



# CZECH TELECOMMUNICATION OFFICE REPORT

on results of monitoring of compliance with Regulation  
Regulation (EU) 2015/2120 of the European Parliament and of the  
Council of 25 November 2015  
laying down measures concerning open Internet access and retail prices  
for regulated communications within the Union  
and amending Directive 2002/22/EC ES and Regulation (EU) No.  
531/2012

**carried out between 1 May 2021 and 30 April 2022**

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## **1. Introduction**

The Czech Telecommunication Office (hereinafter referred to as the "Office" or "CTU"), as the national regulatory authority for electronic communications in the Czech Republic, has prepared, in accordance with Article 5(1) of Regulation (EU) 2015/2120<sup>1</sup> of the European Parliament and of the Council (hereinafter referred to as "Regulation (EU) 2015/2120" or the "Regulation"), a report on the results of monitoring of compliance with the Regulation for the period from 1 May 2021 to 30 April 2022.

In the Czech Republic, there was a 9% decline in the number of Internet access service providers in the period under review, despite a steady, gradual increase in the number of subscribers using this service (up 5%). The largest decrease in the number of providers was recorded among providers offering mobile Internet access service, from the original 204 to the current 167 providers. Internet access service at a fixed location was provided by a total of 1854 providers of electronic communications services. A total of 122 providers offered Internet access services using both methods.

The number of subscribers using mobile data services increased to 10,301,025 subscribers.<sup>2</sup> In the period under review, a total of 3,926,597 subscribers used the Internet access service at a fixed location.<sup>3</sup> This number also includes the number of subscribers using Internet access service at a fixed location via mobile networks (fixed LTE). That method of providing Internet access service has been growing steadily in recent years as data traffic has surged due to the Covid-19 pandemic. In the period under review, a total of 455,147 subscribers used this form of Internet access.

In the period under review, the Office focused mainly on activities related to the issuance of the General Authorisation VO-S/1/08.2020-9 (hereinafter referred to as the "General Authorisation" or "VOS1"), both in terms of its enforcement, as well as in terms of activities aimed at strengthening end users' awareness of their rights, and the development of tools that make it possible to check the performance of the service or, as the case may be, to compare the quality of access to the Internet on the territory of the Czech Republic, and the prices of services.

In the currently monitored period, it should be pointed out that the Office's targeted education has succeeded in achieving a change of attitude on the part of end users who, to a much greater extent, actively exercise their rights related to the quality of the provided Internet access service. This change was made possible by the fact that the quality parameters of the Internet access service were clearly defined by the General Authorisation and, thanks to the inspection activities of the Office, these QoS parameters were implemented in the contract terms of providers and, last but not least, the new certified measuring tool of CTU – NetTest (hereinafter referred to as "NetTest") was put into operation, making it possible to verify the actual performance of the Internet access service. Throughout the period under review, these activities of the Office were accompanied by a media campaign aimed at end users, such as commercials on television and radio, information in monitoring reports, production of an instructional video, publication of a brochure, etc. This has created conditions for end users

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<sup>1</sup> Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015 laying down measures concerning open Internet access and amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services and Regulation (EU) No 531/2012 on roaming on public mobile communications networks within the Union.

<sup>2</sup> The category of mobile services included data on the number of active SIM cards for an Internet access service provided together with a voice service (a service normally used in mobile phones) or separately without a voice service (a service normally used in tablets, laptops, etc., e.g. as part of a USB modem).

<sup>3</sup> The service at a fixed location includes the number of accesses (active connections) to the Internet at a fixed location for all monitored technologies (xDSL, wireless access in free and licenced bands, CATV, FTTH, FTTB, satellite connection, PLC, and others).

that allow them to successfully defend their rights regarding the provision of an Internet access service of the agreed quality.

The application of the provisions of Directive (EU) 2018/1972 of the European Parliament and of the Council establishing a European Electronic Communications Code (hereinafter referred to as "the Code"), which has been implemented in Act No. 127/2005 Coll. on Electronic Communications and on Amendments to Certain Related Acts (Electronic Communications Act), as amended (hereinafter referred to as "Electronic Communications Act"), is also contributing to positive developments in relation to consumers. One of the positives is that it is easy and quick to change Internet access service providers in a relatively short period of time, ensuring continuity of the services provided. Another advantage is that the consumer receives mandatory pre-contractual information prior to the conclusion of the contract, enabling them to make an informed decision about the services they intend to use. The ability to switch providers and the availability of transparent and timely information encourages end subscribers to become active participants in competition. The launch of a free comparison tool<sup>4</sup> for the price and quality of electronic communications services, which offers the general public transparent, up-to-date and comparable information on offers and services, also contributes to this objective. This gives end users the opportunity to choose electronic communications services that meet their requirements.

## **2. Description of the Office's activities in monitoring compliance with Regulation (EU) 2015/2120 during the period from 1 May 2021 to 30 April 2022 and the number and type of complaints and infringements relating to the Regulation**

In connection with the issuance of VOS1, the Office carried out inspections of the implementation of the General Authorisation in contract terms in several stages and also initiated an analysis of the contract terms of selected providers in connection with the transposition amendment to Act No 374/2021 Coll., which transposed the Code into Czech law. The Office continued to systematically educate end users of the Internet access service in order to increase their awareness of speed parameters and the possibility of using the new certified NetTest measuring tool. Last but not least, the Office also continuously monitored the market situation in the application of net neutrality rules in the Czech Republic and carried out a number of technical control measurements.

In this context, the following activities were carried out by the Office in the period under review.

### **2.1. Activities of the Office**

#### **2.1.1. Activities of the Office aimed at monitoring contract terms and limiting end-user rights**

In January 2021, a General Authorisation came into force that redefined the conditions for the disclosure of specific information on the quality of Internet access service and also contributed to a significant improvement in end users' awareness of the speed parameters of the services they use. In 2021, the Office has already launched a large-scale nationwide inspection of all providers offering Internet access services, focusing specifically on the implementation of this General Authorisation in their contract terms. Already in phase I of this inspection activity,

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<sup>4</sup> <https://srovnavac.ctu.cz/>

which was completed in August 2021, a total of 312 inspected entities were fined in subsequent proceedings concerning administrative offences. The follow-up phase II inspection focused on those providers found to be deficient and in breach of their obligations in phase I. This phase was completed in December 2021. Also, at this stage, the Office conducted proceedings concerning administrative offences with 44 inspected entities and fines were imposed for non-compliance with legal obligations. The last phase III of this inspection activity is currently underway and is scheduled for completion in the second half of 2022.

In connection with the entry into force of Act No. 374/2021 Coll., which transposed the Code into the Electronic Communications Act, the Office carried out an analysis of the contract terms of 60 selected service providers, the most significant ones in terms of the number of subscribers, which focused, among other things, on compliance with the obligation to provide pre-contractual information pursuant to Article 4(1) of the Regulation, and on the implementation of new provisions on the possibility of switching Internet access service providers while ensuring continuity of the services provided into the contract terms.

As in previous years, the Office engaged with selected business practices of providers of Internet access services and also focused its attention on zero-rating practices by monitoring the published contract terms of providers that have offered this service to date. The tendency for these offers to decline continued as a result of market developments, with tariffs with higher data volume limits or unlimited data volumes being offered on the market.

The topic of zero-rating was also discussed within BEREC in the period under review, as a result of the CJEU's decision (September 2021) concerning three German cases related to the application of the Regulation, which fundamentally affected the obligation of equal treatment of traffic within the meaning of Article 3(3) of the Regulation. The Office was actively involved in the subsequent professional discussion on this issue and in the preparation of the revision of the Guidelines on the Implementation of the Open Internet Regulation, which was adopted as a result of the decisions issued.

In connection with the issuance of Council Regulation (EU) 2022/350 of 1 March 2022 amending Regulation (EU) No. 833/2014 concerning restrictive measures in view of Russia's actions destabilising the situation in Ukraine, the Office informed about its issuance in a monitoring report and subsequently also informed the professional public with a targeted warning about the content of the Regulation and the possible consequences of non-compliance with the obligations set out therein.

The Office also continuously monitored complaints and queries from end users regarding the Internet access service (for more details see below).

### **2.1.2. Activities of the Office focused on technical monitoring of quality and assessment of the performance of the Internet access service**

In the period under review, the Office decided to develop and operate its own publicly available measuring tool, NetTest,<sup>5</sup> for the purposes of technical monitoring of quality, using the source codes of the RTR-Netztest tool operated by the Austrian regulator RTR-GmbH. To this end, a Memorandum of Cooperation was concluded between the Office and the Austrian regulator on the sharing of experience in the development and operation of measuring tools focusing on crowdsourcing. The NetTest tool, which was launched on 17 September 2021 as a certified monitoring mechanism for the quality of Internet access services, provides the general public with the opportunity not only to test the quality of their Internet connection once or repeatedly, but also to carry out a certified measurement process in the event that the speed actually

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<sup>5</sup> <https://nettest.cz>

achieved in the download or upload direction of the Internet connection does not correspond to the contractually specified speeds.

For the purpose of checking, verifying and presenting selected parameters of data services in mobile and fixed networks to the public, the Measuring System of Electronic Communication (hereinafter referred to as "MSEK") was used, where the NetTest tool is now part of its infrastructure. The comprehensive MSEK measuring system for the purposes of checking, monitoring, control measurements and visualization of selected quality parameters of Internet access services was put into routine operation in the second half of 2021 following a cyber and application security audit.

In order to assess the performance of the Internet access service, the Office analysed the results measured by NetTest and NetMetr with tens of thousands of measurements and available statistical tools. Regarding the effect of VOS1 from 1 January 2021, publicly available data (open data) from NetMetr for the year 2020, before the of VOS1 entered into effect, was included for the purpose of visualizing trends in the development of general quality of Internet access service. The most important finding was based on an analysis of the change in average speed depending on the time of day, with a period of 60 minutes, for the specific period of interest. After the NetTest tool's operational load has stabilized following its launch, this statistical monitoring of the development of service performance started to show a variation of values up to 40% of its daily maximum value, especially in the download direction. This variation of values, when compared with the definition of the normally available speed for Internet access services provided at a fixed location, corresponded to the requirement that the normally available speed, on which large deviations devolve, should be at least 60% of the advertised speed. In other words, that the drop in performance of Internet access services provided at a fixed location be no more than 40%.

The Office carried out technical monitoring of the parameters of Internet access services provided also in mobile networks. The results of measurements of radio and data quality parameters in mobile networks were again made available to the public on the Office's Visualization portal.<sup>6</sup> These visualizations include the results of measurements carried out by the Office at selected stationary points, as well as measurements of coverage during a ride on the motorway network and railway corridors of the Czech Republic carried out in 2021. On the transit railway corridors of the Czech Republic, measurements of the coverage with mobile radio communication network signals were carried out in cooperation with Správa železnic, a state organization, which provided the Office with a measuring railway motor carriage with antennas placed on the roof of the carriage. During this period, a test measurement of the coverage of 4 selected districts was carried out for the purpose of subsequent analysis and evaluation of the data obtained. The Office will look into how to publish the measured data from the coverage of districts in the CTU visualization portal in the future. Radio and data parameters of mobile signals are measured during the ride in order to collect data to check compliance with the development criteria for the use of mobile operators' radio frequencies. The F-Tester® 4drive-box device, developed by the Faculty of Electrical Engineering of the Czech Technical University in Prague, is used to measure the data download speed in mobile networks from the vehicle (carriage) while on a ride. The benefit of the unique F-tester is the simultaneous measurement of data parameters in the mobile networks of three different mobile operators. During the ride, the current location and signal parameters of mobile networks are recorded, with the possibility of displaying the transmission speed and other parameters depending on the location.

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<sup>6</sup> <https://qos.ctu.cz/mapa>



### **2.1.3. Activities of the Office aimed at the general and professional public**

The Office has devoted itself more than in the past to activities aimed at educating the general public about the quality of Internet access services offered by providers. In order to meet the needs of end users and to increase the transparency of up-to-date and comparable information on the quality and prices of the services offered, the Office has launched a price and quality comparison tool and a certified measuring tool NetTest.

In October 2021, after a six-month test run, a comparison tool was launched to facilitate price and quality comparisons of electronic communications services, allowing members of the public to compare the prices of different services offered on the market, such as calls, SMS, data, fixed and mobile Internet, calls at a fixed location and TV, in an easily accessible form. In the period under review, more than 90,000 end users used this service. Information entered directly by the providers on the parameters and prices of services they offer allows end users to choose the best available service.

On 17 September 2021, a web-based version of the NetTest measuring tool was launched for the general public. This measuring tool enables the performance of certified measurements, which makes it significantly easier for end users to submit claims about Internet access services. The launch of NetTest was also accompanied by an extensive media campaign "Pay only for actual speed" on TV, radio, in the media and CTU channels. The campaign used a brochure prepared at the beginning of the year on the topic of measuring and submitting claims about the speed of the Internet access service. These activities were complemented by an educational video produced by the Office, which illustrates the correct use of the NetTest measuring tool for measuring the speed of Internet access services at a fixed location.

The Office continued its Telecommunication Academy project, which organizes lectures by experienced lecturers, especially for the elderly and now also for young people, focusing on the provision of electronic communications services, postal services and the environment of digital platforms, and produces short educational videos for the public. These activities include presentations on how to measure your Internet speed using the NetTest measuring tool and how to submit a claim about a defect in your Internet access service or how to file an objection by CTU.

Experience with the operation of the new NetTest measuring tool was presented by the Office at the "FTTx Networks in 2022" professional seminar. As part of the publishing activity, it is worth mentioning a professional article in NEXT GENERATI@N Telekomunikace (issue 3-4/2021)<sup>7</sup> "ČTÚ-NetTest – princip činnosti nového měřicího nástroje určeného pro širokou veřejnost" ("CTU-NetTest – the principle of operation of a new measuring tool for the general public").

## **2.2. Characteristics and number of claims related to Regulation (EU) 2015/2120**

Based on the data obtained from the ongoing monitoring of complaints and enquiries from end subscribers, the Office noted in the period in question a continuing trend of an increasing number of complaints concerning the fulfilment of the obligations set out in the Regulation by providers of Internet access services. Although the number of complaints related to the Regulation is still only a few dozen, it can be noted that the vast majority of these complaints and enquiries (90%) relate to non-compliance with the agreed quality parameters specified in

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<sup>7</sup> <https://telmag.cz/>

the contract or the inclusion of quality parameters for the Internet access service in the contract that are not in accordance with the General Authorisation issued.

The increasing number and structure of these complaints and enquiries fully reflects the above-mentioned activities of the Office focused on education and increasing the transparency of up-to-date information for end users. The launch of the web version of NetTest, which offers not only the possibility of an indicative speed determination, but also the possibility of performing a certified measurement, made it substantially easier for end users to submit claims about defects of the service. The abundant use of the measuring tool was also reflected in the nature and number of complaints and enquiries received by the Office in the period under review.

Other complaints or enquiries related to non-compliance with QoS parameters counted in units concerned the quality and impact of specialized services (IPTV) on the quality of the Internet access service, limiting the right of end users to use terminal equipment of their choice and the application of traffic management measures.

### **3. Results of inspections carried out in the context of supervision and enforcement of Regulation (EU) 2015/2120**

In the last period under review, the Office already presented information about the launch of an extensive nationwide inspection of Internet access service providers. Whereas in previous periods the Office focused its attention on the largest nationally and regionally active providers of Internet access services, this inspection targeted all providers offering this service. The inspection focused on the compliance with disclosure obligations under Article 4(1)(d) of the Regulation, inclusion of information on remedies available to end users in the event of a continuous or regularly recurring discrepancy from the actual performance of the Internet access service pursuant to Article 4(1)(e) of the Regulation, and also on compliance with the obligations arising from the General Authorisation specifying the method of designating individual speeds and their discrepancies. This unique inspection activity took place in three phases. Phase I was focused on educating Internet access service providers and lasted from January to August 2021. Phase II targeted those providers who had not remedied the deficiencies identified in phase I and was completed in December 2021. The final phase III, currently underway, targets 95 small providers (offering Internet access service at a fixed location of up to 2,000 subscriptions) that have not fulfilled all their legal obligations to date. It is scheduled for completion in the second half of this year.

In the first phase (ending in August 2021), the Office initially adopted an educational approach in relation to the more than 2,000 providers inspected. As part of an extensive inspection, the contract terms published by providers of Internet access services were examined and, through individual consultations with individual providers, the Office sought to facilitate compliance of these published contract terms of the providers with the terms and conditions of the General Authorisation which came into force on 1 January 2021. While at the initial stage of this phase it was found that only less than 4% of the providers of Internet access services complied with the requirements for setting individual speeds and their deviations according to the Office's binding definitions of basic QoS parameters, already within a few months, thanks to this activity of the Office, there was a significant increase in the number of providers that brought their contract terms into line with the General Authorisation. At the end of this first phase, 97% of end users using the service already had adequate information about the parameters of their service. Administrative offence proceedings were initiated against those providers who, despite the approach taken by the Office, failed to remedy the identified deficiencies in a timely manner. A total of 312 fines were imposed, the total amount of which exceeded CZK 2.5 million.



The inspections carried out in the second phase (until December 2021) were less extensive in nature and targeted specifically those providers where the previous phase should have corrected and eliminated the identified faults. This inspection covered a total of 393 providers. At this stage, the Office found that 24% of these providers continued to manifest repeated faults or non-compliance of their contract terms with the mandated QoS parameters. This number was mainly made up of small providers. The Office proceeded to initiate new administrative offence proceedings in these cases. At the end of this phase II, the Office imposed fines on 44 entities totalling CZK 0.5 million.

The third and final phase is currently underway (from January 2022) and is scheduled for completion in the second half of this year. At this final phase, the Office is inspecting 95 providers that have not yet complied with all their legal obligations.

The pursued strategy of the thematically targeted inspections carried out and over 1000 individual meetings initiated by the Office with providers of Internet access services was not only to ensure increased legal awareness among mainly small providers of Internet access services, but also to ensure that the contracts of all end users contain information on the quality parameters of the Internet access service, where these agreed parameters correspond to the conditions set out in the VOS1.

The so-called transposition amendment to Act No 374/2021 Coll., which transposed the provisions of the Code into the Electronic Communications Act, further increased protection of the rights of end users in terms of the availability of transparent information to ensure access to the open Internet, the possibility of mutual comparability of service offers and quality assurance. In February 2022, the Office started analysing the contract terms of the selected top 60 providers of electronic communications services with nationwide presence, focusing, among other things, on compliance with the obligation to provide a pre-contractual summary of the contract, which includes, pursuant to Article 102(3)(f) of the Code, the information required under Article 4(1)(d) and (e) of Regulation (EU) 2015/2120, as well as on the implementation of the new provisions of the Act relating to the possibility of changing the provider of Internet access service with continuity of the services provided in the contract terms.

During the statutory transition period lasting until 30 June 2022, providers of electronic communications services, including providers of Internet access services, are obliged to bring their contract terms into compliance with the amended wording of the Electronic Communications Act. During this transition period, the Office again took an educational approach to providers. Based on the analysis of the published contract terms, an informative letter was sent to 42 entities in which the Office drew attention to the most important changes and at the same time pointed out the obligation to bring the contract terms into compliance with the applicable legislation. At the same time, the Office offered the contacted providers the opportunity to consult on the new legislation so that after the transposition amendment comes into force, end users will already have compliant contract documentation at their disposal.

Through regular checks of contract terms, targeted requests for information and monitoring the nature of complaints, the Office continued to monitor regularly whether the rights of end users to use the terminal equipment of their choice within the meaning of Article 3(1) of Regulation (EU) 2015/2120 are not being restricted. In the period under review, 4 cases of suspected restrictions on the free choice of terminal equipment were recorded. In one case, the inspection revealed that there was a restriction on the choice and use of the terminal device of one's choice, regardless of the location of the end user or provider or the location, origin or destination of the information, content, application or service. The provider who violated Article 3(1) of the Regulation in this manner was fined a total of CZK 1.65 million in the joint administrative proceedings. In another case, the inspection has not yet been completed and in the other cases no breach of the Regulation has been found.

In this period under review, two administrative proceedings were also finally terminated by the imposition of a fine and the discontinuation of proceedings which did not result in a final decision in the previous period. One administrative offence proceeding initiated in the previous period has not yet resulted in a final decision.

In the context of the ongoing Covid-19 pandemic, no emergency situations or potential breaches of Regulation (EU) 2015/2120 have been identified by the Office with regard to the application of traffic management measures by Internet access service providers.

#### **4. Results of technical monitoring and measurements and their evaluation in relation to the implementation of Regulation (EU) 2015/2120**

For the purposes of checking and verifying the quality of Internet access services, technical monitoring and practical measurements were provided by MSEK measuring system and, more recently, by the publicly available NetTest measuring tool, where the Office opted for a variant of its own tool with direct management, based on the RTR-NetzTest tool in its latest version. The reasons for using the source codes of the open-source tool of the Austrian regulator were the updating of key parts of the core, the available recurring and certified measuring modes (in the web version only for service at a fixed location), the detailed measuring results to facilitate the production of reports, studies and analyses on market developments. Other advantages of running CTU's own tool include a simpler tool certification process, detailed knowledge of the source code and its properties in terms of operational change options, close cooperation with the RTR-Netztest development team, the possibility of dedicating an RMBT server separately for the certified measurement mode, and overall lower costs for running the tool.

The NetTest measuring tool is part of the infrastructure of the major information system MSEK, which has a 10 Gbit/s capacity of connectivity to the Internet exchange NIX.CZ along with 10 Gbit/s capacity of transit connectivity. Before the tool was put into operation, the Office carried out a verification process (see Chapter 4.1) of the tool's measuring characteristics in accordance with the BEREC assessment methodology BoR (17) 178, including the forthcoming draft amendment to this document. At the same time, prior to the launch of the tool, the Office implemented a series of measures to ensure that in the event of extreme load on the tool (connectivity, servers, etc.), the measurement results are not adversely affected in any way by the operation of the tool itself. On the launching day of the tool, a total of 33,281 tests were performed by 26,118 users. This is still a record load to date and no problems, technical or other, have been reported during the launch of this tool. From its launch until 30 April 2022, more than 570,000 measurements have been performed by users, see Figure 1. We are currently preparing to link the results measured by NetTest with the Visualization Portal,<sup>8</sup> which serves as a tool for users to compare the quality of various telecommunications services in the Czech Republic.

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<sup>8</sup> <https://qos.ctu.cz>

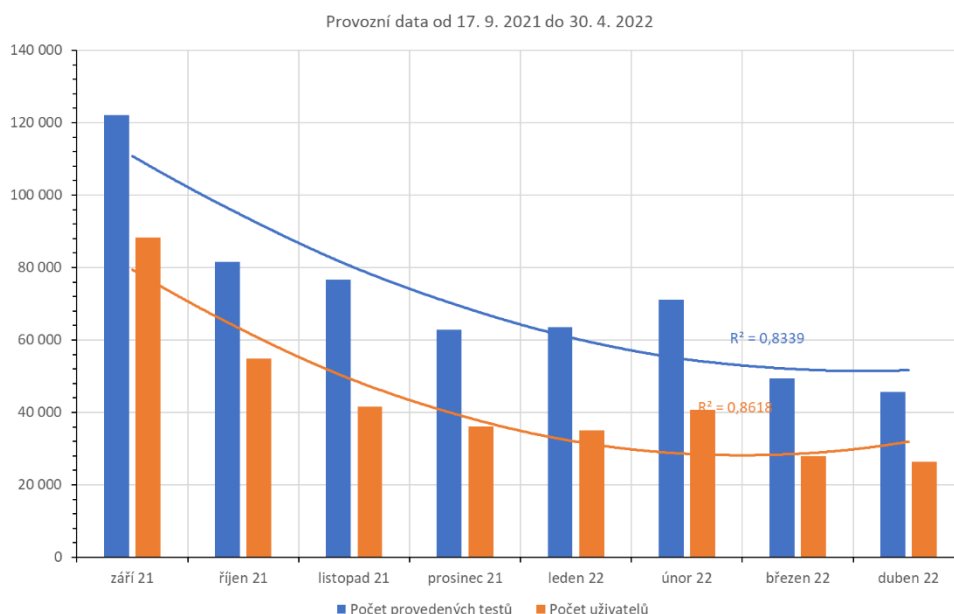


Figure 1: NetTest traffic data

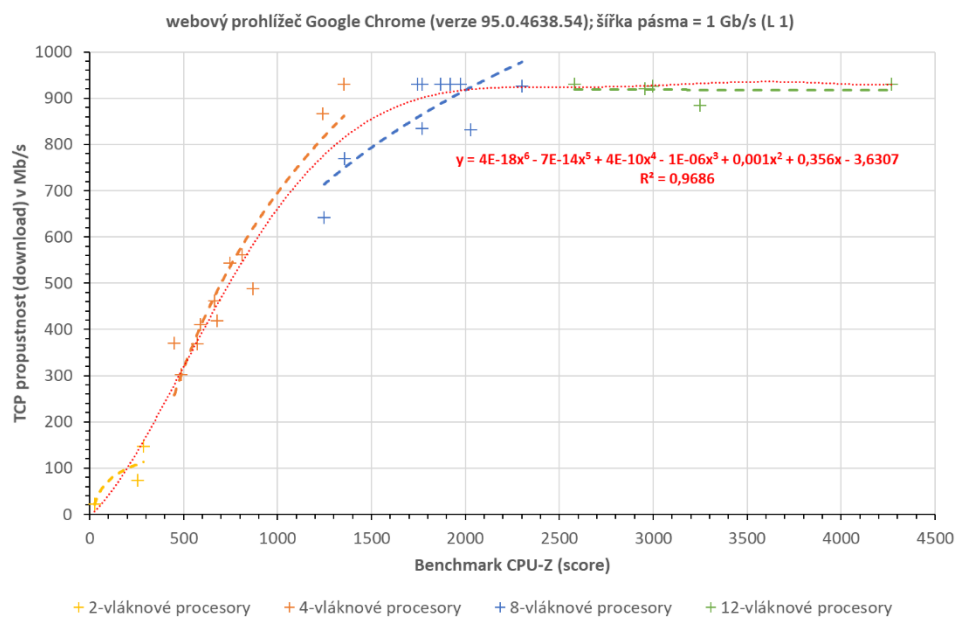
The results of the NetTest tool through the certified mode can be used by end users when submitting a claim about their Internet access service, i.e. when they detect the occurrence of large discrepancies in service performance or when they detect a service outage (a drop below the minimum speed). In the case of investigations based on complaints about the quality of the Internet access service, the Office uses calibrated measuring technologies, where the measurement is carried out by the Office staff according to the methodological procedure directly at the end user premises with HW dedicated measuring device against a measuring server located at the NIX.CZ Internet exchange with a capacity of 10 Gbit/s, including transit connectivity of the same capacity.

#### **4.1. Verification of measurement properties of the new CTU-NetTest tool**

Before the official launch of the NetTest tool to the general public, a verification process of its measurement properties was carried out. This process is based on the results of monitoring of the quality of Internet access service at a fixed location through 6 selected open source web-based tools (QoSmetr, Librespeed, NetMetr, RTR-NetzTest, Breitbandmessung, CESNET speedtest), where measurements were carried out at 47 termination points over a period of 7 days and a total of 11,844 tests were performed across the Czech Republic. Due to the inconsistency of the measurement results, it was not possible to identify a reference tool for the verification process. Accordingly, a verification tool MSEK Downloader was created in Python, against which the measurement results were compared by NetTest.

Several factors and their impact on measurement results were considered in this verification process, including the use of the BEREC assessment methodology BoR (17) 178 and its forthcoming update:

- the influence of web browsers,
- the impact of the performance of user devices (PC, laptop) according to CPU-Z benchmark results,
- the impact of the different access technologies,
- the effect of the settings of active elements and their performance (buffer size, internal structure, etc.),
- measurements at all possible demarcation points (DeP) of the network.

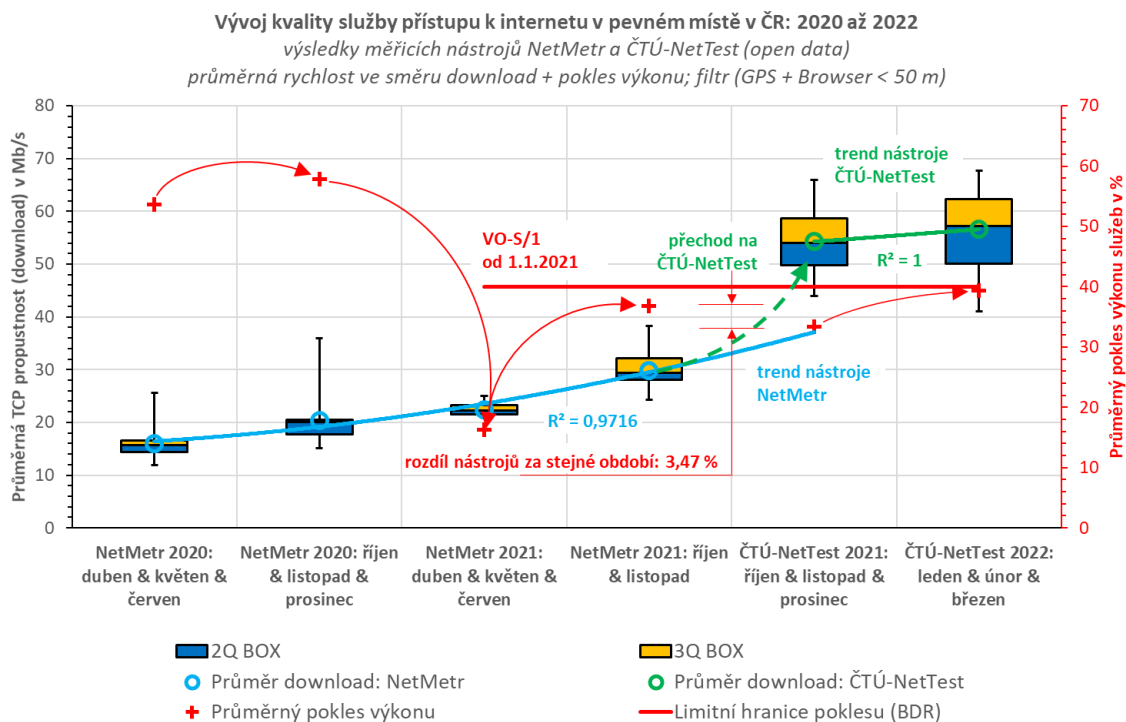


**Figure 2:** Effect of CPU power of user devices on measurement results

The results of the verification process showed that the new NetTest measuring tool can measure up to gigabit speeds when combined with a powerful user device (PC, laptop) and a suitable (optimized) browser (ideally based on Chromia). But based on an assessment of the factors influencing the measurement results and considering a "typical" user device that matches the median in its category (4 core 4 thread processor, CPU-Z: 811 points), NetTest is capable of seamlessly handling 500/250 Mbps, see Figure 2. Therefore, this limit was used in the certified measurement, and coincidentally, the same limit is also defined by the Austrian regulator. The Office also detailed the conditions that must be met by end users for measuring through the certified mode. A more detailed description of the verification process of the NetTest measurement properties is attached hereto as Annex 1.

#### **4.2. Visualization of trends in the general quality of Internet access service at a fixed location**

In order to assess the performance of the Internet access service, the Office analysed the results measured by NetTest and NetMetr by available statistical tools with tens of thousands of measurements. Regarding the effect of VOS1 from 1 January 2021, publicly available data (open data) from NetMetr for the year 2020, before the of VOS1 entered into effect, was included for the purpose of visualizing trends in the development of general quality of Internet access service. The most important finding was based on an analysis of the change in average speed depending on the time of day, with a period of 60 minutes, for the specific period of interest. After the NetTest tool's operational load has stabilized following its launch, this statistical monitoring of the development of service performance started to show a variation of values up to 40% of its daily maximum value, especially in the download direction. This variation of values, when compared with the definition of the normally available speed for Internet access services provided at a fixed location, corresponded to the requirement that the normally available speed, from which large deviations devolve, should be at least 60% of the advertised speed. In other words, that the drop in performance of Internet access services provided at a fixed location be no more than 40%.



**Figure 3:** Aggregate evolution of the quality of Internet access services at a fixed location in the period 2020 to 2022; publicly available tools NetMetr and CTU-NetTest; average TCP throughput & service performance decline

The traffic data since launching the tool has also been analysed, namely the extent to which NetTest has been used by end users. The data was filtered according to the location parameter (GPS position with an estimated deviation of up to 50m) and then visualized in the form of a "heat map" for individual speed categories based on BEREC Guidelines BoR (20) 42. The tool was used across the Czech Republic, with visualized measurement results corresponding to a total of 91,459. The aggregate results of the monitoring of the quality of Internet access service at a fixed location via the tool are attached hereto as Annex 2.

## **5. Measures taken and applied pursuant to Article 5(1) of Regulation (EU) 2015/2120**

In conclusion, the Czech Republic has made significant progress in the implementation of the Regulation from the time the Regulation was issued in 2015 until this year, bringing benefits to end users when using Internet access services and largely meeting the objectives pursued by the Regulation.

The prerequisites for achieving these objectives are primarily legislative instruments, both the Regulation itself, which defines the basic theses for the provision of Internet access services, and the VOS1, which defines the specifications of the basic QoS parameters, at the national level. After 1 January 2022 (or 1 July 2022, following the end of the transitional period), these legal provisions will be supplemented by a transposing amendment of the Code, including additional conditions for the provision of Internet access services and the definition of end user rights.

Over the last few years, the Office has also developed and operates a number of IT tools that facilitate end users' ability to make an informed choice of provider, whether it is a price and quality comparison tool or a visualization map of mobile signal coverage in the Czech Republic, or the activation of remedies, in the event of insufficient service performance, whereby they can use the NetTest measuring tool to carry out a certified measurement of their service performance and then use the results effectively in the claims process.

Based on these assumptions, end users can now make informed decisions about their choice of Internet access service provider and have enough resources to effectively defend their rights in the event of poor service performance.

On the other hand, the described state of affairs, which has been achieved in the Czech Republic as a result of the work of the Office, also puts pressure on providers to improve their networks, provide quality service and relevant information to end users, and implement corrective processes in case of defects in the service provided.

In the next period, the Office will evaluate the impact of the transposing of the Code in the area of Internet access services, e.g. with regard to the newly regulated right to change the provider of an Internet access service while ensuring the continuity of the services provided. The Office will also monitor the impact of the development of high-capacity networks and the associated expanding portfolio of services offered. Last but not least, the Office will continue its regular activities such as monitoring the contract terms and business practices of providers, as well as carrying out technical measurements and developing the tools described above, e.g. by providing a mobile application within the NetTest tool to the general public and linking the measured results with the Office's Visualization Portal.

# Annex 1

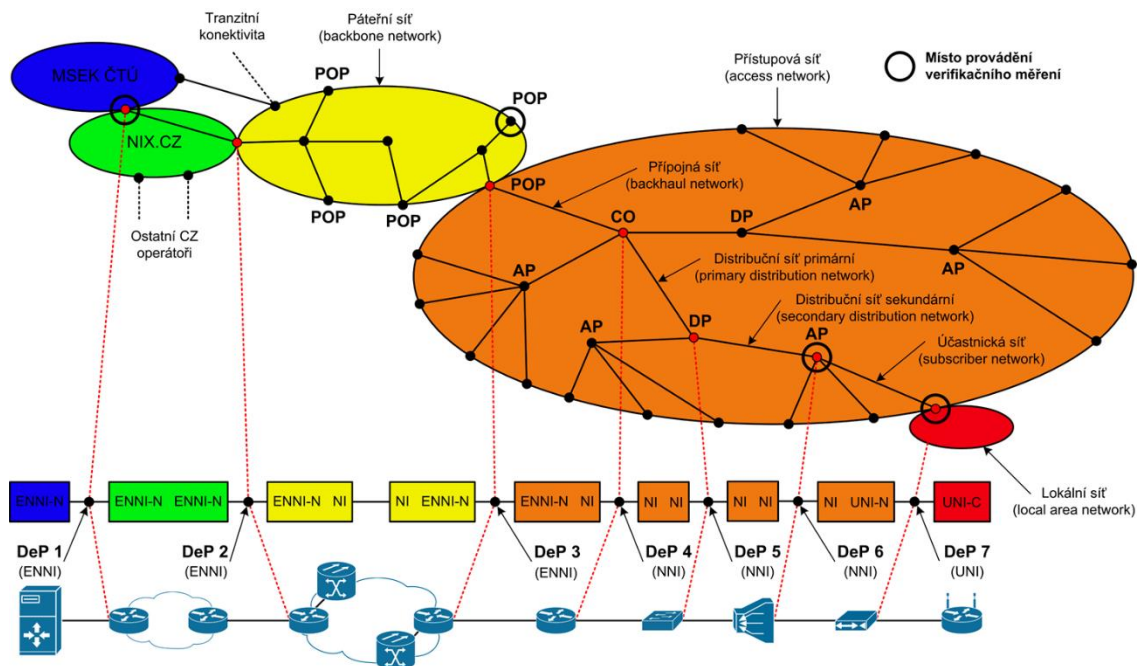
## Verification of measurement properties of the new CTU-NetTest tool

Before the official launch of the NetTest tool to the general public, a verification process of its measurement properties was carried out. This process is based on the results of monitoring of the quality of Internet access service at a fixed location through 6 selected open source web-based tools (QoSmetr, Librespeed, NetMetr, RTR-NetzTest, Breitbandmessung, CESNET speedtest), where measurements were carried out at 47 termination points over a period of 7 days and a total of 11,844 tests were performed across the Czech Republic. Due to the inconsistency of the measurement results, it was not possible to identify a reference tool for the verification process. Accordingly, a verification tool MSEK Downloader was created in Python, against which the measurement results were compared by NetTest. The working principle of this tool is based on downloading a file (100 GB) with a selectable measurement time interval. In the initial measurement phase, the TCP connection initial phase (TCP handshake) is automatically removed. The tool operates on a port of normal web traffic (80), including access to the network interface, and the actual transfer rate (current speed) is measured and plotted, with the current TCP throughput value written every second. The result is an evaluation of the actual speed achieved in the form of the resulting arithmetic average and the time-weighted average. The tool records the local and source IP address, the NAT IP address and the total amount of data downloaded.

Several factors and their impact on measurement results were considered in this verification process, including the use of the BEREC Assessment Methodology BoR (17) 178 and its forthcoming update:

- the influence of web browsers,
- the impact of the performance of user devices (PC, laptop) according to CPU-Z benchmark results,
- the impact of the different access technologies,
- the effect of the settings of active elements and their performance (buffer size, internal structure, etc.),
- measurements at all possible demarcation points (DeP) of the network.





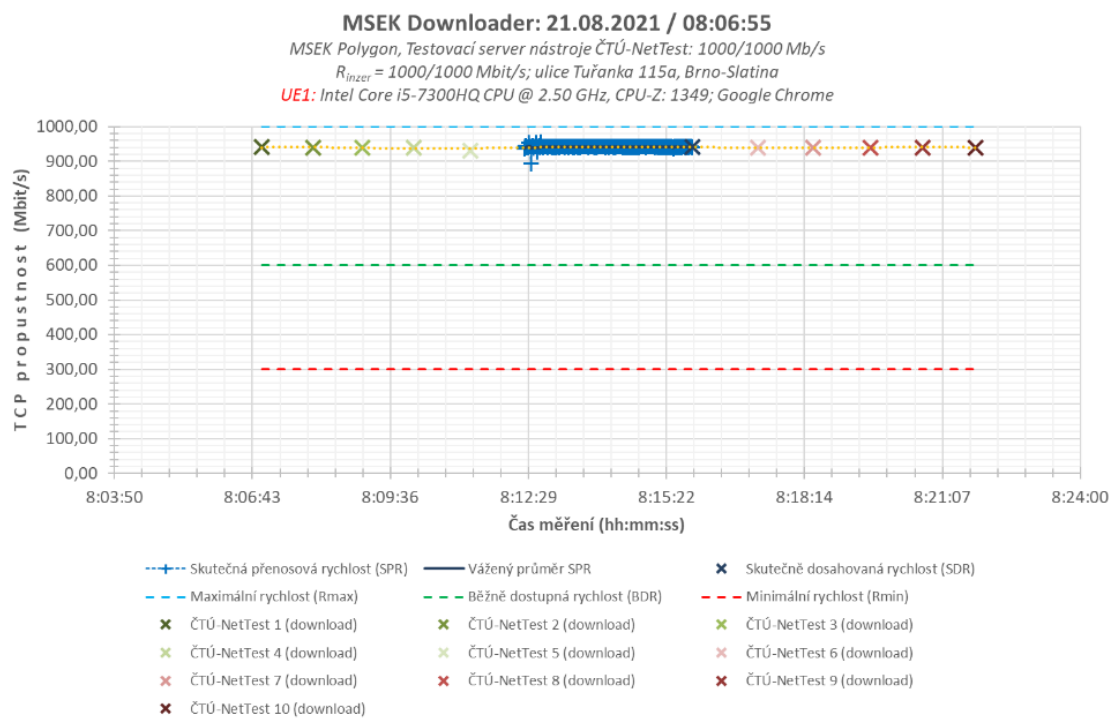
**Figure 1:** Demarcation points DeP corresponding with verification points

The measurement procedure that has been proposed respects the theory of measurement uncertainty (error theory). A script was created that performed measurements in a "5 + 1 + 5" scenario without user intervention, i.e. 5 measurements with NetTest, 1 measurement with MSEK Downloader and again 5 measurements with NetTest. For the measurements, Internet access services at a fixed location with advertised speeds above 100 Mbps (download) were chosen. The measurement locations were chosen based on the hierarchy of DeP demarcation points, see Figure 1:

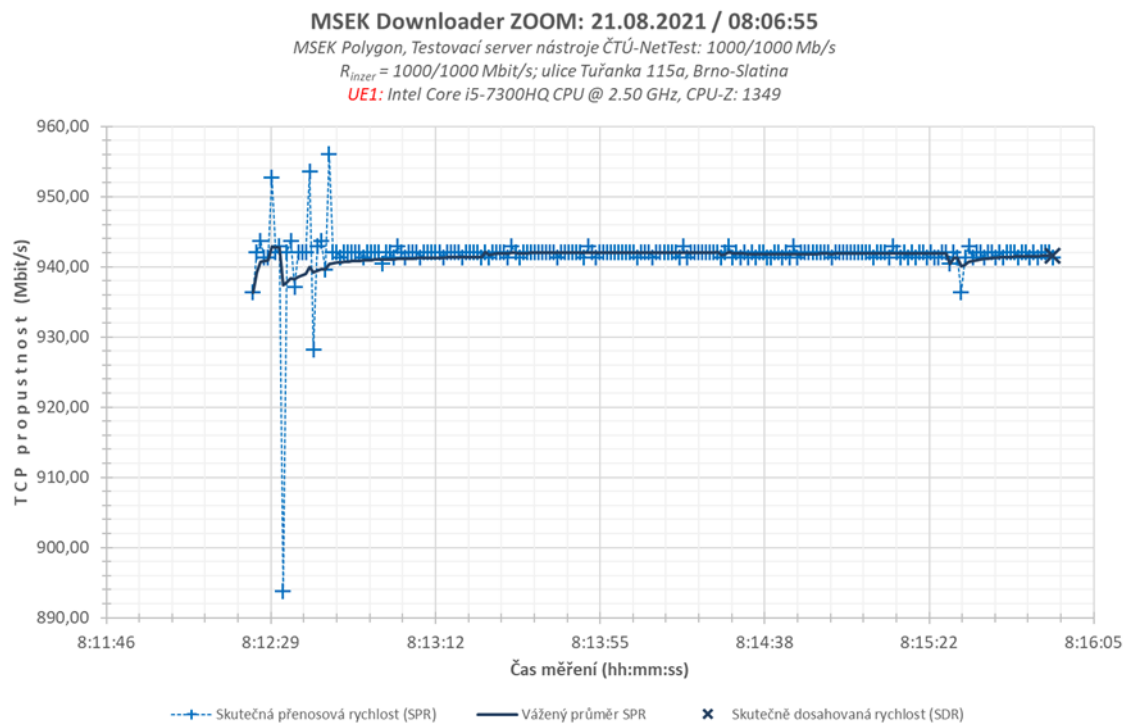
- measurements in the VIS MSEK Internet exchange (DeP 1) + laboratory measurements (DeP 0),
- measurements in the remote connection network (DeP 3),
- measurements on different types of access networks (DeP 6 and DeP 7).

Furthermore, the impact of the user environment was assessed in terms of the impact of the selected web browsers Google Chrome, MS Edge and Mozilla Firefox as well as the impact of the performance of user devices with 1 Gbit/s interface (PC, laptop). Therefore, in order for the performance of the user equipment to be qualified and the measurement to be repeatable, it was necessary to express this performance in the form of an equivalent numerical value. It turned out that CPU performance is important for all web browser-based tools, so it was obvious to use a CPU benchmark for equivalent performance using the available CPU-Z tool. The measurement results are shown graphically below:

- laboratory measurements on MSEK polygon (DeP 0)



**Figure 2:** Measurement result on a NetTest tool's test server



**Figure 3:** Detailed measurement by MSEK Downloader tool

- results of measuring the impact of selected web browsers

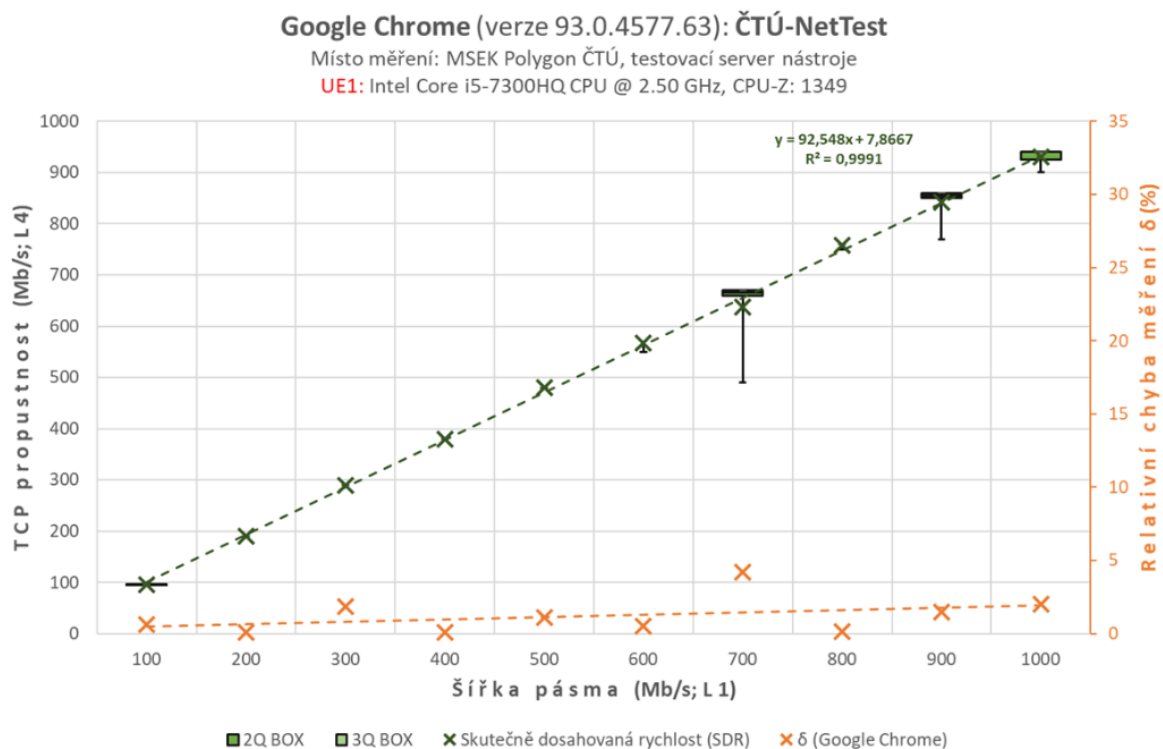


Figure 4: Google Chrome

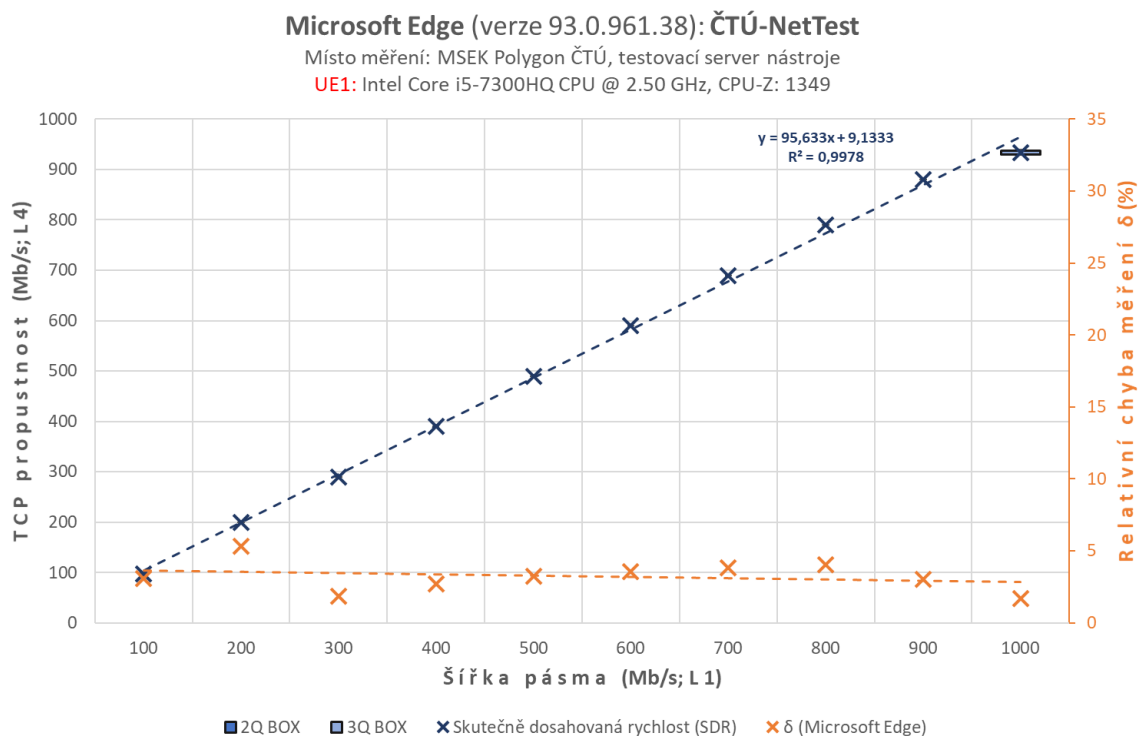
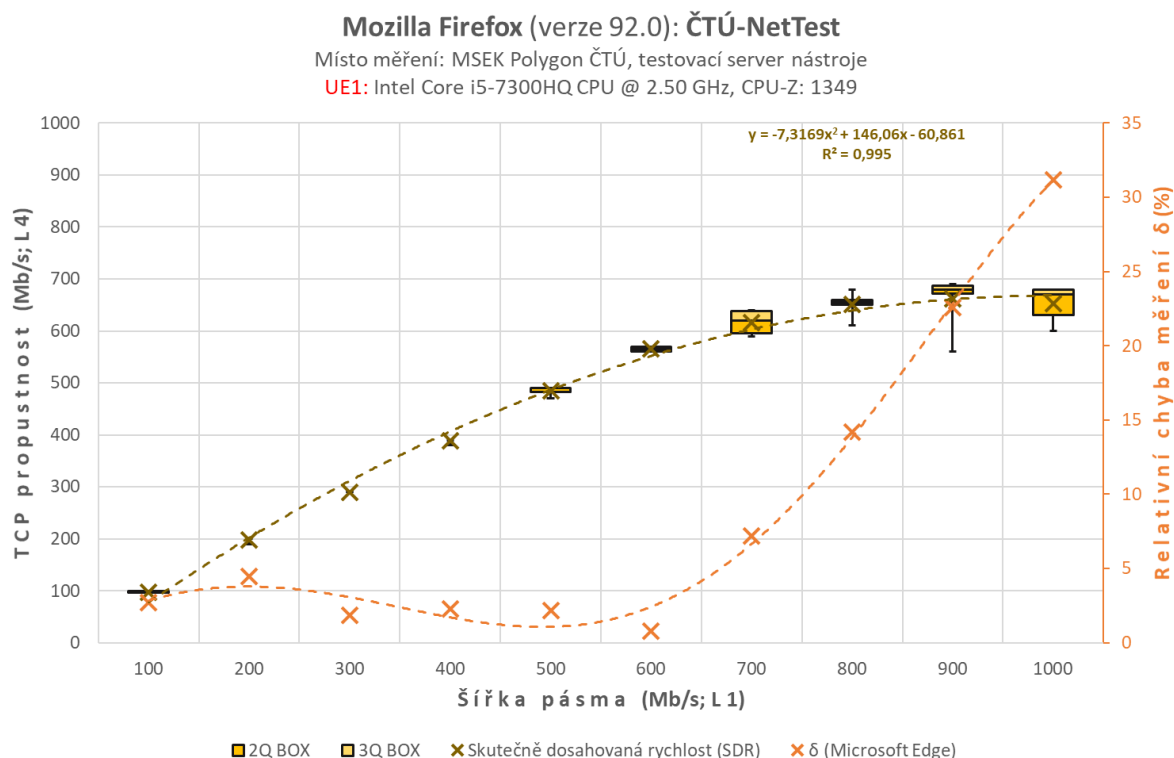
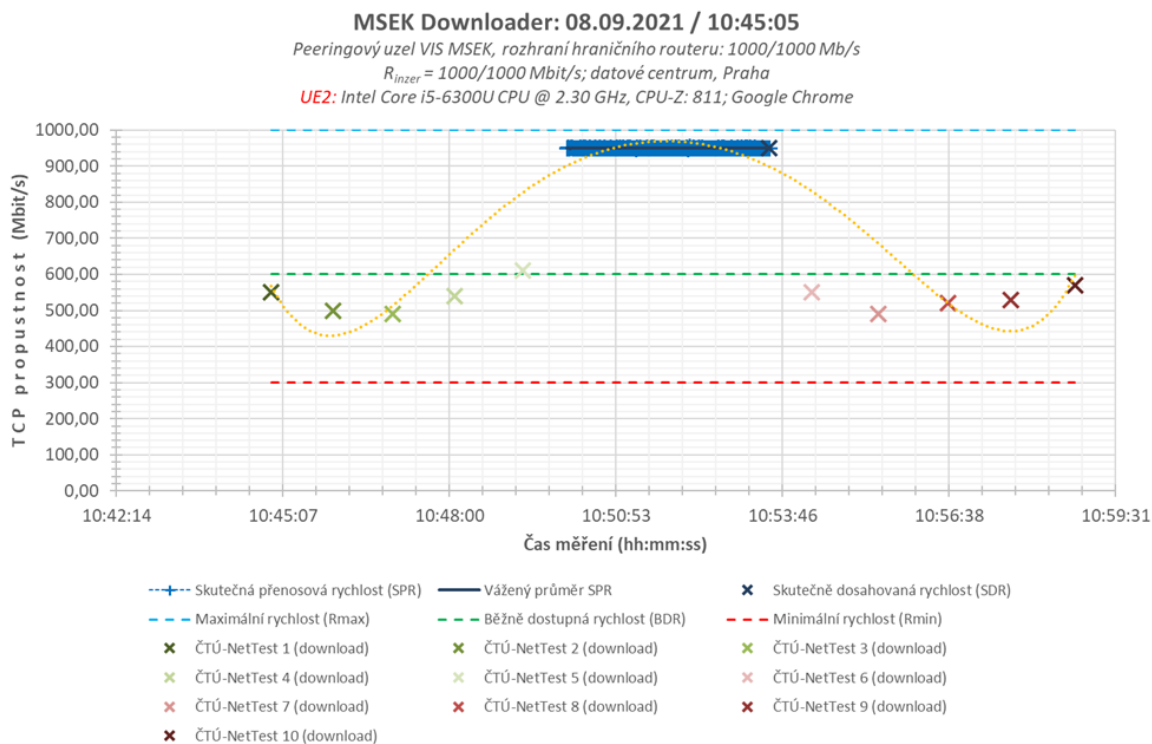
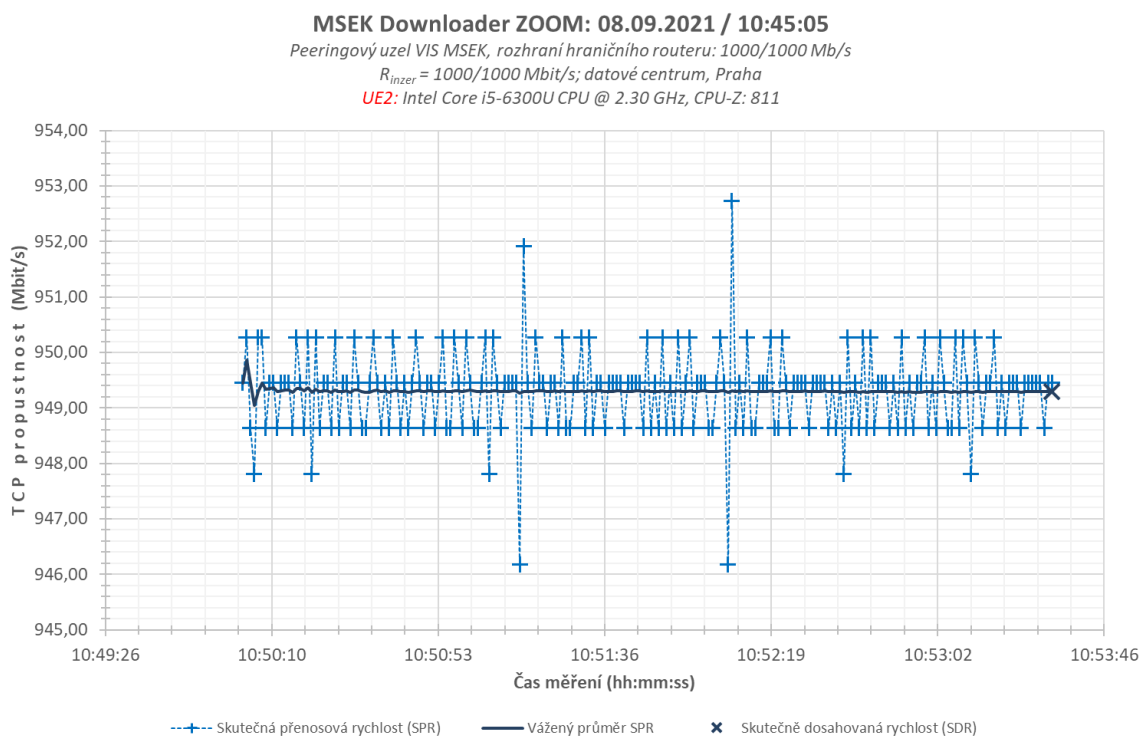


Figure 5: Microsoft Edge

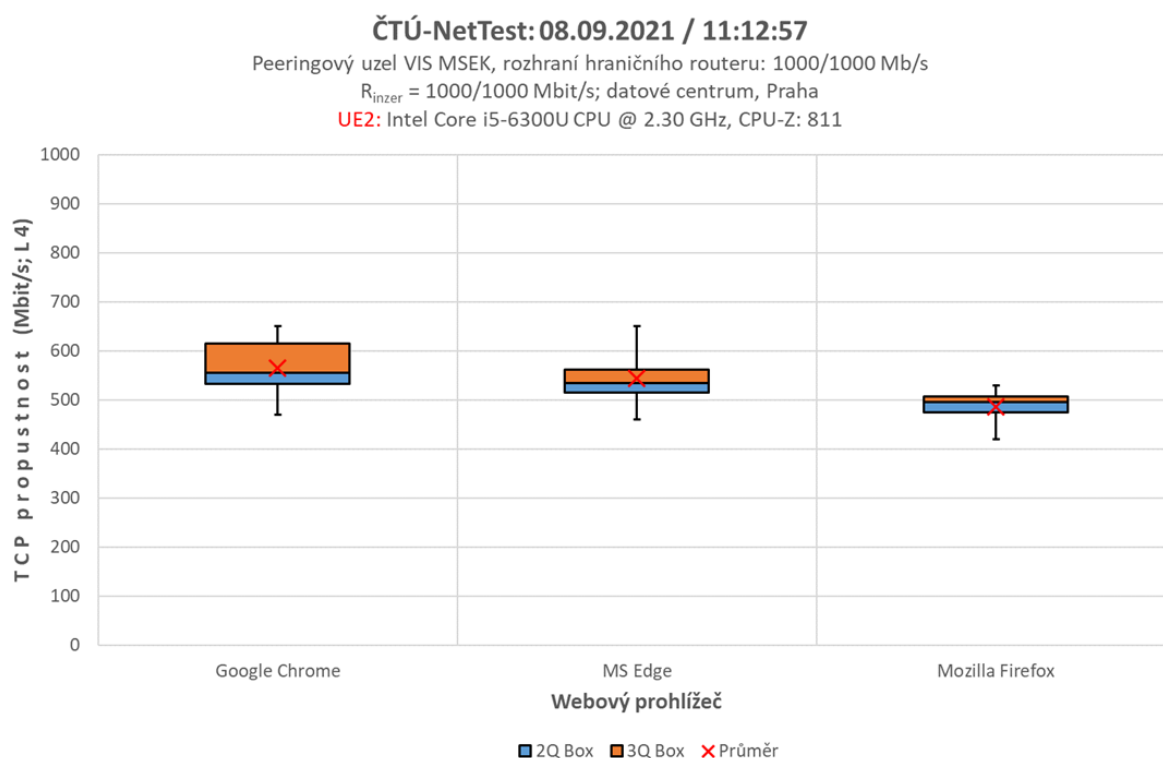


- measurements in the VIS MSEK Internet exchange (DeP 1) – measurements were performed directly in the data centre with typical user device performance determined by the CPU benchmark as a median with a score of 811





**Figure 8:** Detailed measurement by MSEK Downloader tool



**Figure 9:** Results of measuring the impact of web browsers

- measurements on different types of access networks (DeP 6 and 7) – measured against the NetTest server within the MSEK system, where the measurements were performed at end users' address point

### MSEK Downloader: 06.09.2021 / 12:13:40

Název poskytovatele služby, FTTH (FTTx): Název služby

$R_{inzer} = 500/150 \text{ Mbit/s}$ ; ulice Zdeňka Bára, Ostrava

UE2: Intel Core i5-6300U CPU @ 2.30 GHz, CPU-Z: 811

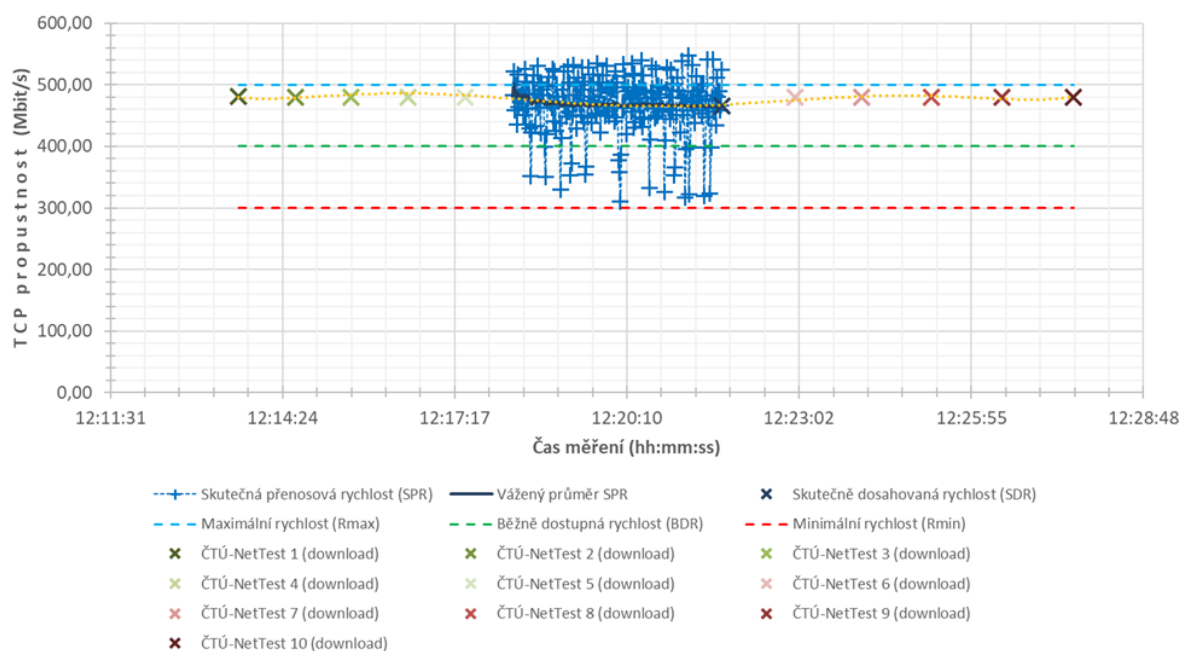


Figure 10: Access networks based on FTTx, 500/150 Mbit/s service

### MSEK Downloader: 26.08.2021 / 16:22:07

Název poskytovatele služby, FTTH (FTTx): Název služby

$R_{inzer} = 350/100 \text{ Mbit/s}$ ; ulice Marie Majerové, Ostrava

UE2: Intel Core i5-6300U CPU @ 2.30 GHz, CPU-Z: 811

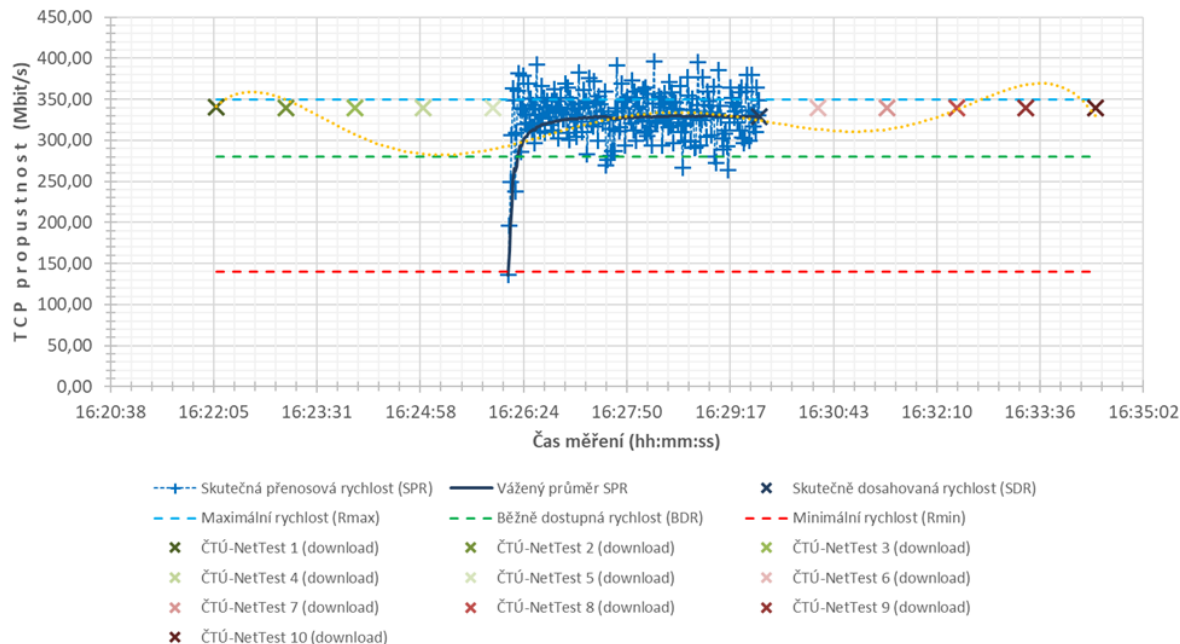
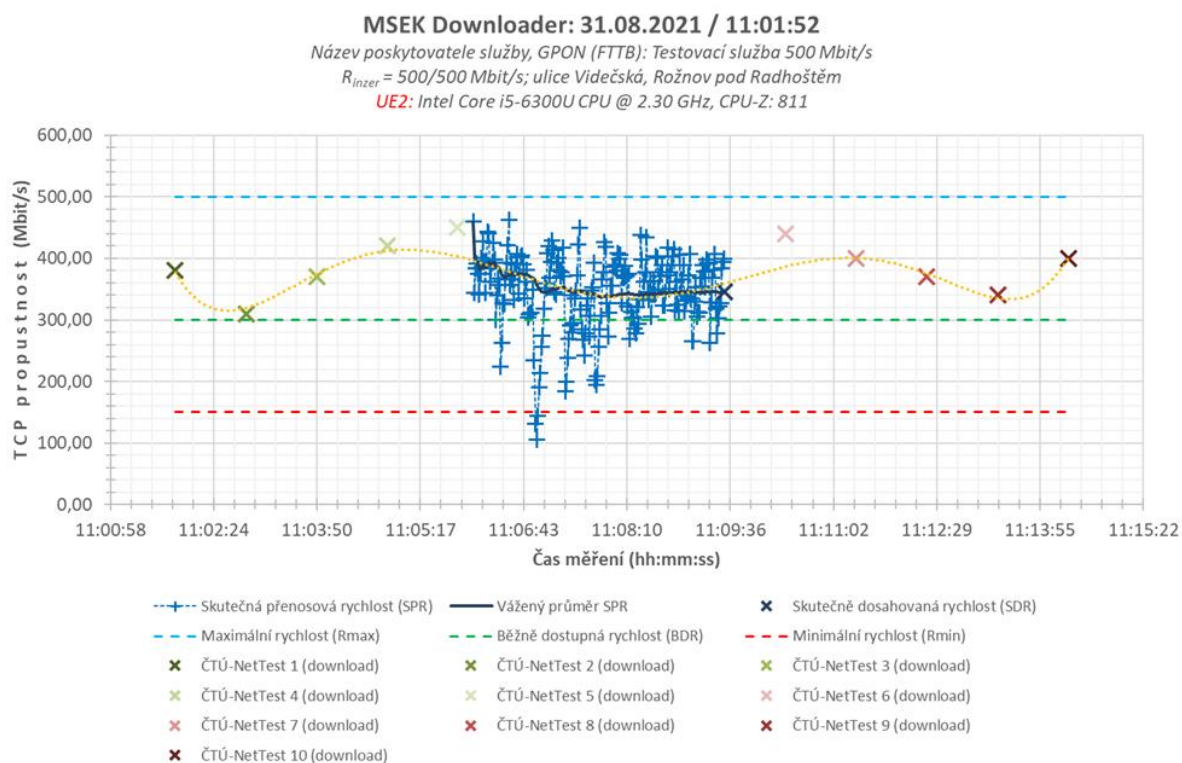
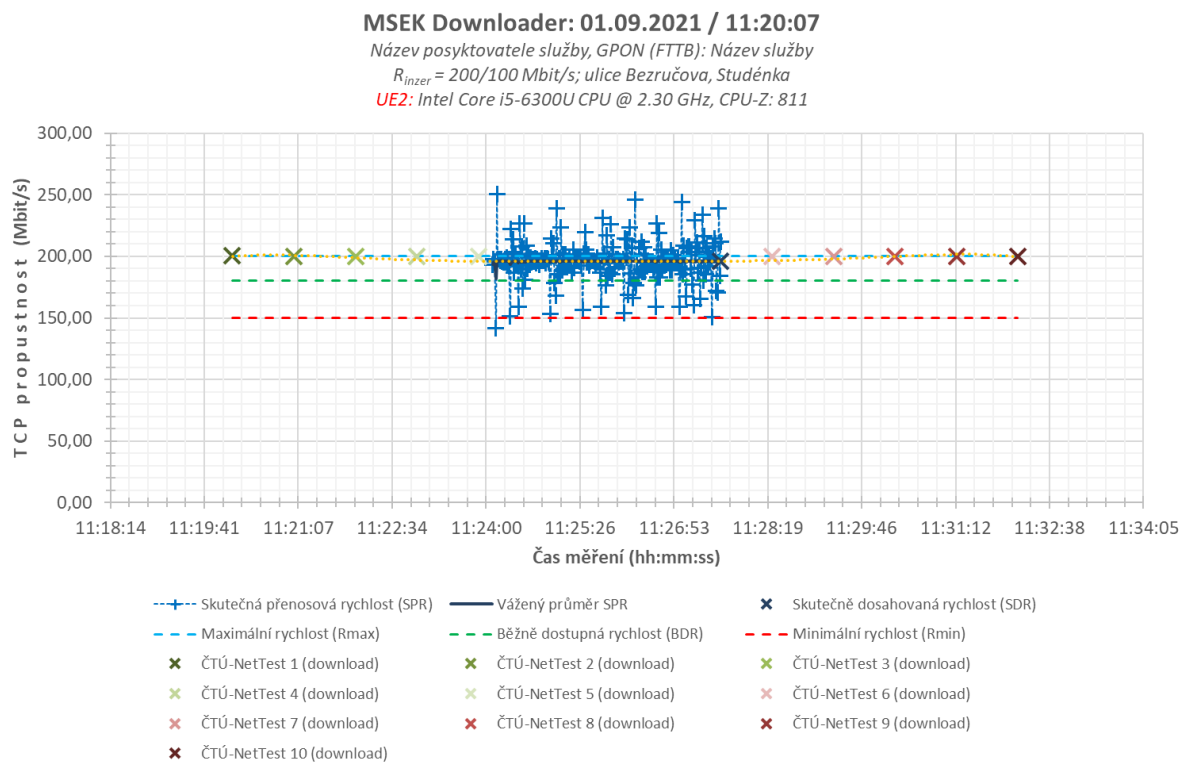


Figure 11: Access networks based on FTTx, 350/100 Mbit/s service



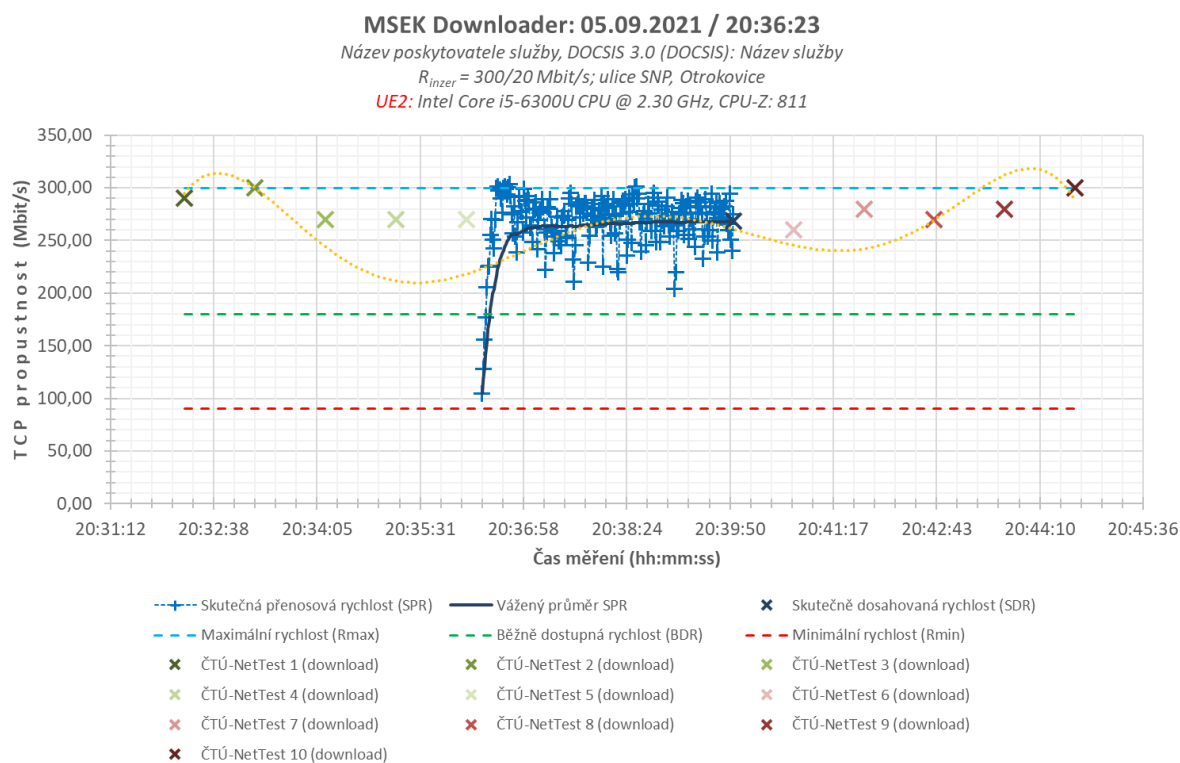


**Figure 12:** Access networks based on FTTx (GPON, FTTB), 500/500 Mbit/s test service

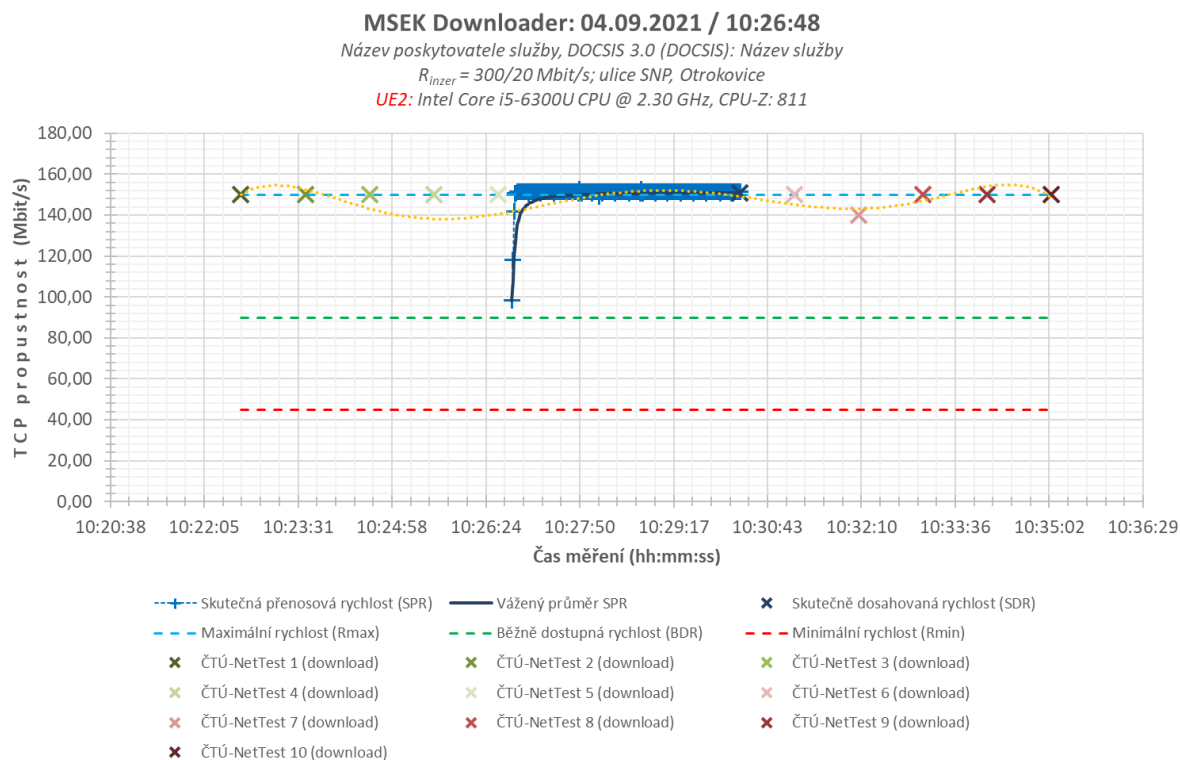


**Figure 13:** Access networks based on FTTx (GPON, FTTB), 200/100 Mbit/s service

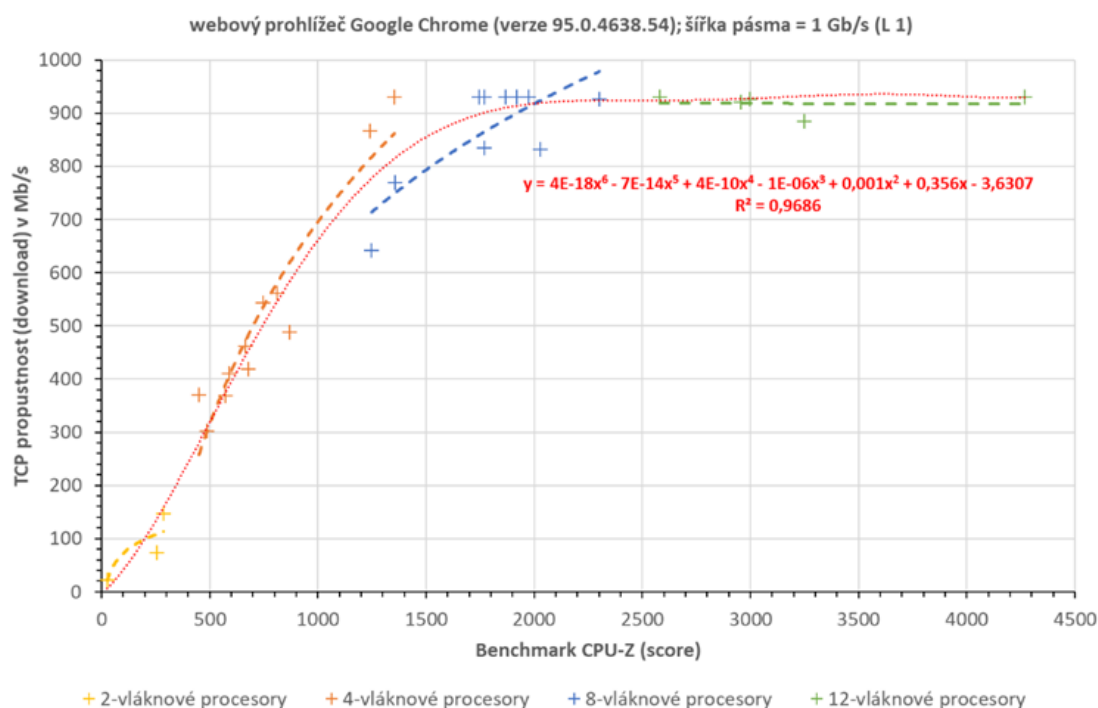




**Figure 14:** Access networks based on DOCSIS, 300/20 Mbit/s service



**Figure 15:** Access networks based on DOCSIS, 150/10 Mbit/s service



**Figure 16:** CPU power impact of end user devices on the measurement results

The results of the verification process showed that the new NetTest measuring tool can measure up to gigabit speeds when combined with a powerful user device (PC, laptop) and a suitable (optimized) browser (ideally based on Chromia). But based on an assessment of the factors influencing the measurement results and considering a "typical" user device that matches the median in its category (4 core 4 thread processor, CPU-Z: 811 points), NetTest is capable of easily handling 500/250 Mbit/s, see Figure 16. Therefore, this limit was used in the certified measurement, and coincidentally, the same limit is also defined by the Austrian regulator. The Office also detailed the conditions that must be met by end users for measuring through the certified mode.

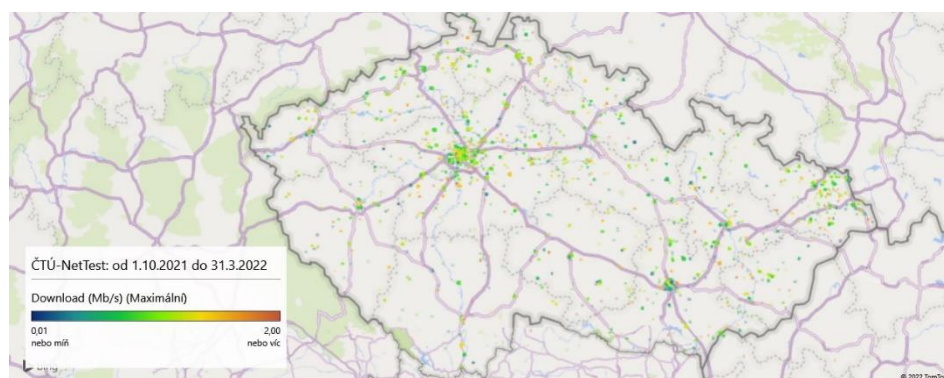
Given the finding that the impact of user device performance has a significant impact on the NetTest results, the Office proceeded to more detailed testing with user devices. Currently, about 3 dozen user devices have been tested. The Office's intention is to create a dynamic curve for the certified mode, where a static level of 500/250 Mbps is currently set, for the use of NetTest for higher advertised speeds based on the results of the performance scores (CPU benchmark) of user devices.

## Annex 2:

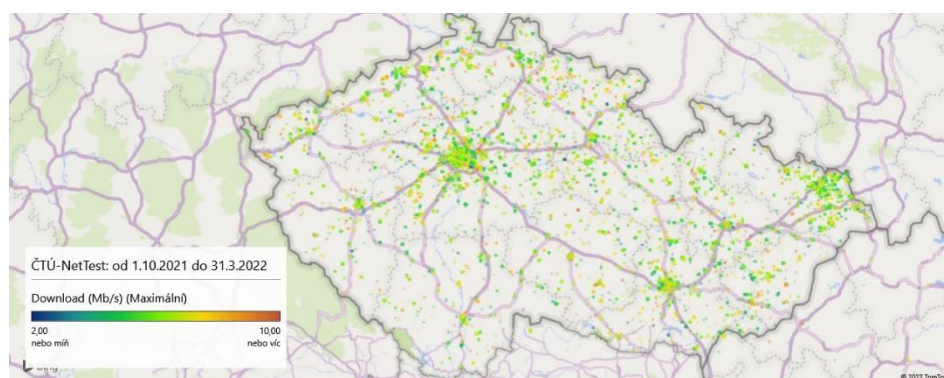
# Visualization of trends in the general quality of Internet access service at a fixed location

In order to assess the performance of the Internet access service, the Office analysed the results measured by NetTest and NetMetr with tens of thousands of measurements and available statistical tools. Regarding the effect of VOS1 from 1 January 2021, publicly available data (open data) from NetMetr for the year 2020, before the of VOS1 entered into effect, was included for the purpose of visualizing trends in the development of general quality of Internet access service.

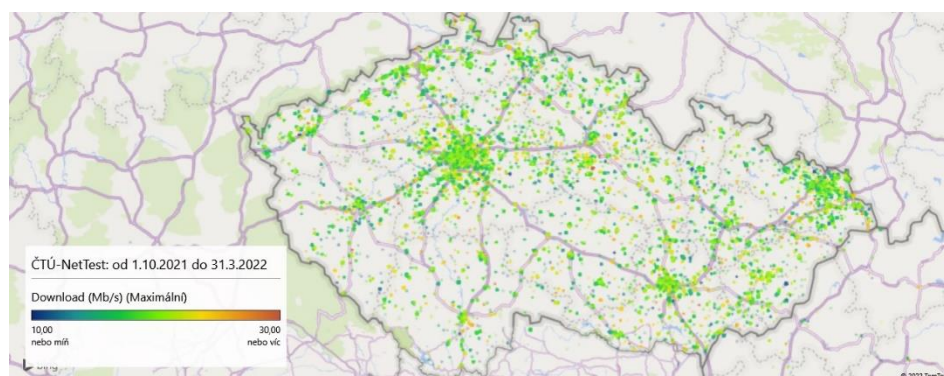
The traffic data since launching the tool has also been analysed, namely the extent to which NetTest has been used by end users. The data was filtered according to the location parameter (GPS position with an estimated deviation of up to 50m) and then visualized in the form of a "heat map" for individual speed categories based on BEREC Guidelines BoR (20) 42. As can be seen in Figure 1, the tool was used across the Czech Republic, with visualized measurement results corresponding to a total of 91,459.



a)

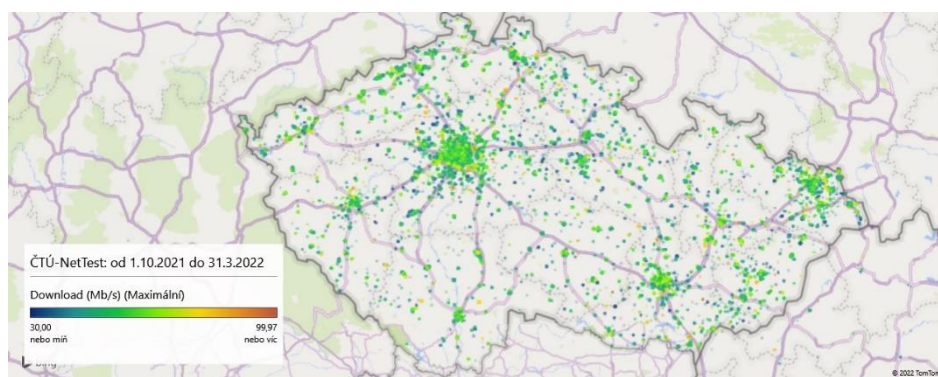


b)

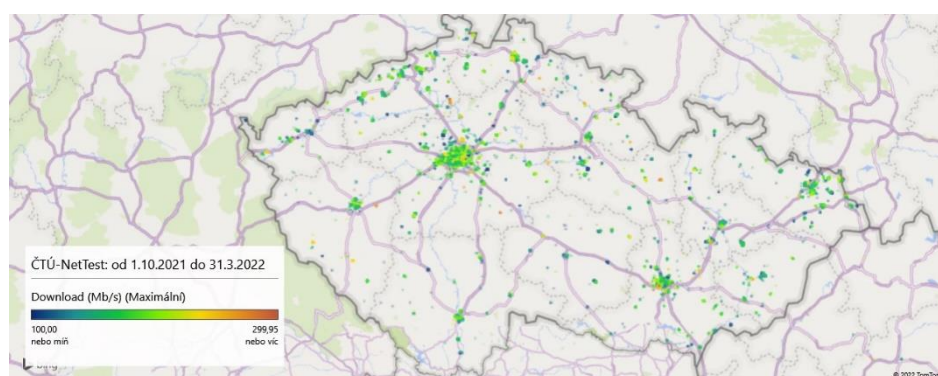




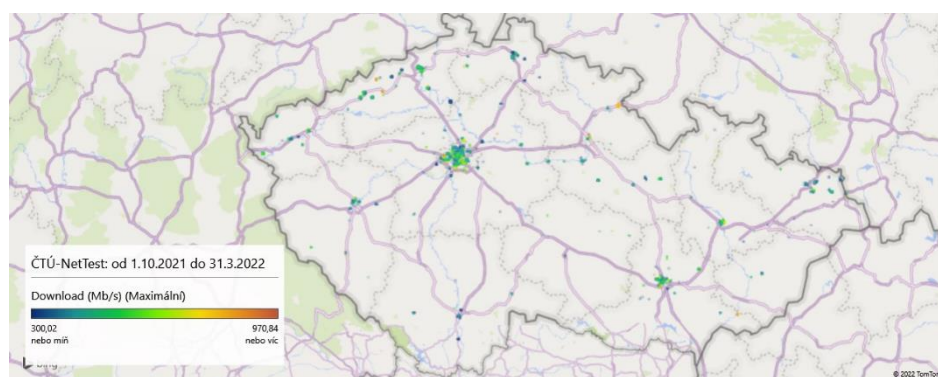
c)



(d)



(e)



(f)

**Figure 1:** Traffic data of the publicly available CTU-NetTest tool for 2021 and 2022 (download): (a) 0-2 Mb/s; (b) 2-10 Mb/s; (c) 10-30 Mb/s; (d) 30-100 Mb/s; (e) 100-300 Mb/s; (f) 300-1000 Mb/s, total number of visualized measurement results is 91 459 (after being filtered)

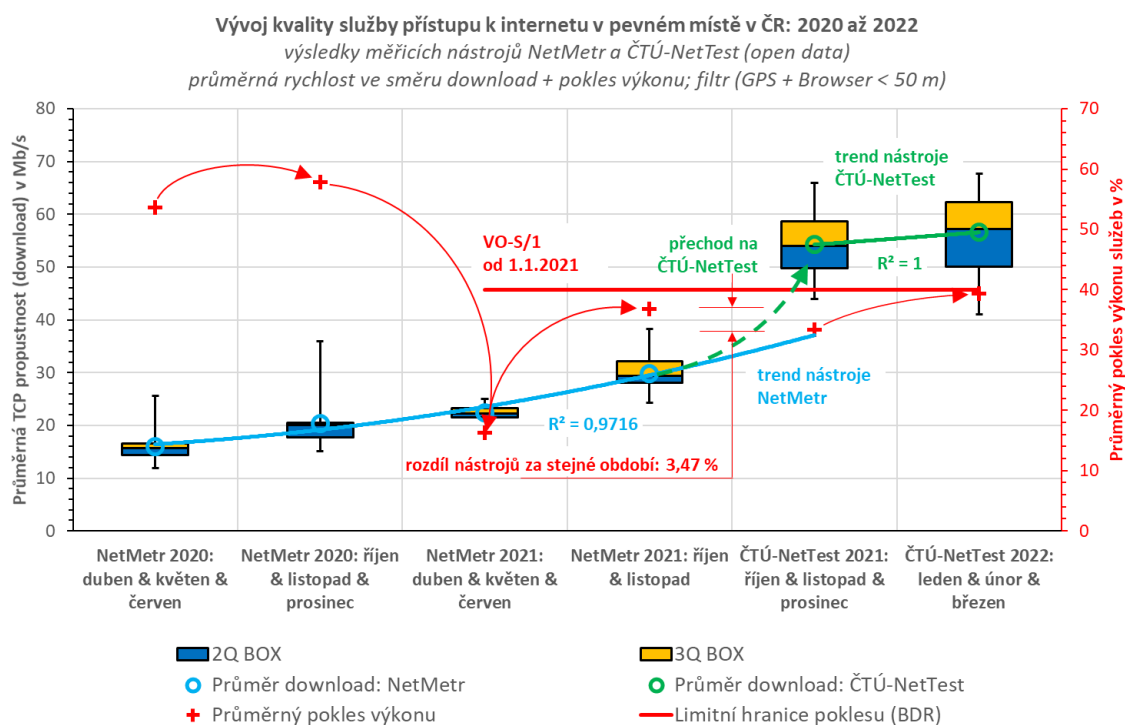
## Average speed variation in the download direction

The most important finding was based on an analysis of the change in average speed<sup>9</sup> depending on the time of day, with a period of 60 minutes, for the specific period of interest. After the NetTest tool's operational load has stabilized following its launch, this statistical monitoring of the development of service performance started to show a variation of values up to 40% of its daily maximum value, especially in the download direction. This variation of values, when compared with the definition of the normally available speed for Internet access services provided at a fixed location, corresponded to the requirement that the normally available speed, on which large discrepancies are based, should be at least 60% of the

<sup>9</sup> Corresponds technically to TCP throughput, i.e. the speed at the transport layer when using the TCP protocol.

advertised speed. In other words, that the drop in performance of Internet access services provided at a fixed location be no more than 40%.

Although the result of the evolution of the service performance over the last 24 hours can, as a matter of principle, be distorted as it evaluates all measurement results, i.e. measurements via the home WLAN network, measurements in the mobile phone web browser, regular ISP/operator measurements at specific points in their network, a limited sample of measurements within 1 day  $\approx$  2,000 tests, CTU has decided to analyse the evolution of the average speed (average service performance) depending on the time of day, with a period of 60 minutes for the relevant period of operation of the CTU-NetTest tool (1 October to 31 March 2022, data for April 2022 not included due to quarterly assessment), while the set of publicly available data (open data) was filtered by a combination of GPS coordinates and the BROWSER parameter (estimated measurement location deviation) only up to 50 m. The result of this analysis, shown in Figure 8, showed a very similar value for the average decrease in service performance in the download direction as the results of monitoring of the evolution of the average service performance over the last 24 hours, namely 33.36%. Therefore, CTU decided to perform the same analysis over the publicly available data (open data) of the NetMetr tool, going back 1 year before the VOS1 came into effect to the same December 2021 (the publicly available NetMetr tool is still in operation), which even made it possible to compare the results of a pair of tools on a similar measuring core based on the RTR-NetzTest tool for the same period.<sup>10</sup> The aggregate results are shown in Figure 2.



**Figure 2:** Aggregate evolution of the quality of Internet access services at a fixed location in the period 2020 to 2022; publicly available tools NetMetr and CTU-NetTest; average TCP throughput & service performance decline

The aggregate results show that in the period under review prior to the entry into effect of VOS1, i.e. in 2020, the average decrease in performance ranged from 53% to 58%. It should be noted that at this time, the so-called detectable change in performance was in effect, which corresponded to up to 50% of the contracted value of the normally available speed. For example, if the contractually stated value of the normally available speed was equal to 80 Mbps, a large discrepancy and thus the right to submit a claim about the service only arose

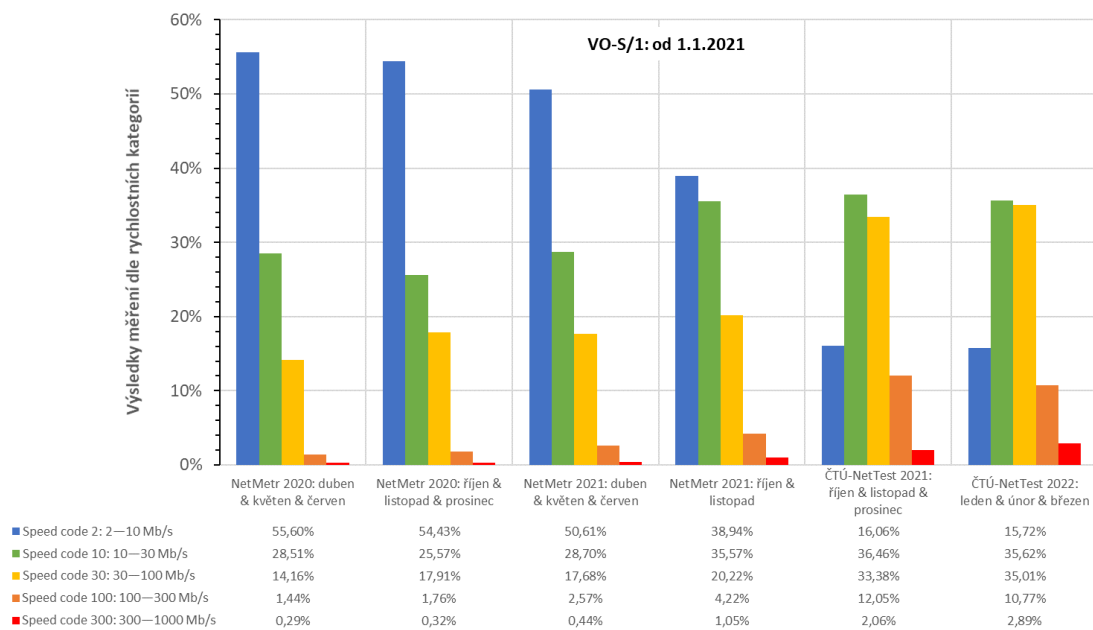
<sup>10</sup> NetMetr data for December 2021 was not available for download.

when the speed dropped below 40 Mbps. With the entry into effect of VOS1, the quality of Internet access services in the Czech Republic improved dramatically, with the average performance drop reaching 16% between April and June 2020, according to the results of the NetMetr measuring tool. As shown in Figure 2, this decline cannot be attributed to changes in the pattern of service performance achieved in the download direction, assessed by speed category based on BEREC Guidelines BoR (20) 42. The pattern of service performance was almost identical before and after the introduction of VOS1, differing only slightly.

In the second half of 2021, although there was an increase in the value of the average decrease in performance of Internet access services, this decrease did not exceed the 40% threshold which is based on the definition of normally available speed. Interestingly, over virtually the same period (October to December, with October to November 2021 in the case of NetMetr), the two tools showed almost identical average performance decreases, NetMetr 36.83% and CTU-NetTest 33.36% (4Q 2021) and 39.29% (1Q 2022), notwithstanding the fact that the CTU-NetTest tool, due to its newer version of the measuring core and other technical aspects related to the overall structure of the VIS MSEK, makes it possible to achieve much higher absolute values of speeds during measurements (impact on the change in the trend of the average speed in the download direction; blue vs. green curve in Figure 2). The rule of thumb is that even if there is a positive change in the characteristics of the measuring tool, the network load and the associated drop in service performance depending on the time of day is still the same.

The results of the analysis presented in Figure 3 provide further insights into the change in the pattern of service performance achieved in the download direction, assessed by speed category (see above). By the end of 2021, there have been significant changes, with service performance in the category of speed code 2, i.e. 2 to 10 Mbps, no longer being the most common measurement outcome. This trend of change, which can also be described as an increase in the quality of Internet access services in the Czech Republic, is also indicated by the NetMetr tool. The average performance of the Internet access service at a fixed location in the period of October-December 2021 in the download direction was 54 Mbps (based on 50,500 measurements across the Czech Republic) and in the period of January-March 2022 the average performance of the Internet access service at a fixed location in the download direction was 56.5 Mbps (based on 40,959 measurements across the Czech Republic).

Vývoj kvality služby přístupu k internetu v pevném místě v ČR: 2020 až 2022  
výsledky měřicích nástrojů NetMetr a ČTÚ-NetTest (open data)  
poměr rychlostních kategorií ve směru download; filtr (GPS + Browser < 50 m)



**Figure 3:** Aggregate evolution of the quality of Internet access services at a fixed location in the period 2020 to 2022; publicly available tools NetMetr and CTU-NetTest; services performance structure according to speed category based on BEREC Guidelines BoR (20) 42

## Results of the analysis of the change in average speed (download) over the time of day

### 1. NetMetr 2020: April + May + June (GPS filtering + Browser < 50m)

Average measured speed (download): **16.04 Mbps**

Maximum value of average speed (download): 25.54 Mbps

Minimum value of average speed (download): 11.86 Mbps

Decrease in the evolution of the average speed over time (download): **53.57%** (>40% max)



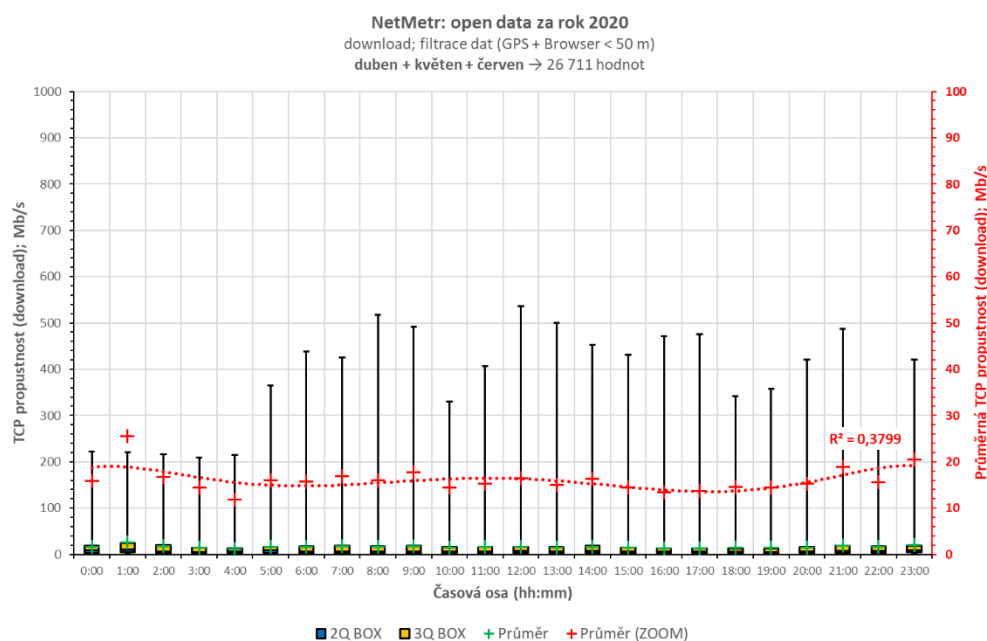


Figure 4: NetMetr 2020 in the period of April & May & June

2. **NetMetr 2020: October + November + December (GPS filtering + Browser < 50m)**

Average measured speed (download): **20.29 Mbps**

Maximum value of average speed (download): 39.95 Mbps

Minimum value of average speed (download): 15.15 Mbps

Decrease in the evolution of the average speed over time (download): **57.83%** (>40% max)

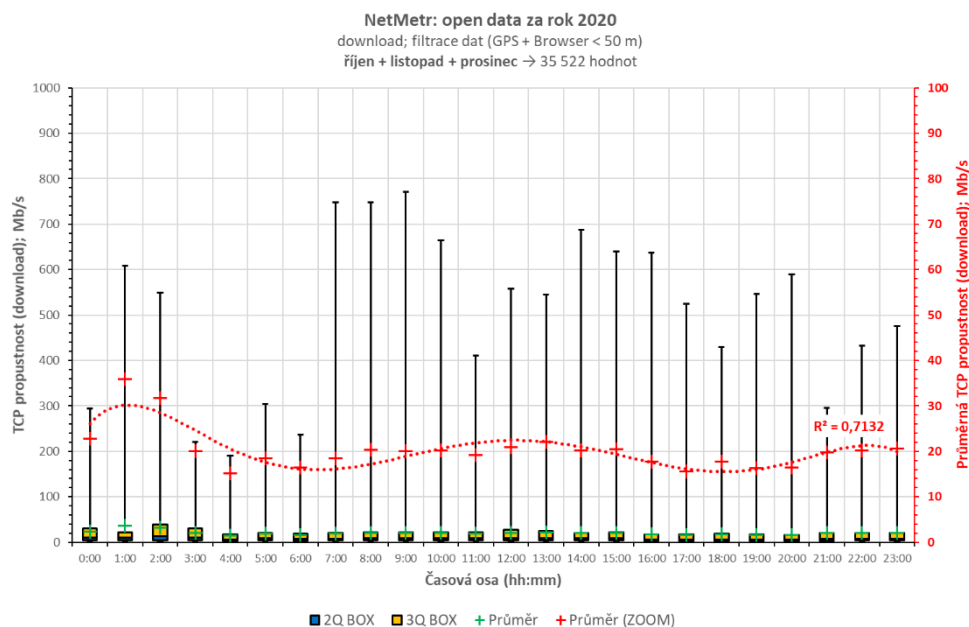


Figure 5: NetMetr 2020 in the period of October & November & December

3. **NetMetr 2021: April + May + June (GPS filtering + Browser < 50 m)**

Average measured speed (download): **22.39 Mbps**

Maximum value of average speed (download): 25.06 Mbps

Minimum value of average speed (download): 20.99 Mbps

Decrease in the evolution of the average speed over time (download): **16.24%** (<40% max)  
→ VOS1

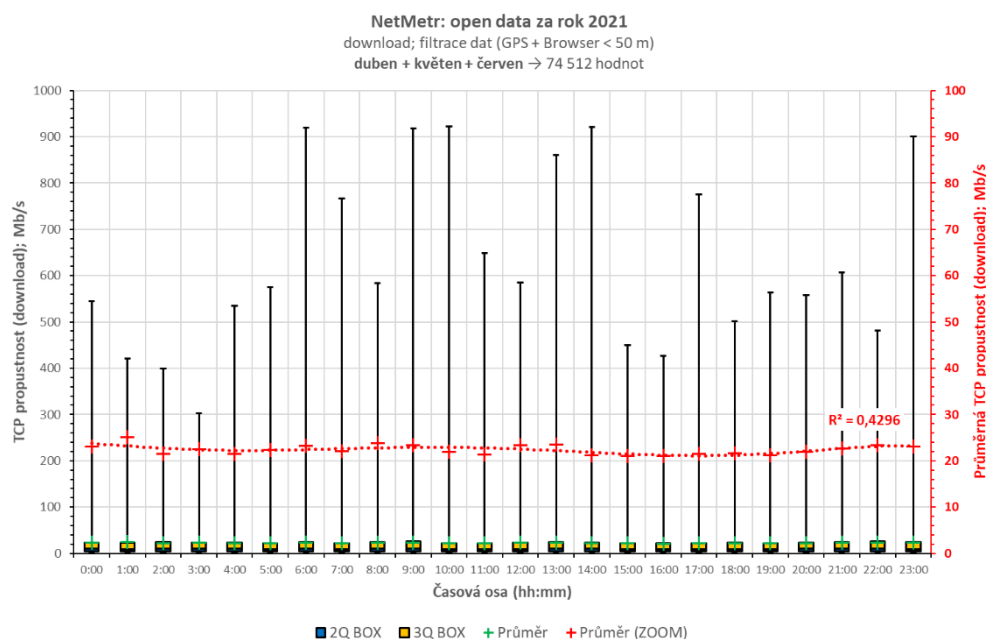


Figure 6: NetMetr 2021 in the period of April & May & June

4. **NetMetr 2021**: October + November (GPS filtering + Browser < 50m) → December unavailable

Average measured speed (download): **29.88 Mbps**

Maximum value of average speed (download): 38.33 Mbps

Minimum value of average speed (download): 24.21 Mbps

Decrease in the evolution of the average speed over time (download): **36.83%** (<40% max)

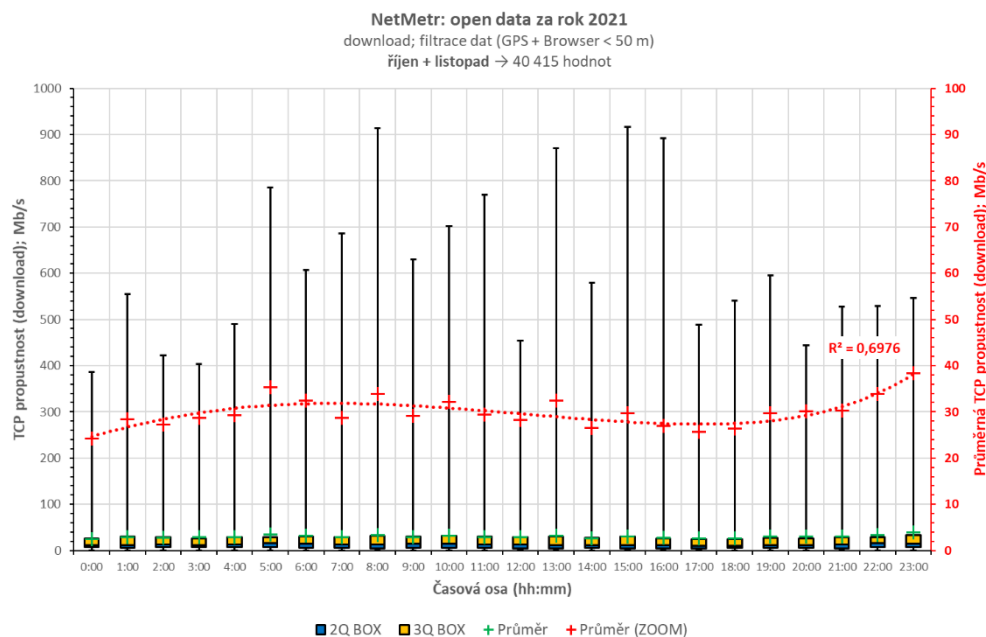


Figure 7: NetMetr 2021 in the period of October & November

5. **CTU-NetTest 2021:** October + November + December (GPS filtering + Browser < 50m)  
Average measured speed (download): **54.23 Mbps**  
Maximum value of average speed (download): 65.93 Mbps  
Minimum value of average speed (download): 43.94 Mbps  
Decrease in the evolution of the average speed over time (download): **33.36 %** (<40% max)

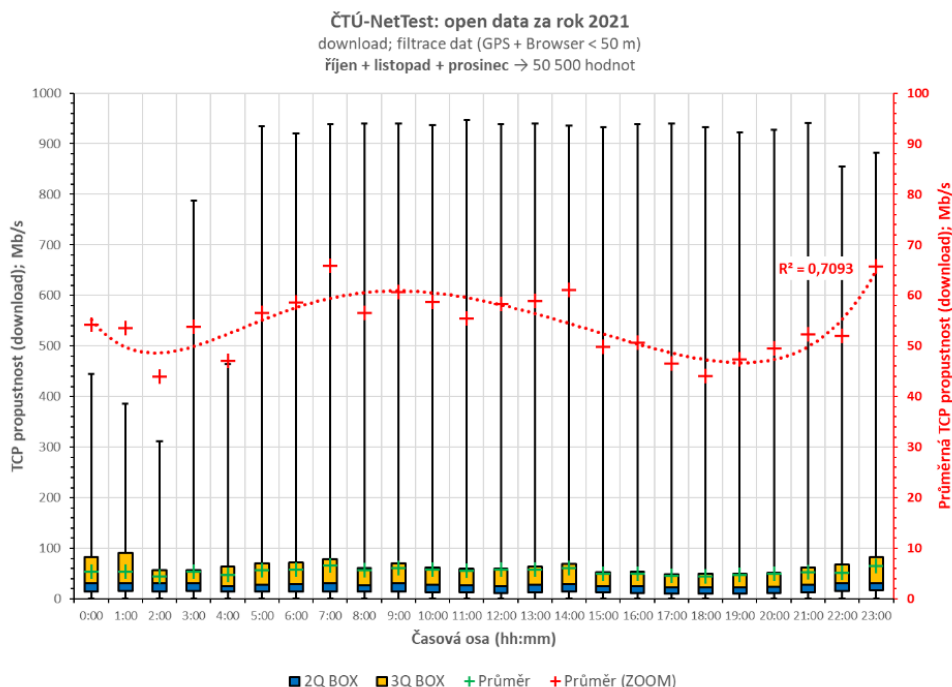
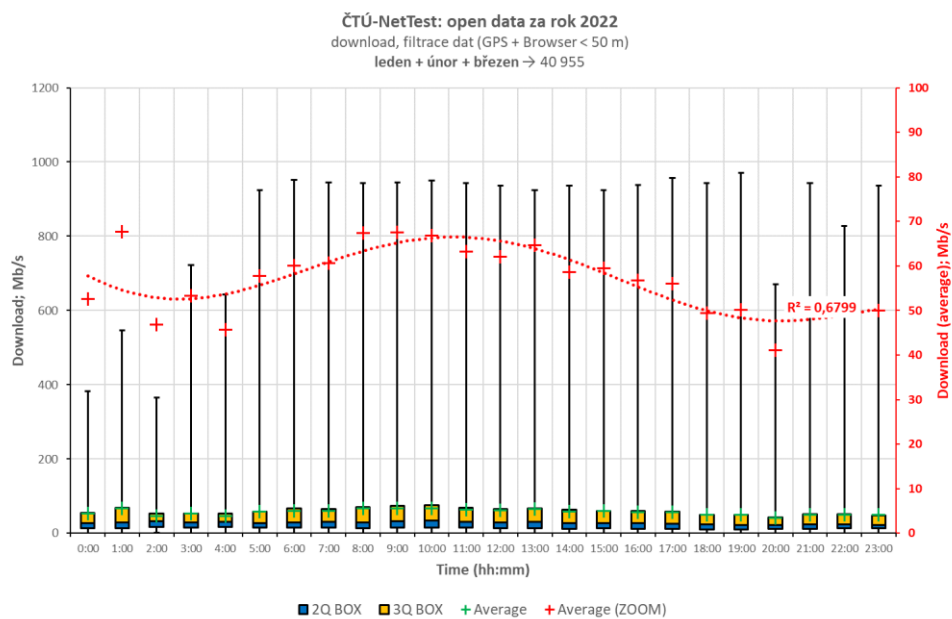


Figure 8: CTU-NetTest 2021 v období in the period of October & November & December

6. **CTU-NetTest 2022:** January + February + March (GPS filtering + Browser < 50m)  
Average measured speed (download): **56.58 Mbps**  
Maximum value of average speed (download): 67.64 Mbps  
Minimum value of average speed (download): 41.06 Mbps  
Decrease in the evolution of the average speed over time (download): **39.29%** (<40% max)



**Figure 9:** CTU-NetTest 2022 in the period of January & February & March