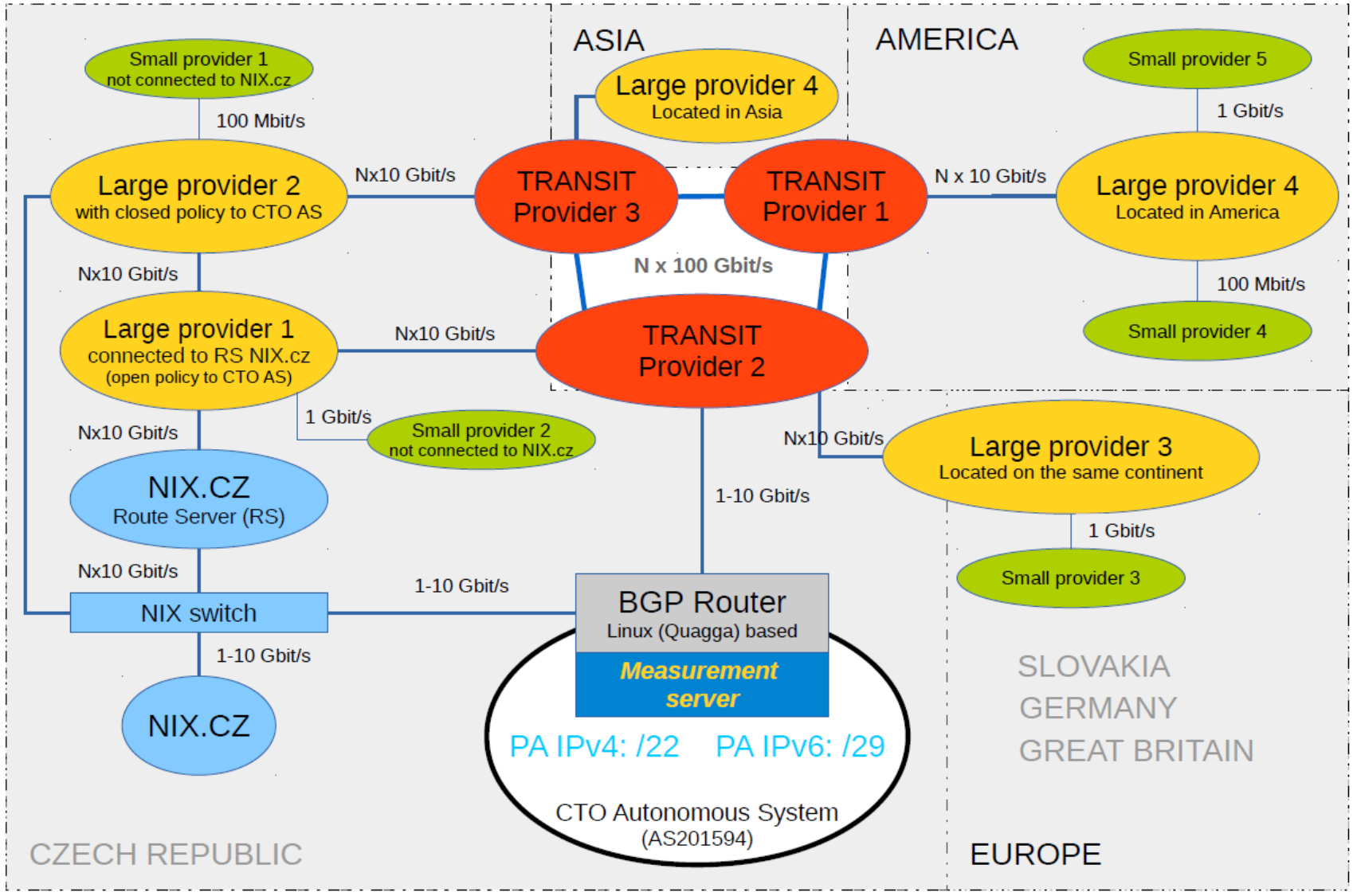
Which measurement methodology is used?

- Based on Layer 4 measurement according to IETF RFC 6349 (independent on technology)
- Specify necessary and sufficient conditions, how to declare measured parameters (MTU, RTT, BB, RWND, number of sessions etc.)
- Describes difference between TCP and UDP measurement (question of security and service representation)
- Diversifies between static measurement and drivetest and evaluates data differently
- Technological dependent layers are solved with respect to specific technologies and added in form of separate enclosure

Measurement infrastructure



Measurement server and connectivity



Measurement server and connectivity

1. **Router & Measurement server**
   - Linux (Quagga) based BGP EDGE router combined with measurement server and online post-processing application
   - Autonomous System (AS) in property of CTO → full connectivity independence
   - Location in largest collocation premises in the Czech Republic (CE COLO Prague)

2. **Connectivity & management**
   - RIPE & NIX.CZ membership
   - 10 Gbit/s link to Neutral Czech eXchange point
   - 10 Gbit/s link to transit peering partner
   - AS (32 bit ASN), IPv4 (/22) and IPv6 (/29) assigned to CTO
   - Measurement server and edge router is fully in CTO management

Measurement terminals

Mobile networks

1. **Physical design**
   - Chassis
     - Integrated mobile terminal solution (phones inside modules) with SMA antenna connectors, easy changeable SIM cards, robust design, enables easy benchmarking and scanner connection
     - Disadvantages are expensive solution with necessity to control via PC (NTB) software and limited mobility
   - Mobile terminal
     - Solution without antenna connectors, hard changeable SIM cards and fragile design for everyday use
     - Relatively cheap solution without need of additional control software

Measurement terminals

Mobile networks

1. **Physical design**
   - Hybrid
     - Combines advantages of integrated mobile terminal (chassis) solution such as SMA antenna connectors, easy changeable SIM cards, robust design with cheap solution of mobile terminal, no need of additional software and high mobility
     - Enables wide deployment and RF scanner use with the same reference antenna

Measurement terminals

Mobile networks

2. **Measurement software requirements**
   - Technology – GSM, WCDMA, HSPA, HSPA+, LTE, LTE-A, Wifi etc.
   - Measurement of RF parameters – RSRP, RSRQ, RSSI, PCI, etc.
   - IMPORTANT: Forcing features (RAT lock, Band lock, Cell lock)
   - Data parameters measurement – HTTP, FTP throughput, RFC6349 testing, ICMP ping, PDP, VoIP testing, Wifi testing
   - Measurement test scripting and scripting editor, BTS list
   - Other characteristics – charts, offline maps, indoor & outdoor measurement, FTP & HTTP log file upload, autotesting, screenshot, quick manual testing, event-base testing, GPS note
   - PC software – log file import, conversion and export (csv, xls), replay function, script editor

Measurement terminals

Fixed lines

1. **Physical design**
   - Technology
     - Ethernet
       - Metallic – 10/100/1000Base-T
       - Optical – 1000Base-X, 10GBase-X (SFP, SFP+)
     - Wifi b/g/n (ac) – 2,4GHz, 5GHz
     - Other – PDH, SONET / SDH, Fiber Channel
   - Touch screen, battery design, easy mobility, robust and compact (undivided) design

Measurement terminals

Fixed lines

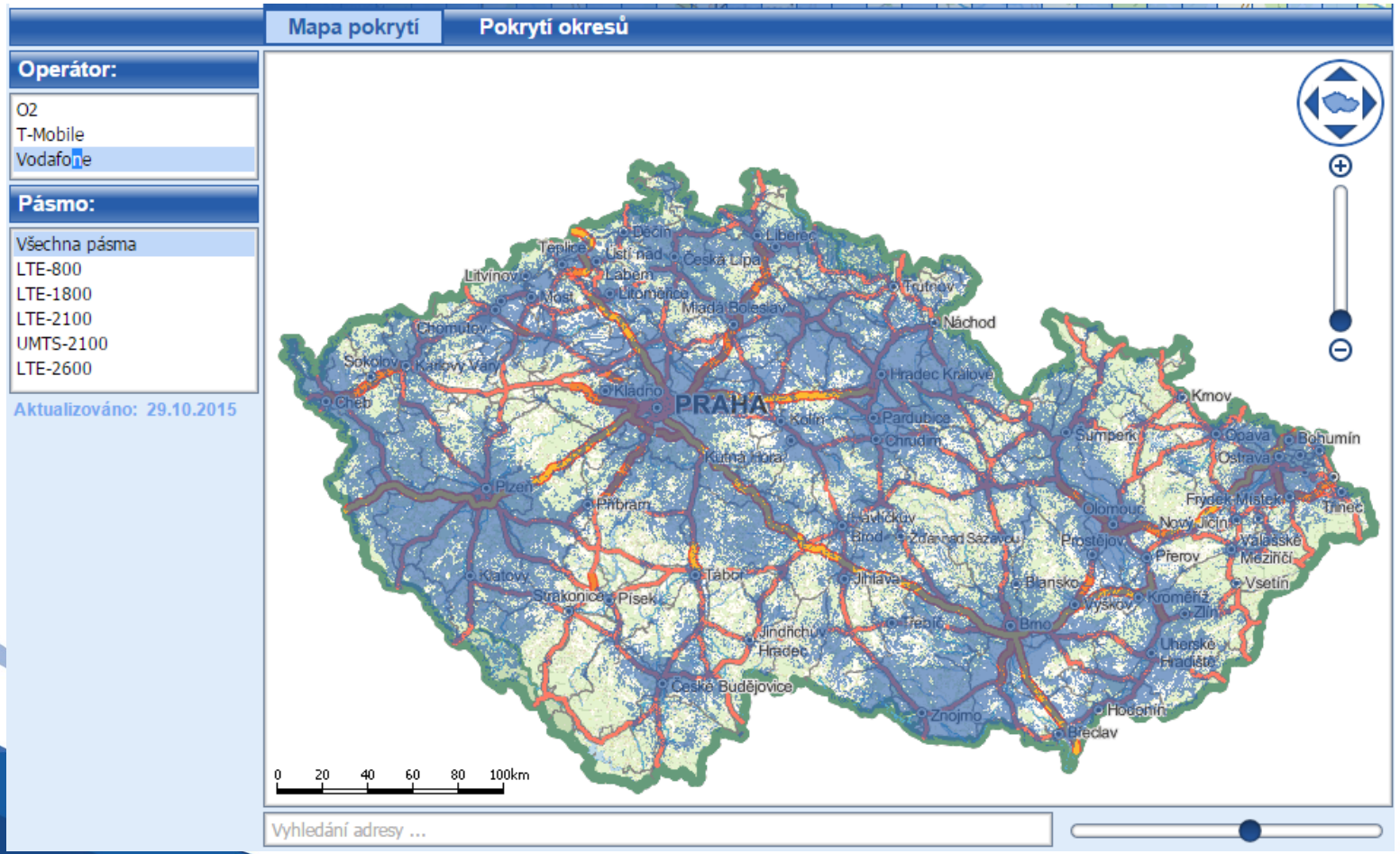
2. **Software and testing**
   - ITU Y.1564, IETF RFC 2544, IETF RFC 6349 testing
   - Measurement of data parameters – HTTP, FTP, TCP throughput, RTT & traceroute, VoIP and IPTV (SD, HD, TS) testing, Wifi testing, MX discovery, VLAN and LAN scan
   - IPv4 & IPv6, MPLS, VLAN, QinQ, IP streams and multiservice configuration
   - Other parameters – charts, log file upload, autotesting and remote testing and control, screenshot, quick manual testing, report generation, result upload
   - Options – OTDR, FPGA RFC 6349, BERT, Wireshark, browser, etc.

Software

Coverage prediction – CRC Data Radiolab

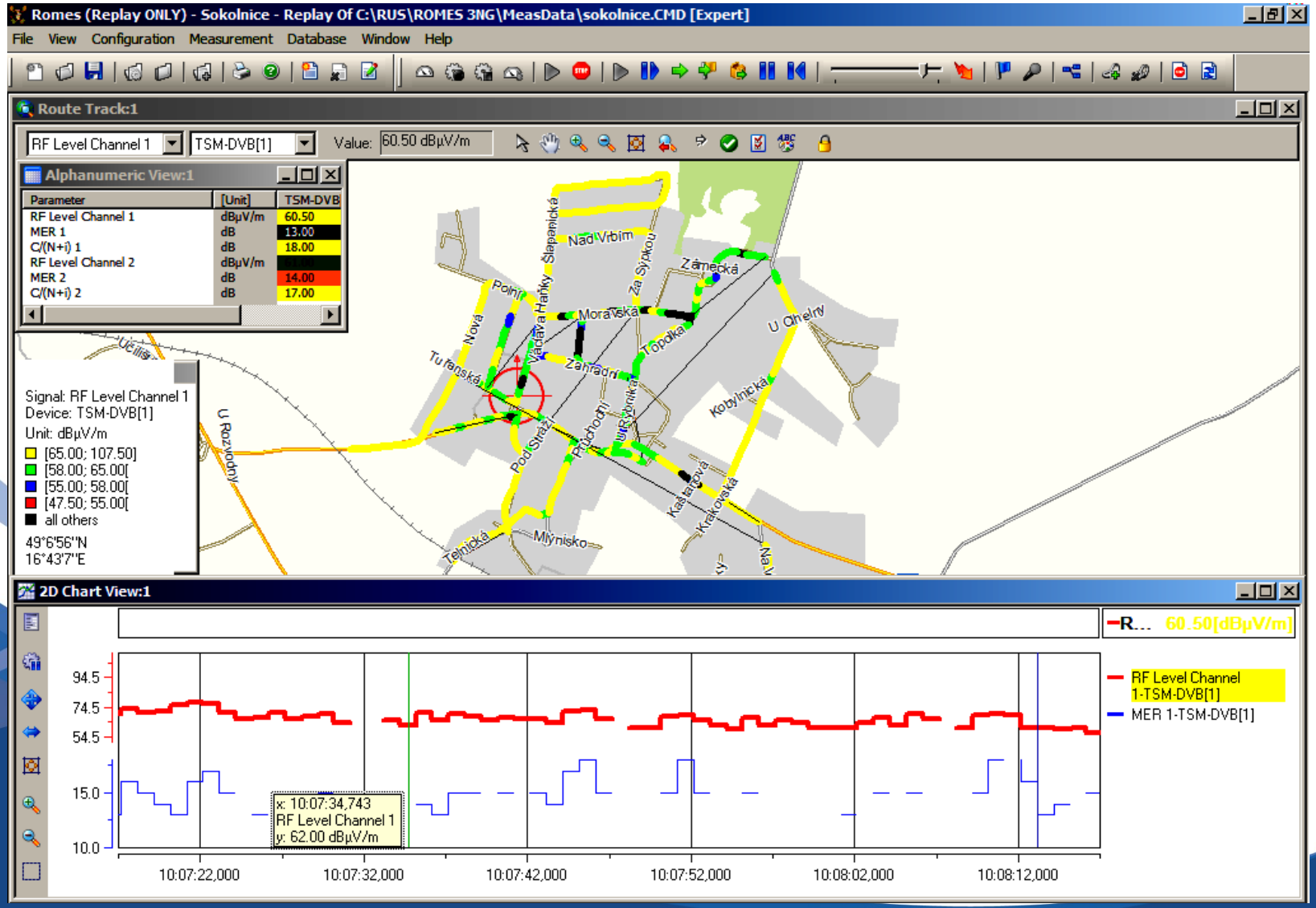
Example:
Vodafone
All bands

Public access:
lte.ctu.cz

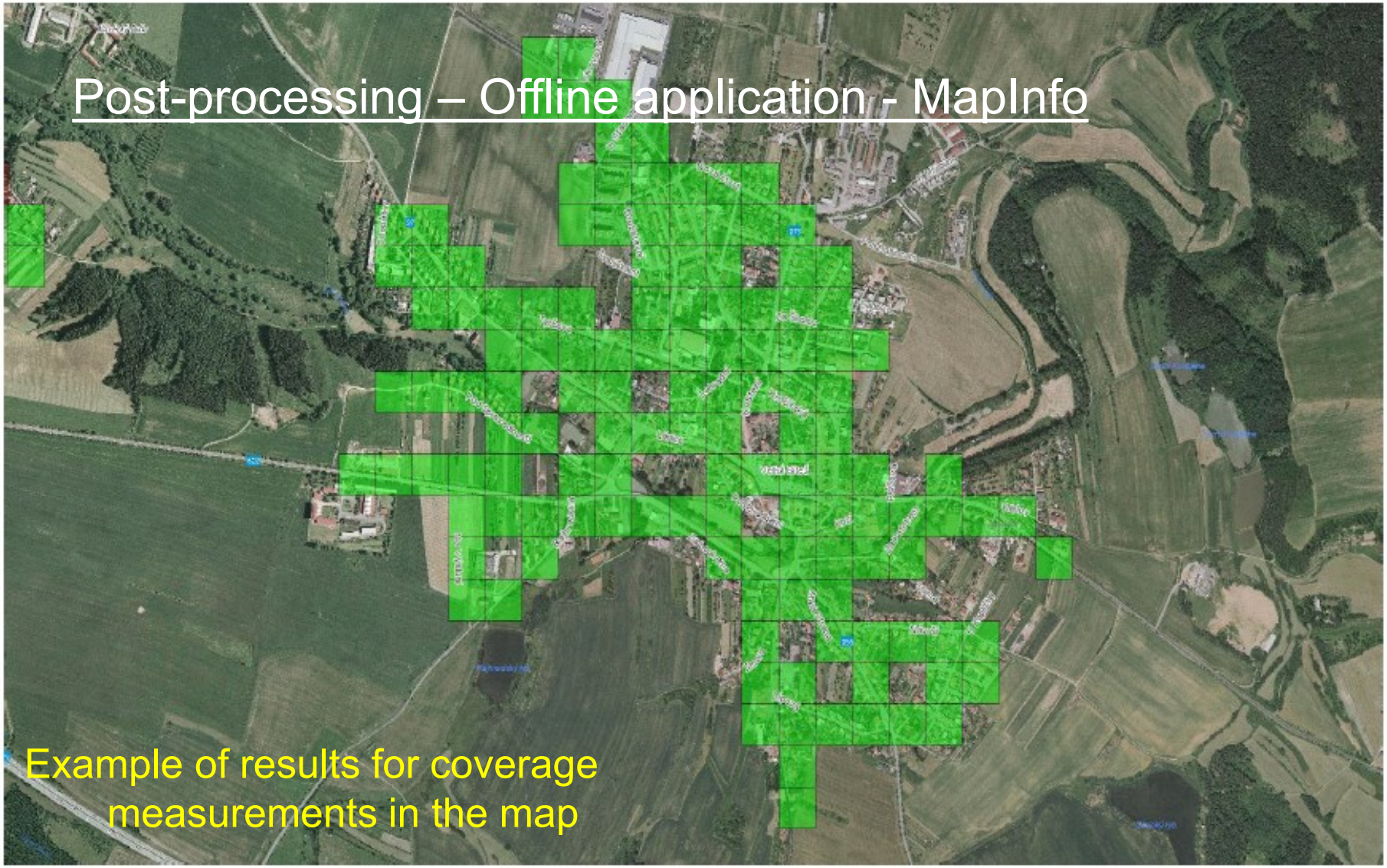


Software

Scanner software – R&S Romes



Software


Post-processing – Offline application - MapInfo
Example of results for coverage measurements in the map

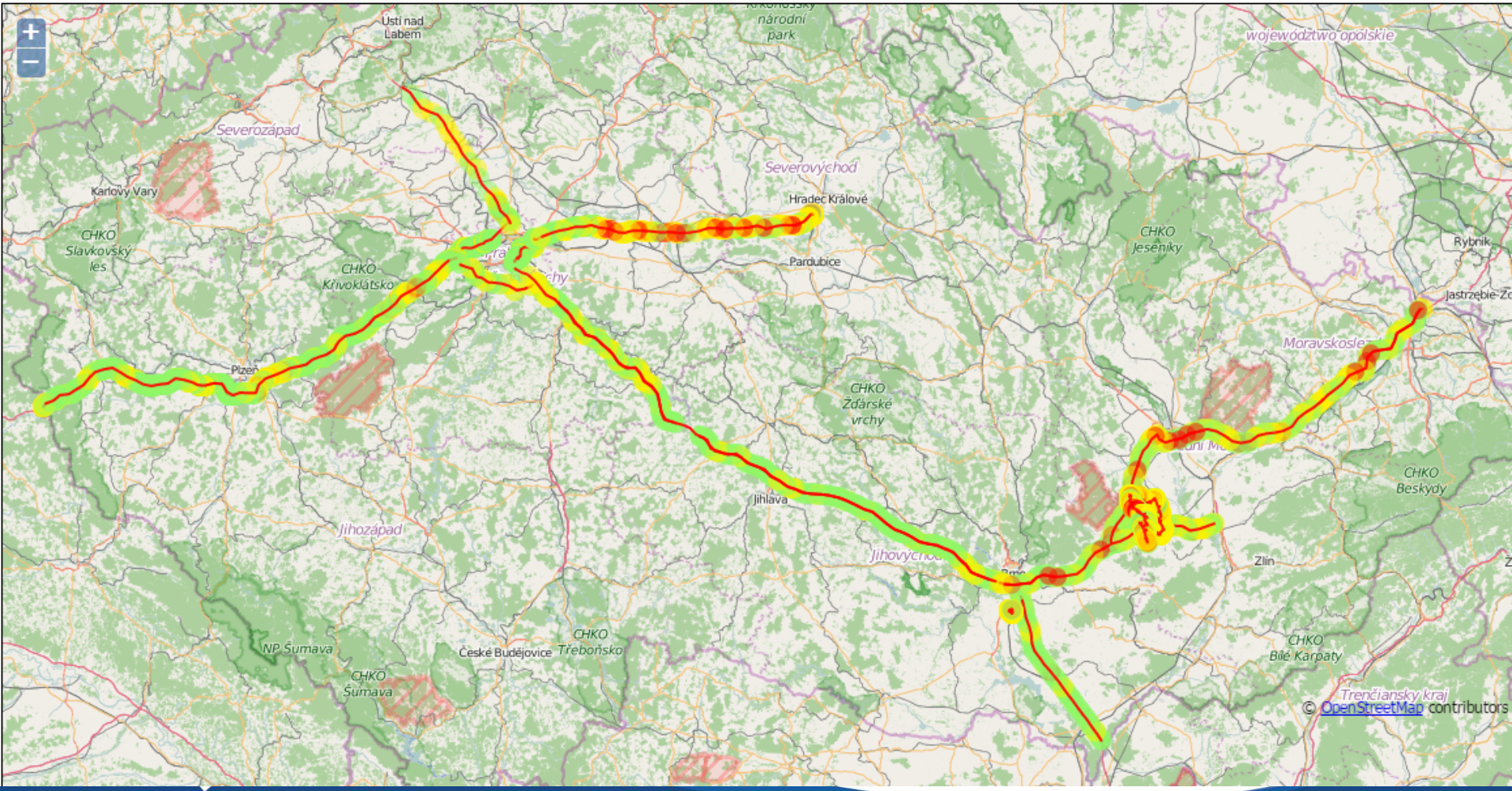
Scenarios

1. **Drivetest**
   - Data acquisition from R&S Romes, Nemo Handy, SwissQual QualiPoc
   a) Highways, roads, railways coverage
   b) Villages and cities coverage
   c) BTS coverage
2. **Activation test of NGA services ready** – EXFO FTB-860G (FTB-1 platform)
3. **Long term stationary test**
   a) Mobile probe test
   b) Fixed line probe test – core, customer measurement – EXFO FTB-860G
4. **Coverage measurement**
5. **Indoor measurement**
   - Measurement of business & shopping center, railway station

Scenarios – drivetest

Post-processing – Online application

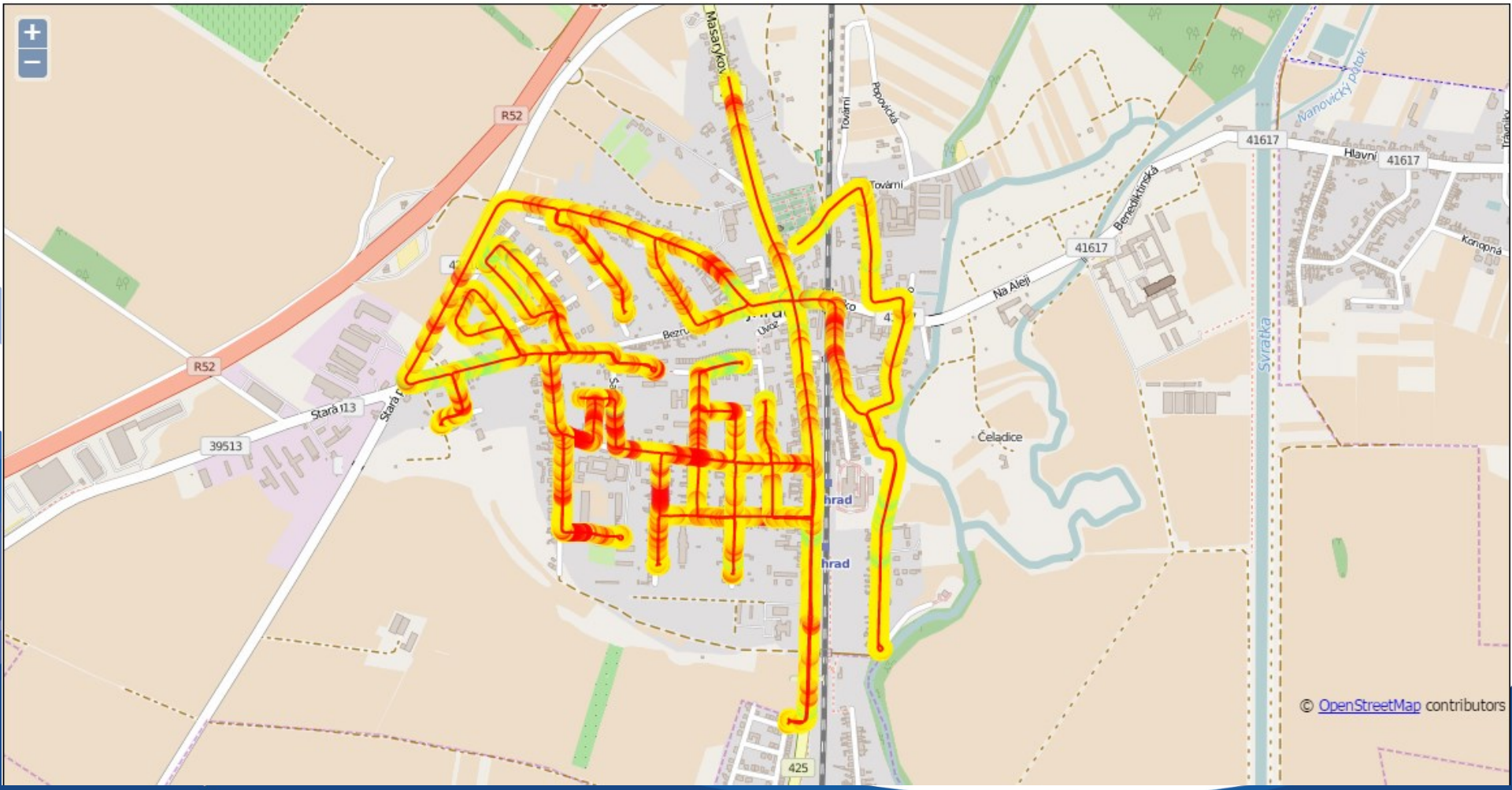
Czech Highways – LTE SINR



Software - drivetest

Post-processing – Online application

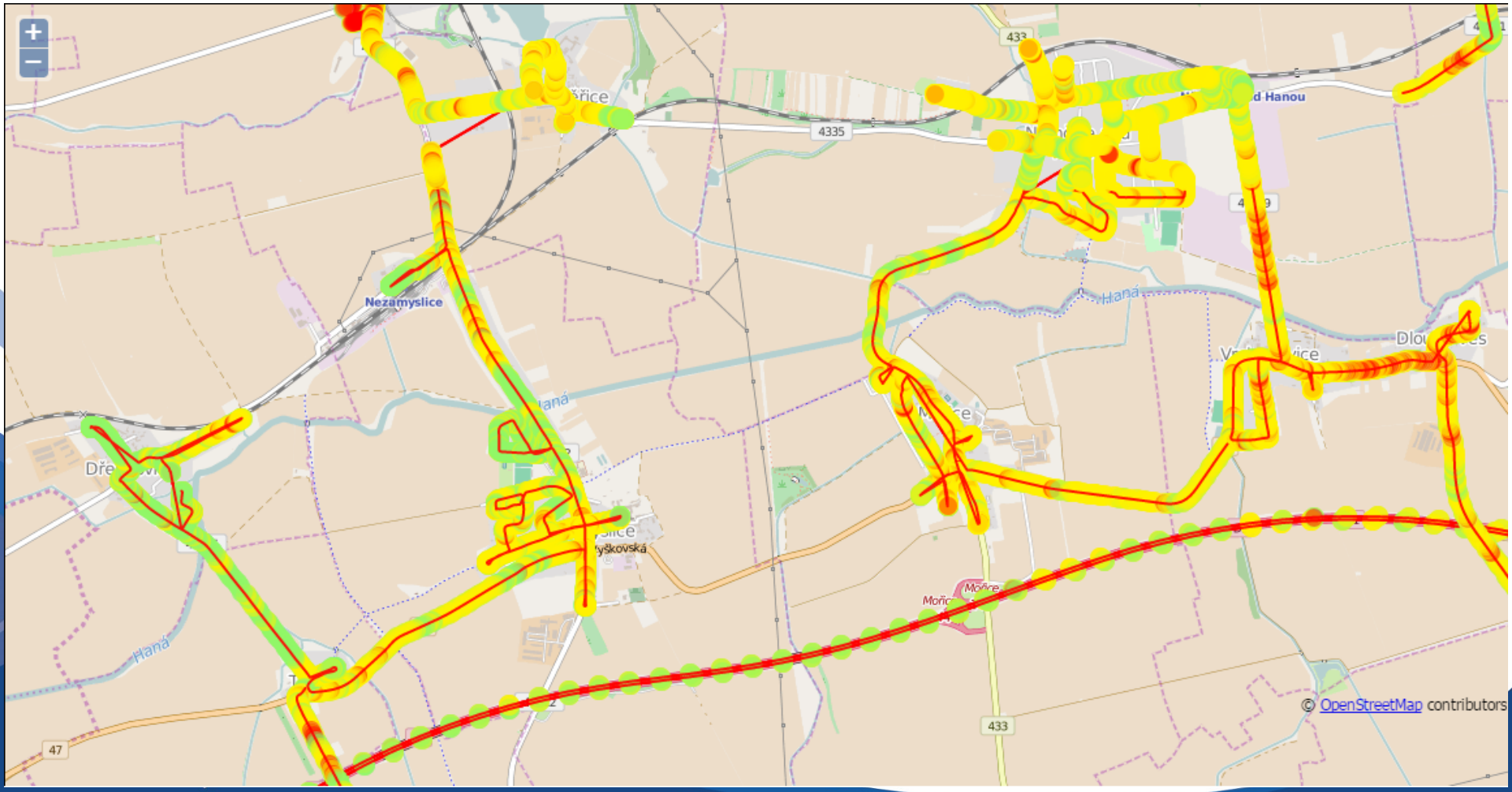
Village Rajhrad – LTE SINR



Scenarios - drivetest

Post-processing – Online application

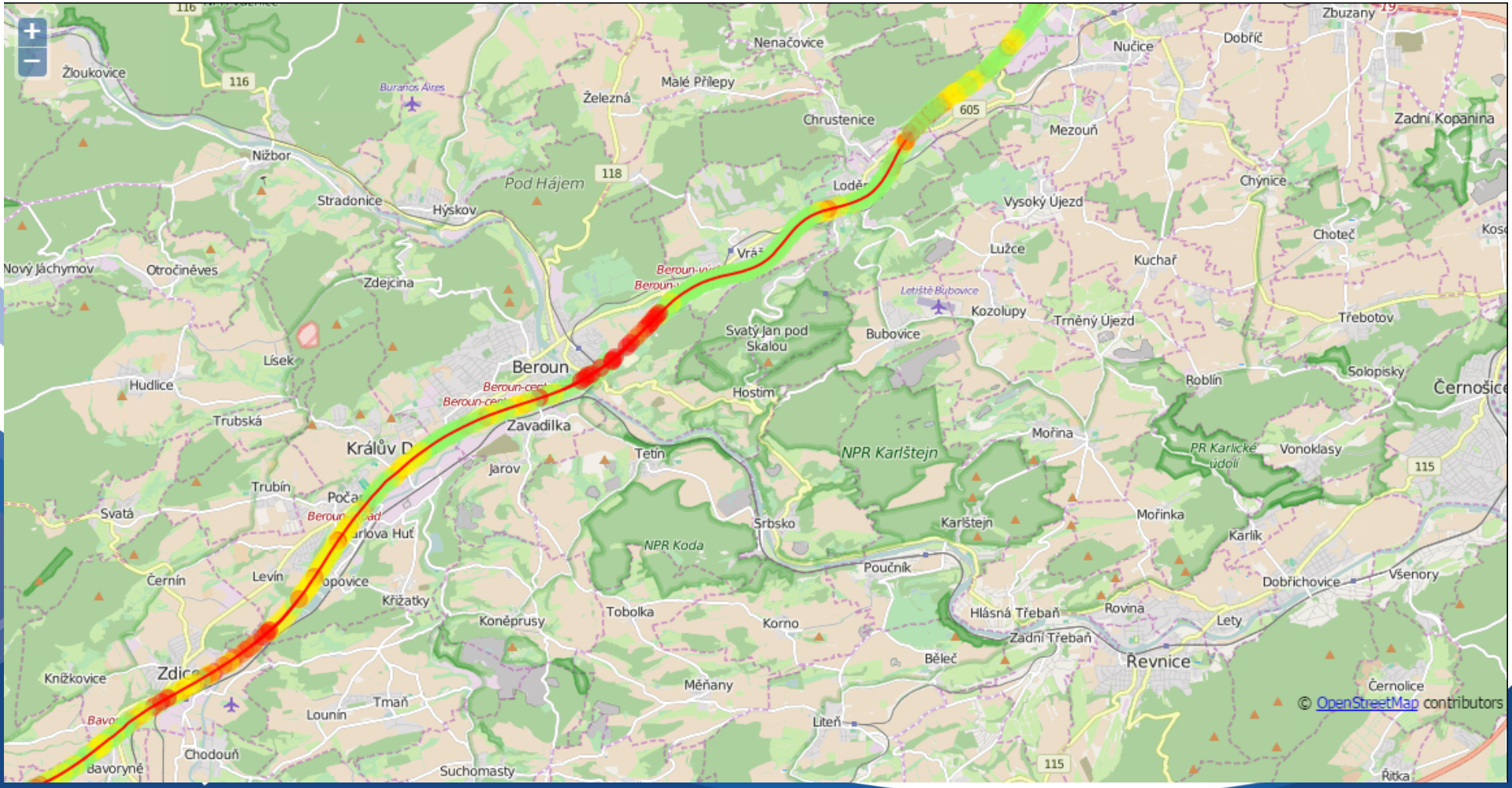
Region Prostějov – LTE SINR



Scenarios - drivetest

Post-processing – Online application

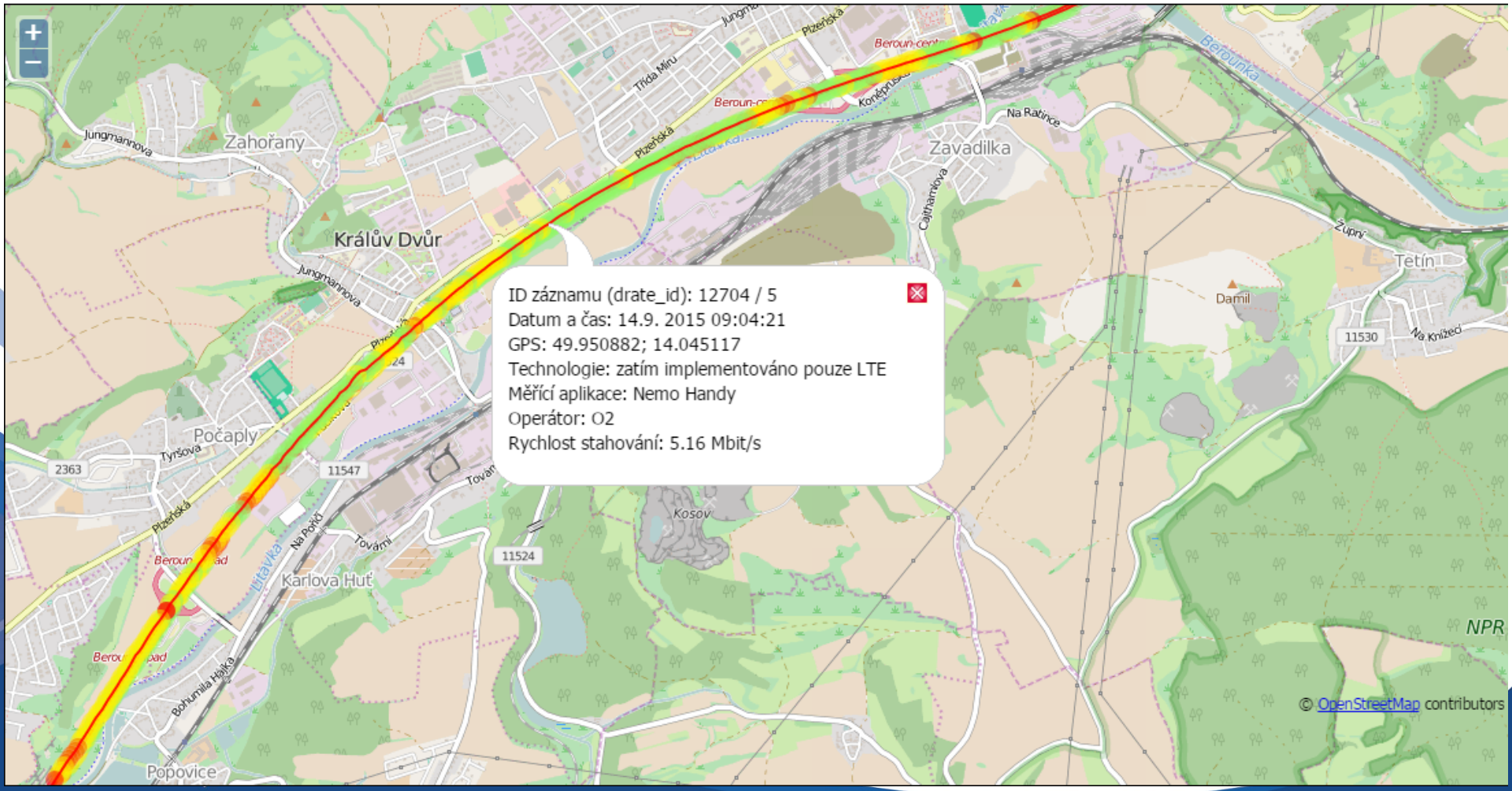
Highway D5 – Beroun – LTE Downlink speed



Scenarios - drivetest

Post-processing – Online application

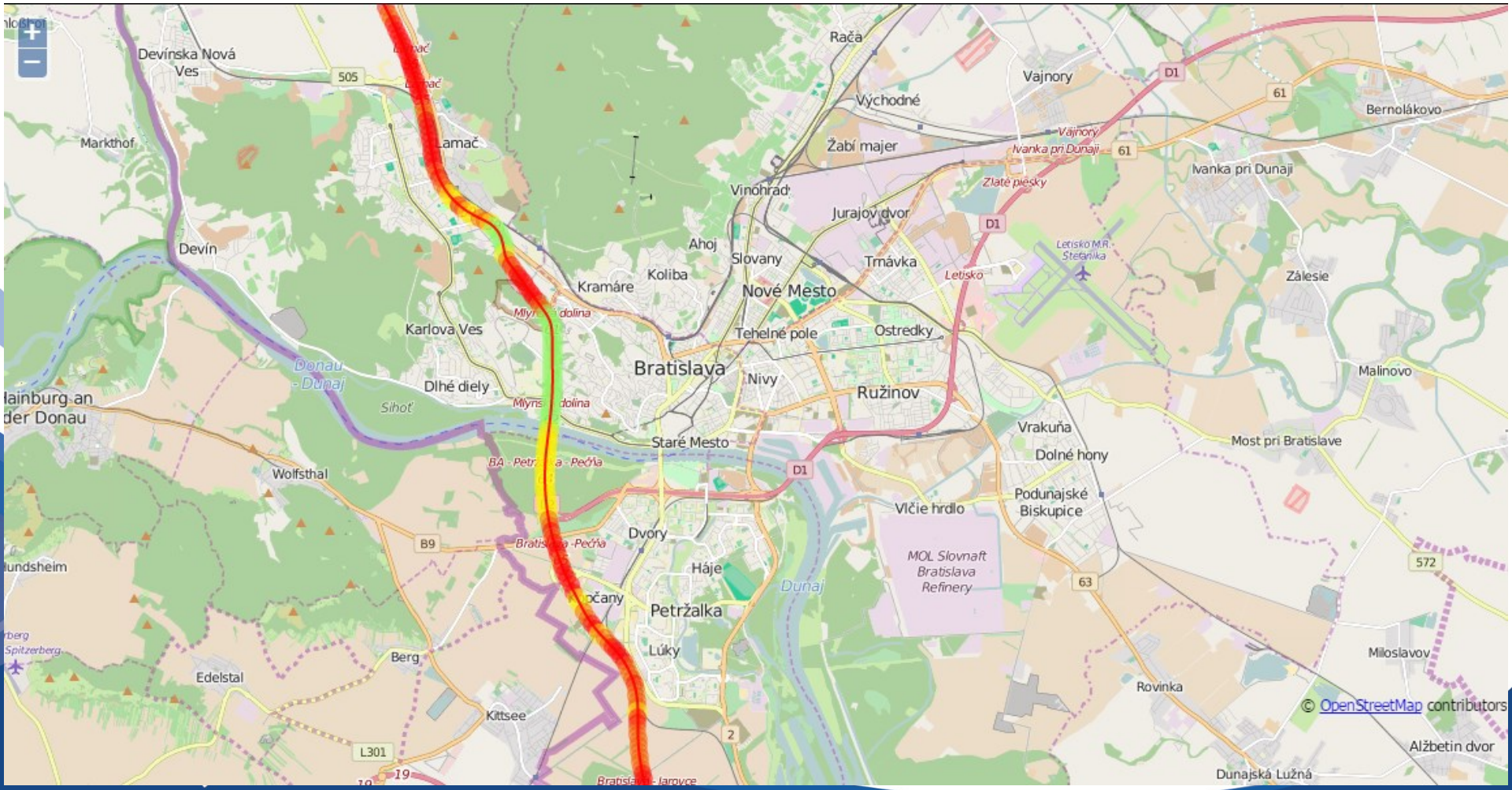
Highway D5 – Beroun – LTE Downlink speed – sample detail



Scenarios - drivetest

Post-processing – Online application

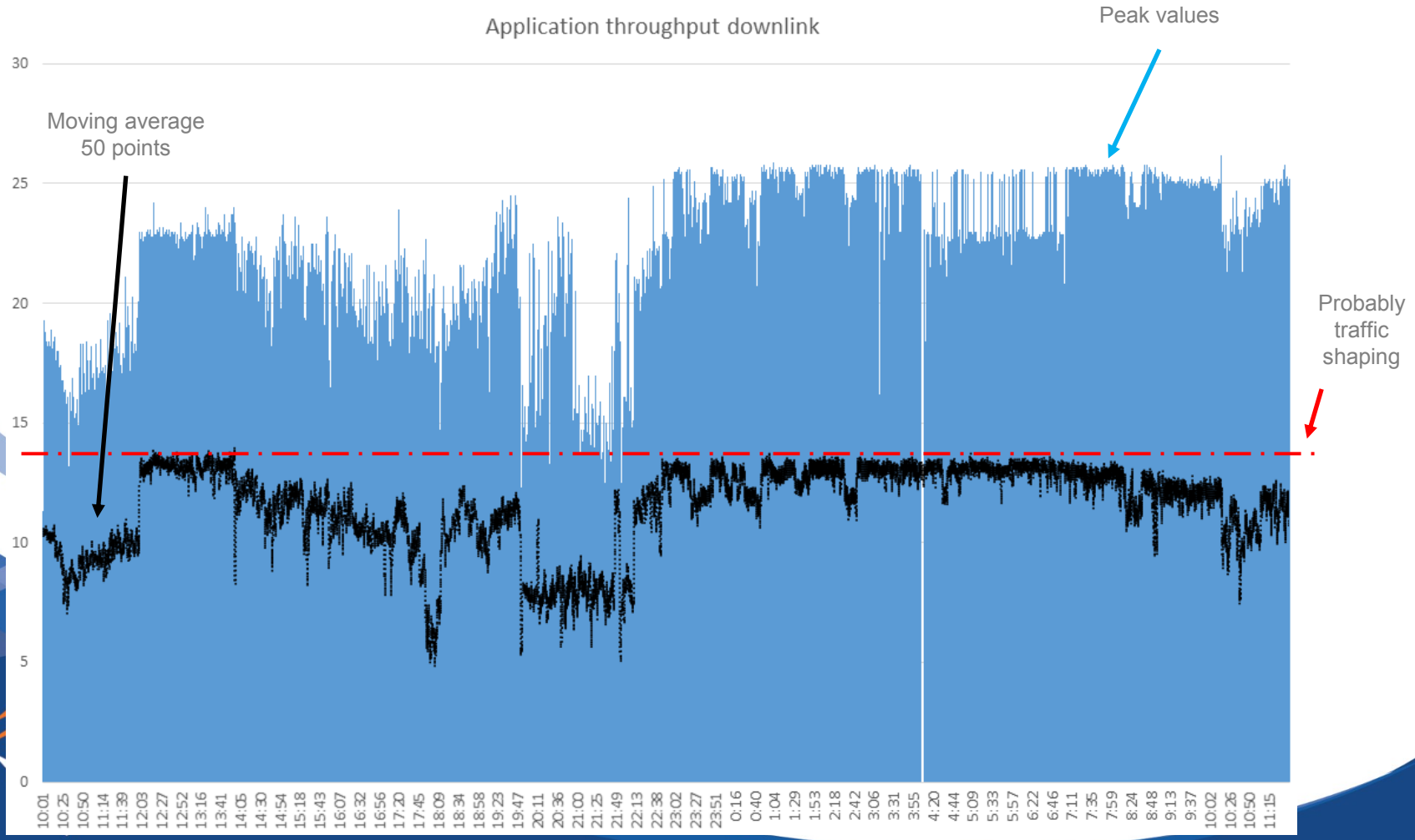
Highway D2 – Bratislava – RSRP



Scenarios – mobile stationary test

Operator O2 Czech Republic – weekend

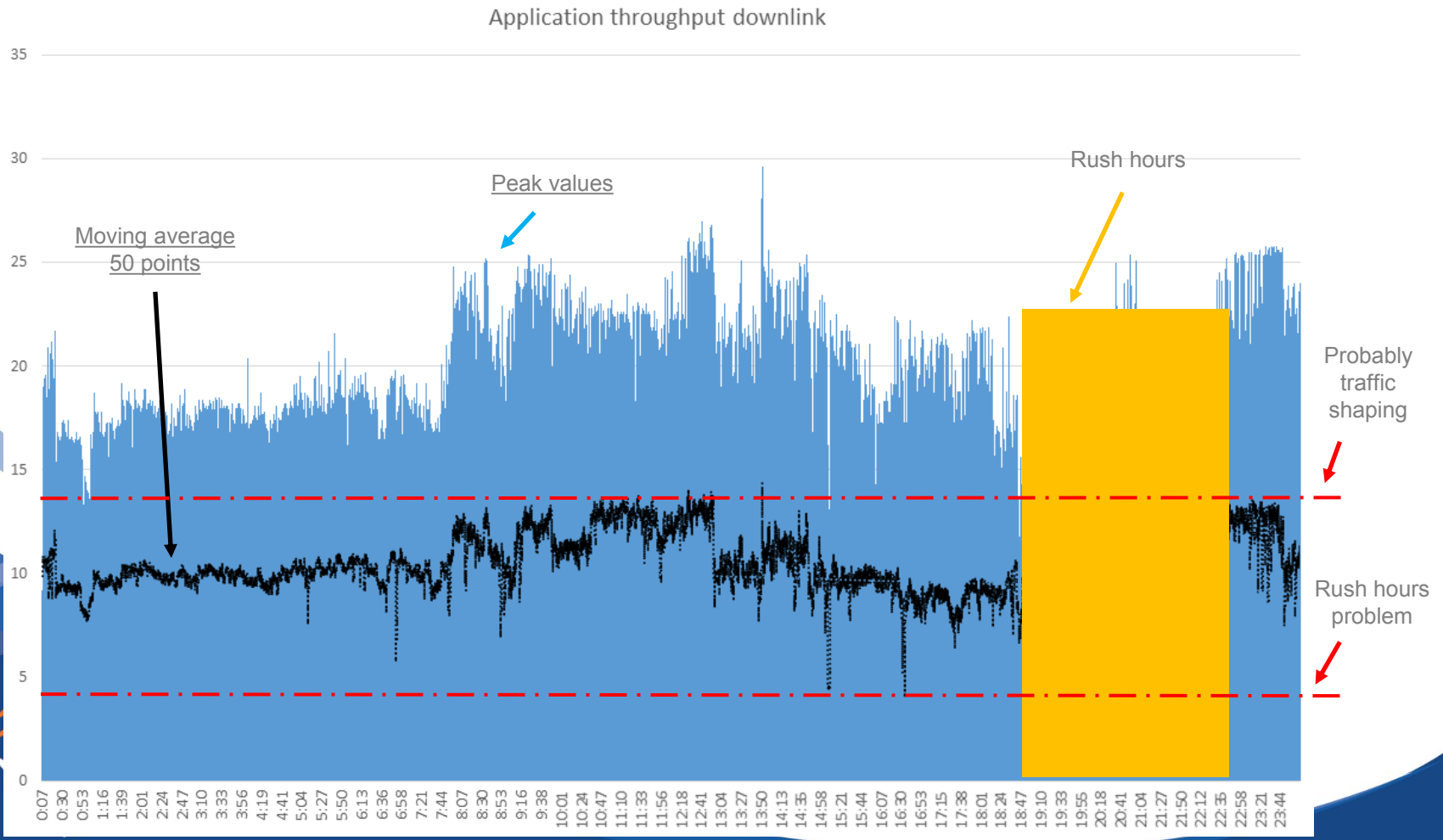
Brno – LTE Downlink speed



Scenarios – mobile stationary test

Operator O2 Czech Republic – working day

Brno – LTE Downlink speed



Which QoS cooperation is done?

1. **Memorandum of cooperation - QoS**
   - Members – Czech Republic, Slovakia, Poland, Slovenia, Croatia, Romania (in process of adoption)

   a) Sharing experiences and results of measurement
   b) Project and tools sharing and cooperation

2. **Czech Telecommunication office is**
   a) RIPE LIR member - AS, IPv4, IPv6
   b) NIX.CZ (Czech Neutral Exchange Point) member - peering
   c) Partner of CZ.NIC (Czech domain administrator) – NetMetr.cz project, datacenter collocation

Thank you for your attention.

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