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# Quality report on Electronic Communications Services for 2018

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## List of Abbreviations

2G - second generation mobile electronic communications network;

3G - third generation mobile electronic communications network;

4G - fourth generation mobile electronic communications network;

5G - fifth generation mobile electronic communications network;

Voice control system - Telephone network quality control system;

Voice telephony service - domestic voice telephony service in the fixed and mobile electronic communications network;

BEREC - The Body of European Regulators for Electronic Communications;

*BITE Latvija* - Limited Liability Company "BITE Latvija";

Fixed voice telephony service - domestic voice telephony service in the fixed electronic communications network;

Fixed internet service - public internet access service in the fixed electronic communications network;

Internet control system - internet access service quality control system https://itest.sprk.gov.lv;

Internet service - public internet access service in the fixed and mobile electronic communications network;

SMS service - electronic message transmission service in the mobile electronic communications network;

kbit/s - kilobits per second;

Merchant - Electronic Communications Merchant;

Quality report - Quality report on Electronic Communications Services;

*Lattelecom* - Limited Liability Company "Lattelecom", as of 1 April 2019 - Limited Liability Company "Tet";

Contract - electronic communications service contract;

LMT - Limited Liability Company "Latvijas Mobilais Telefons";

Mbit/s - megabits per second;

Mobile voice telephony service - domestic voice telephony service in the mobile electronic communications network;

Mobile internet service - public internet access service in the mobile electronic communications network;

ms - milliseconds;

Service - public electronic communications service;

Regulator - Public Utilities Commission;

*Tele2* - Limited Liability Company "Tele2".

## List of abbreviations of laws and regulations

Open Internet Access 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 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;

Regulations on service quality requirements - Regulator's 30 November 2017 Decision No. 1/31 "Rules on submission and public disclosure of electronic service quality requirements and quality reports";

Regulations on a general authorisation - Regulator's 4 June 2015 Decision No. 1/8 "Regulations on a general authorisation in the electronic communications sector", which was in force until 31 December 2018. As of 1 January 2019 - Regulator's 20 November 2018 Decision No. 1/35 "Regulations on a general authorisation in the electronic communications sector" is in force;

Electronic communications services quality measurement methodology - Regulator's 23 November 2017 Decision No. 1/30 "Electronic communications services quality measurement methodology".

# Introduction

The Regulator, in accordance with points 1, 6, 8 of the first paragraph of Article 9, Article 13 of the law "*On Regulators of Public Utilities*" and Article 59 of the "*Electronic Communications Law*", supervises the quality of electronic communications services provided by electronic communications merchants, and informs the public thereof.

The Regulator draws up a Quality Report once a year, wherein it summarises the service quality parameter measurement results.

The Quality report provides insight into the principles of defining and supervising service quality requirements, their respective laws and regulations, as well as provides general information on the duties of electronic communications merchants regarding the quality of electronic communications services, as well as on the supervision of quality of services provided by the Regulator.

In accordance with the measurements of service quality provided by the Regulator, the Quality report includes information on the results of measurement performed by the Regulator and their analytical presentation for the following service types:

- fixed voice telephony service;
- mobile voice telephony service;
- mobile internet service.

In 2018 the Regulator has performed scheduled service quality measurements in the electronic communications networks of operators such as *Lattelecom, BITE Latvia, Tele2 and LMT.*

# QUALITY REQUIREMENTS

## I Duties of merchants regarding the quality of electronic communications services and its assurance

The range of quality requirements that are binding to the merchant and which determine their duties in regard to the services quality assurance and availability of information on service quality, are contained within the following laws and regulations:

- Regulations on service quality requirements;
- Regulations on a general authorisation;
- Open Internet Access Regulation.

The service quality supervision rules, criteria and technical aspects, which are binding to the merchants and define certain duties, are included in the Regulator's Rules on service quality requirements in accordance with Article 59 of the Electronic Communications Law.

The Rules on service quality requirements define the regulations on a general authorisation that are binding to the merchant in regard to service quality, imposing a duty for the merchant to include specific consumer protection requirements in subscriber contracts, including quality requirements for the services provided to the subscriber.

The detailed and technically specified service quality requirements are defined for the following service types:

- voice telephony service;
- SMS service;
- internet service.

The Open Internet Access Regulation specifies the requirements to ensure open internet access, providing equal and non-discriminatory treatment of traffic in the provision of the internet service. The Open Internet Access Regulation also sets out the requirements for information to be included in the contract.

It follows from the aforementioned laws and regulation that merchants are obliged to inform users about the quality parameters of the provided services, by declaring the quality parameter values and including the specified service quality values in the contract with the user. The merchant's declarations reflect the average service quality values, which can be provided in the merchant's electronic communications network. Therefore, when looking at the merchant's declarations, the user can find out what service quality values the merchant will be able to provide. Each merchant's declared quality parameter values can be viewed on the Regulator's website in the Declarations submitted by merchants. In the event of failure to provide the services quality specified in the contract, the user shall have the opportunity before terminating the contract to receive compensation in accordance with the period of nonconformity or to terminate the contract without penalty, by submitting the complaint to the merchant or Regulator[1].

In the case of user complaints about the quality of services, the Regulator performs quality measurements by placing measuring equipment at the place of provision of the service and performing a quality check, selecting the scale and type of measurements depending on the nature of the complaint and the factual circumstances. If the Regulator finds that the quality values of the provided service do not meet the information in the contract, the merchant must provide compensation to the user or an opportunity to terminate the contract without a

[1] The procedure for submitting a complaint can be consulted on the Regulator's website, in the "Complaint handling" section.

penalty. Table 1 summarises the service quality parameters specified in the quality declaration and contract.

*Table 1. Service quality parameters specified in the quality declarations and contracts*

| | **Parameters to be specified in the quality declarations** | **Quality parameters to be included in contracts** |
|---|---|---|
| **Fixed voice telephony service** | • Average supply time<br>• Number of faults<br>• Average fault repair time<br>• Unsuccessful call ratio<br>• Average call set-up time<br>• Average speech transmission quality | • Fault repair time<br>• Minimum speech transmission quality |
| **Mobile voice telephony and SMS service** | • Average fault repair time<br>• Unsuccessful call ratio<br>• Average call set-up time<br>• Average speech transmission quality<br>• Ratio of unsuccessfully sent short messages (SMS)<br>• Average time for sending SMS | • Minimum speech transmission quality<br>• Maximum short message (SMS) sending time |
| **Television programme broadcasting service** | • Average supply time<br>• Number of faults<br>• Average fault repair time<br>• Average subjective visual picture quality evaluation | • Fault repair time<br>• Minimal subjective visual picture quality evaluation |
| **Fixed internet service** | • Connection speed range<br>• Average supply time<br>• Number of faults<br>• Average fault repair time<br>• Average packet loss ratio<br>• Average latency<br>• Average jitter<br>• Service availability | • Minimum guaranteed connection speed (≥20% of maximum connection speed)<br>• Maximum (advertised) connection speed (indicated as a range or numerical value)<br>• Normally available connection speed (indicated as a range or numerical value)<br>• Fault repair time<br>• Service availability |
| **Mobile internet service** | • Number of faults<br>• Average fault repair time<br>• Average packet loss ratio<br>• Average latency<br>• Average jitter<br>• Service availability | • Minimum guaranteed connection speed (≥256 kbit/s)<br>• Advertised connection speed<br>• Estimated maximum connection speed |

# II Voice telephony service

## 1. Voice telephony service quality parameter measurement conditions

In 2018 the Regulator measured the quality parameters of the fixed voice telephony service in the *Lattelecom* electronic communications network, and mobile voice telephony service quality parameters in the *BITE Latvia*, LMT and *Tele2* mobile electronic communications networks.

The Regulator performs voice telephony service quality measurements by using a voice control system.

The Regulator performs voice telephony service measurements in accordance with the following parameters of the Regulations on service quality requirements:

- unsuccessful call ratio;
- call set-up time;
- speech transmission quality.

For the determination of the unsuccessful call ratio and call set-up time, the confidence level of the measurement results shall be at least 95% with a relative accuracy of not less than 10%.

Speech transmission quality is assessed using the PESQ[2] algorithm, describing the value in accordance with the 5-point-scale in Table 2.

*Table 2. Speech transmission quality assessment scale*

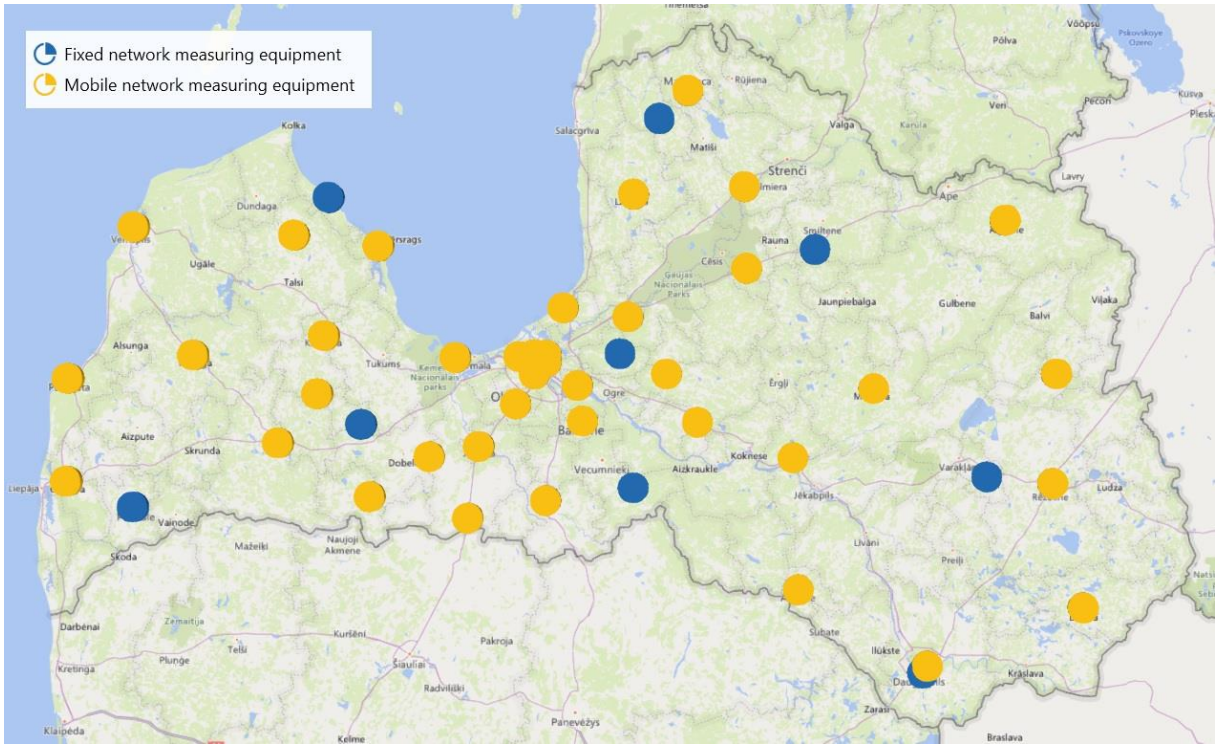
| **Value score** | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|
| **Quality assessment** | Excellent | Good | Satisfactory | Bad | Weak |

The Regulator measures voice telephony service quality parameters if the operator, who provides the voice telephony service, has no less than 20 000 end-users at the end of the first half of the previous calendar year.

In measuring the voice telephony service, the Regulator mainly placed the electronic communications network measuring equipment in the post offices of the state joint stock company "Latvijas Pasts", moving them between the different post offices. The placement of voice telephony measuring equipment is shown in Figure 1.

[2] *PESQ Perceptual Evaluation of Speech Quality.*

*Figure 1. Measurement sites, where voice telephony service quality measurements were performed in 2018*




The Regulator uses two pieces of fixed network measuring equipment to perform the scheduled fixed voice telephony service measurements, which are connected to the fixed telephone network termination points defined by the Regulator in different populated areas. In total, fixed voice telephony services quality measurements were performed in 10 different geographical locations.

Mobile voice telephony service quality measurements were performed by using two pieces of mobile network measuring equipment connected to the mobile telephone network to be measured in the coverage areas of different base stations. Each mobile network measuring equipment was provided a *Bite Latvia*, LMT and *Tele2* connection. In total, mobile voice telephony services quality measurements were performed in 40 different geographical locations.

## 2. Overview of quality parameter measurement results

The summary of the parameters measured in the voice telephony service measurement performed by the Regulator in 2018 is shown in Table 3, which includes the unsuccessful call ratio, average call set-up time and speech transmission quality values.

The amount of unsuccessful calls is a parameter which expresses the amount of unsuccessful calls in relation to the total amount of attempted calls as a percentage. Reviewing the 2018 voice telephony service quality measurement results, the Regulator concludes that the value of this parameter is negligible, without reaching a tenth of a percent. The unsuccessful call ratio of merchants offering mobile voice telephony services reaches 0.02%, whereas for *Lattelecom* - 0.003%, which indicates that all operators provide electronic communications networks of excellent quality.

The call set-up time is a parameter, which expresses the period of time from sending the called number until a call control signal, busy signal or response is detected in seconds. Examining in detail, the average call set-up time of *Lattelecom* is between 1 and 2 seconds, and more precisely - 1.04 seconds in 2018. Simultaneously, the parameter value in the mobile electronic communications network is 3-7 seconds, and in more detail: LMT - 3.56 seconds, *BITE Latvia* - 4.21 seconds, and *Tele2* - 5.48 seconds. Having evaluated the total call set-up time in the merchants' electronic communications networks, the Regulator

concludes that after sending the called number, users are provided a connection speed in line with the values declared by the merchants.

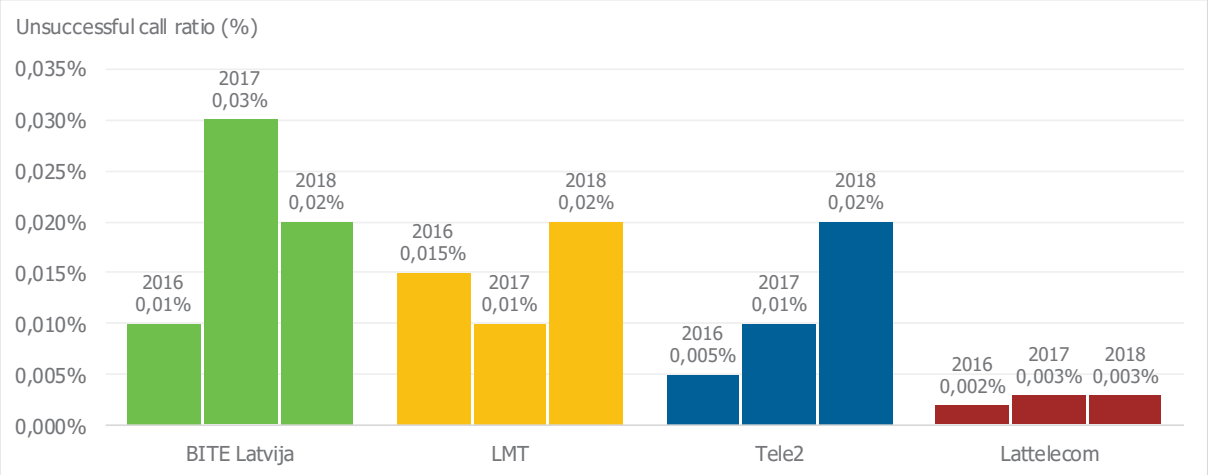
Average speech transmission quality - parameter which scores the average arithmetic value of the speech transmission quality of the total number of measurements. The Regulator evaluates speech transmission quality by using the PESQ algorithm. The Regulator notes that speech transmission quality is excellent if the voices are clearly audible without any noise; good if there is little noise; satisfactory if some words are not clearly audible due to poor audibility; weak, if only some words are audible due to high noise levels. Speech transmission quality results in the mobile electronic communications network are very similar and only differ by a few tenths - *BITE Latvia* - 3.62 point, LMT - 3.36 points, *Tele2* - 3.61 points. The speech transmission quality in *Lattelecom's* fixed electronic communications network reaches 4.09 points, which is a comparatively very high value.

*Table 3. Results of voice telephony service quality measurements*

| **Service quality parameter/ Merchant** | **Unsuccessful call ratio, %** | **Average call set-up time, seconds** | **Speech transmission quality, score** |
|---|---|---|---|
| Lattelecom | 0.003 | 1.04 | 4.09 |
| BITE Latvija | 0.02 | 4.21 | 3.62 |
| LMT | 0.02 | 3.56 | 3.36 |
| Tele2 | 0.02 | 5.48 | 3.61 |

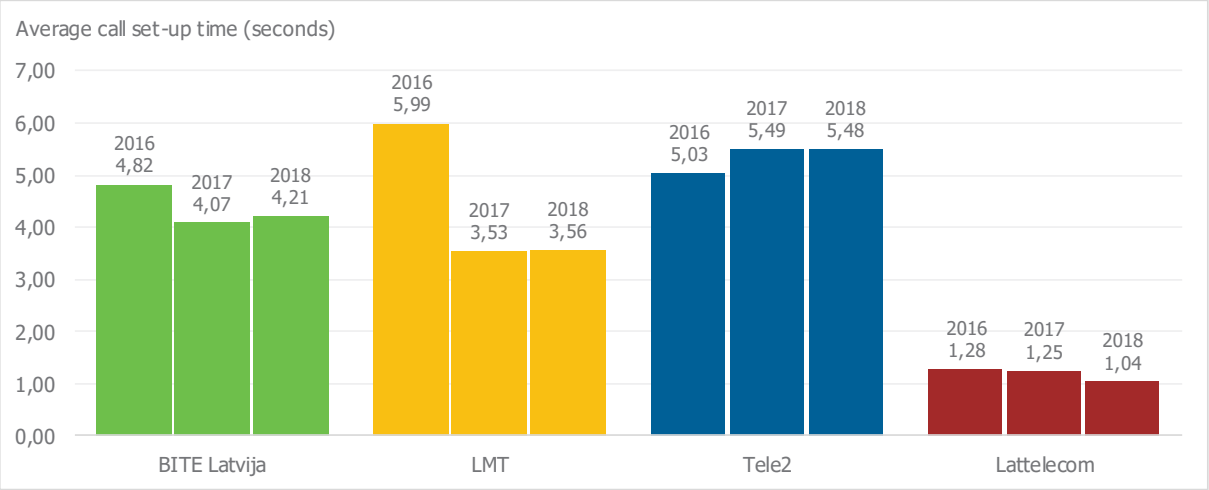
Having assessed the unsuccessful call ratio measurement results over three years (Table 2), the Regulator does not observe drastic changes in the parameters of the fixed and mobile electronic communications networks. The unsuccessful call ratio is an order of magnitude higher in mobile communications networks compared to *Lattelecom's* fixed network, however this parametric value does not reach 0.1%. This means that over the course of several tens of thousands of calls only a few have resulted in unsuccessful calls.

*Figure 2. Comparison of unsuccessful call ratio by years*



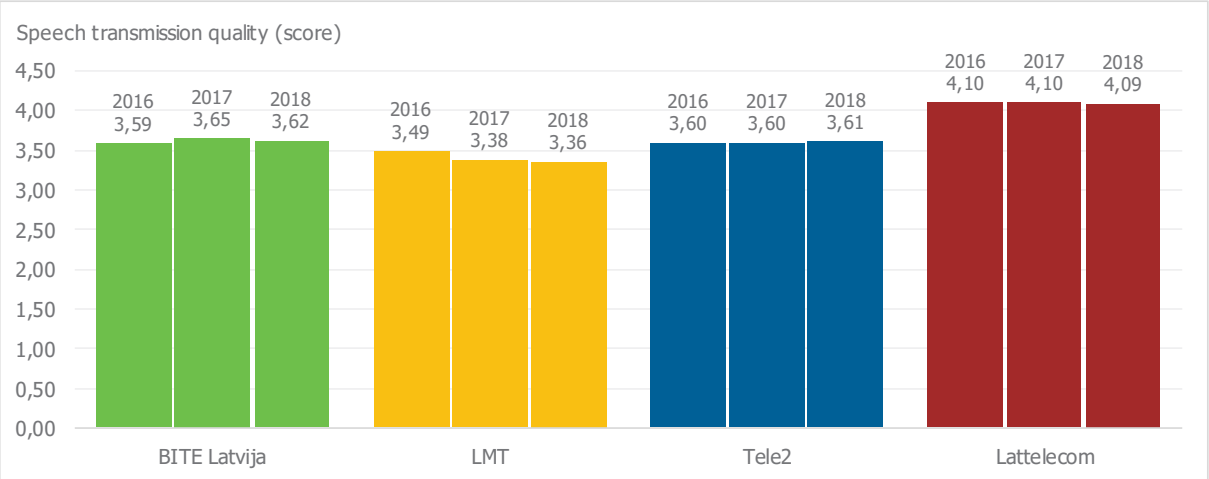

Looking at the average connection time over the past three years (Table 3), The Regulator concludes that there are no significant changes in the quality indicators of the voice telephony services provided by the merchants. When making a call in the mobile electronic communications network, it will be connected in 2-7 seconds, and within 1-2 seconds in a fixed electronic communications network. The length of the call set-up time is affected by the technologies used in the networks of the merchants, and the call set-up time will be faster in a fixed network than in a mobile network.

*Figure 3. Comparison of average call set-up time measurements by years*




Comparison of speech transmission quality measurement results by years can be viewed in Table 4. The speech transmission quality indicator of the voice telephony service in *BITE Latvia* and *Tele2* networks are on average 3.6 points, providing users with good audibility during calls. The indicator for LMT users is a little lower - at 3.4 points on average. The aforementioned parameter of the fixed voice telephony service for *Lattelecom* reaches 4.1. points, which is an excellent result for the speech transmission quality assessment.

*Figure 4. Comparison of average speech transmission quality measurement results by years*




## 3. Summary of voice telephony service quality

In 2018, the Regulator measured the parameters characterising voice telephony services provided by the electronic communications merchants - amount of unsuccessful calls, call set-up time and speech transmission quality.

The Regulator concludes that, overall, the unsuccessful calls ratio to total amount of attempted connections in the voice telephony service, both in the mobile and fixed electronic communications network, is very low, not even reaching a tenth of a percent. For *BITE Latvia*, LMT and *Tele2* the value reaches 0.02%, but for the *Lattelecom* network - 0.003%. The value of this indicator over three years is considered to be stable with minimal changes. The connection when users make calls is only interrupted in rare cases.

Looking at the average call set-up time in the mobile electronic communications network, the value of the parameter is 3-7 seconds, and 1-2 seconds in a fixed electronic communications network. Having evaluated the total call set-up time in the merchants' electronic communications networks, the Regulator concludes that after sending the called number, users are provided a fast connection. The Regulator has not observed significant changes in values in recent years.

In 2018 the speech transmission quality score for the mobile voice telephony services reaches 3.5 points, and 4 points for the fixed voice telephony service. The Regulator concludes that, in comparison with the mobile voice telephony service, the assessment of this parameter is higher in the fixed electronic communications network.

Analysing the declarations of quality submitted by the merchants, in which the electronic communications operator declares the values of the factually and guaranteed quality parameters to the end-users, the Regulator concludes that all parameter values indicated by the providers of the voice telephony service are in line with the values presented in the declarations of quality. In addition, this confirms the objectivity of the information provided by the merchants to users.

Having evaluated the 2018 voice service quality parameter measurement results, the Regulator concludes that users receive good-quality voice telephony services, regardless of the technology used by the service provider.

# III Internet Service Quality

## 4. Measurement of internet service quality parameters

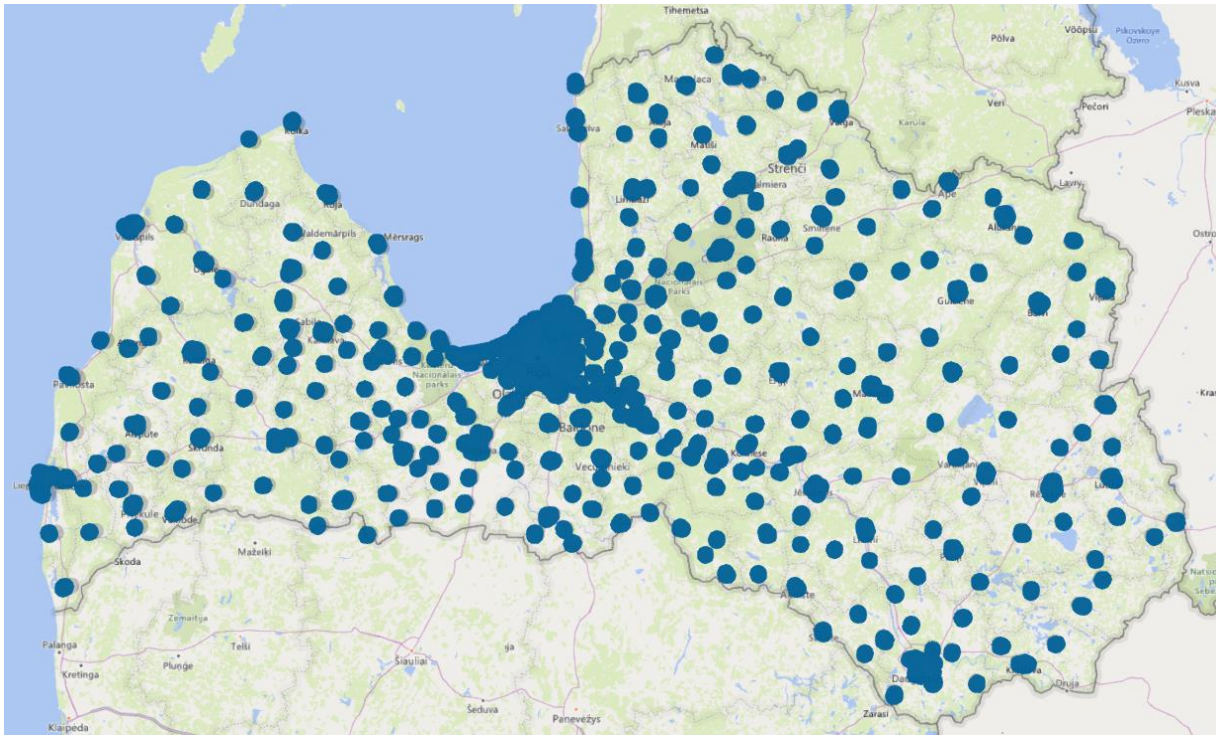
In 2018 the Regulator performed service quality measurements in the mobile electronic communications networks of *BITE Latvia*, LMT and *Tele2*.

The Regulator performed the measurements by using the Regulator's internet control system https://itest.sprk.gov.lv, which ensures the evaluation of internet service quality between the termination point and Latvian internet exchange point.

In 2018 the Regulator performed both random and serial service quality measurements in the mobile electronic communications networks of *BITE Latvia*, LMT and *Tele2* in different parts of Latvia.

In total, measurements were performed in 1203 freely chosen, mostly populated geographic locations, covering the territory of Latvia as uniformly as possible (Table 5), including more than 200 locations in Riga (Table 6). The number of measurements in the 20 largest cities of Latvia by population was chosen in proportion to population size. In total, over 18 000 random sample measurements were performed during the year, with more than 6000 measurements made in each operator's electronic communications network. 183 700 serial measurements were performed.

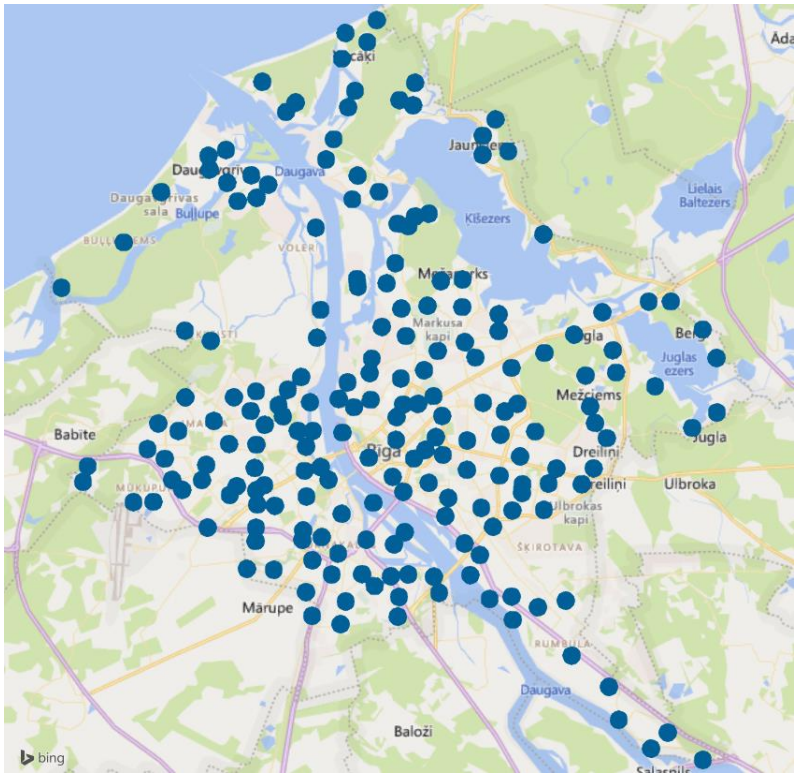
*Figure 5. Measurement sites, where internet service quality measurements were performed in 2018*




Measurements of *BITE Latvia*, LMT and *Tele2* internet service quality were performed using terminals that provide measurements in 2G, 3G and 4G technology networks with a theoretical data rate of up to 300 Mbit/s. The connections used tariff plans without data rate limitations. Measurements were performed for 2G, 3G and 4G technological solutions by choosing the newest available generation technology in a specific location in the case of stable mobile electronic communications network coverage. In the case of atypically low

quality indicators for a specific technology, measurements were repeated by choosing the previous generation technology.

*Figure 6. Measurement sites in Riga, where internet service quality measurements were performed in 2018*




The Regulator measures the following parameters of the internet service:

- connection - download and upload;
- latency;
- jitter;
- packet loss ratio.

Measurement results that describe the measured parameters in Latvia as a whole have been obtained by mathematical treatment of the measurement data, ensuring that the service quality indicators describe and cover 95% of the measurements, not including separate higher and critically low values, thus characterising the service quality indicators available to the users as objectively as possible.

## 5. Overview of internet service quality parameter measurement results

### 5.1. Results of connection speed random sample measurements

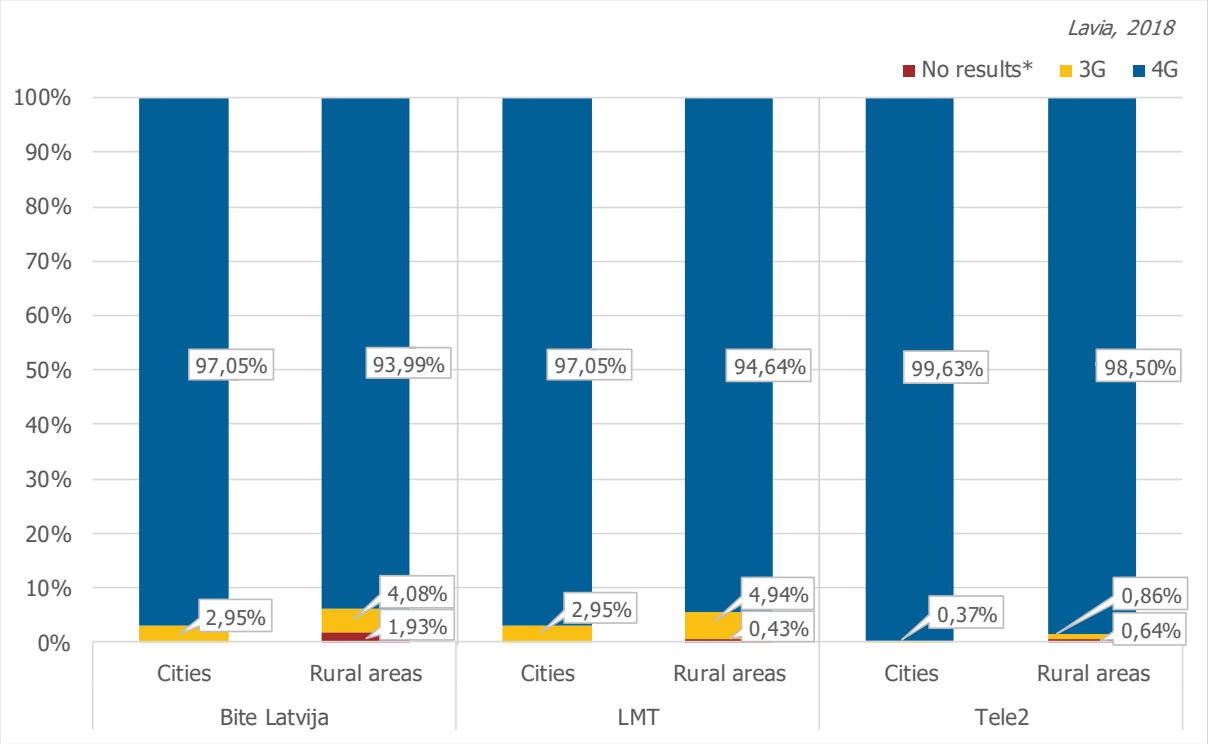
Connection speed describes the information transfer speed (download and upload) in the data channel, which in the measurements performed by the Regulator is assessed between the termination point and Latvian internet exchange point, so as to ensure uniform measurement principles. Connection speed is measured by downloading and uploading a data file between the Regulator's control system server and the computer connected to the termination point. The total amount of data transmitted during the measurement is variable, and depends on the speed values of the internet connection at the specific moment in time.

The download speed of the connection indicates the speed at which data is transmitted from the internet resource to the user's terminal. Whereas upload speed describes the speed at which data is transmitted from the terminal. For comparison - a theoretically constant speed of 10 Mbit/s allows one to transfer a 10 megabyte file in eight seconds.

The quality overview focuses on download speed measurements, as they remain important for the majority of users in choosing an internet service, as well as merchants, in offering their services, often advertise download speed values.

It should be taken into account that connection speed of the internet service measurements were performed at different locations, and different times, and, generally, were performed during working days, i.e. between 8.30 and 17.00. Measuring in the evening hours, as well as over a longer period of time or repeatedly, the connection speed values may vary or be different, which is especially characteristic of internet services in a mobile electronic communications network. In addition, in order to assess connection speed values during different times of day, the Regulator performs serial measurements. The connection speed of the internet service available at the specific time and place, even within the same data transmission technology generation, can be significantly dependant on many factors, for example, availability of internet resources, coverage and stability of the electronic communications network, as well as the activities of the internet service users within the particular base station.

*Figure 7. The percentage distribution of 2018 download speed measurements by data transmission technologies in Latvia*




** No results - locations, where internet service was unavailable during the performance of measurement due to unstable or non-existent mobile electronic communications network coverage*

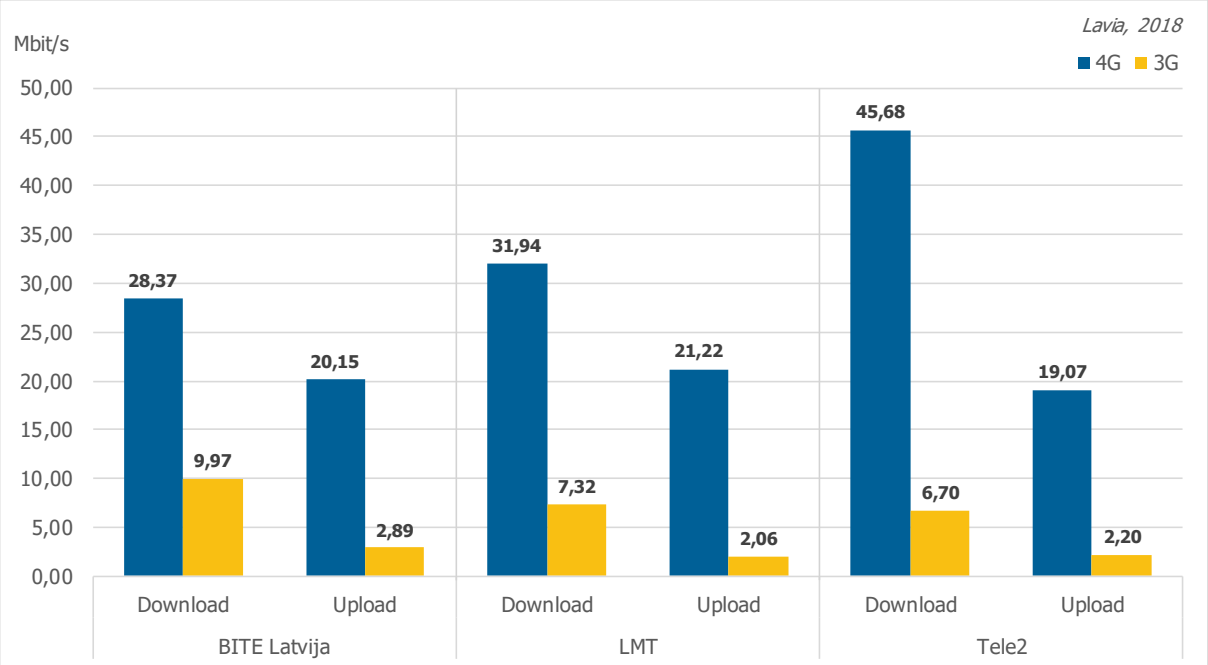
Analysing the results of the 2018 measurements, it can be concluded that the 4G network is widely developed in Latvia. At the measurement sites, both in cities[3] and rural areas, 4G connectivity was available in more than 90% of measurements. Furthermore, in several locations, where internal service was being measured using a 3G connection, 4G connectivity was also available, however, due to the atypical quality indicators of the technology, measurements were repeated using 3G connectivity, and the summary used results with the highest values, which, in such cases, were often the results obtained while using 3G connections.

In 2018 no measurements were performed in the 2G network, therefore it can concluded that in locations were mobile internet is available, at least 3G connectivity is available.

[3] Nine cities and 67 towns, in accordance with the Latvian territorial division of the Ministry of Environmental Protection and Regional Development.

However, there are still multiple locations where quality measurements were impossible to perform due to unstable or non-existent mobile electronic communications network coverage. As in the previous year, such a situation is observed in rural areas. In 2018 as well, in locations where one of the operators did not have mobile electronic communications network coverage, it was provided by one or both of the other merchants, and in most cases the average download speed of over 10 Mbit/s was provided. It can therefore be concluded that users in the territory of Latvia can choose at least one mobile operator, which can provide good-quality mobile internet services.

*Figure 8. Connection speed average value in 95% case comparison for BITE Latvia, LMT and Tele2 data transmission technologies in Latvia*

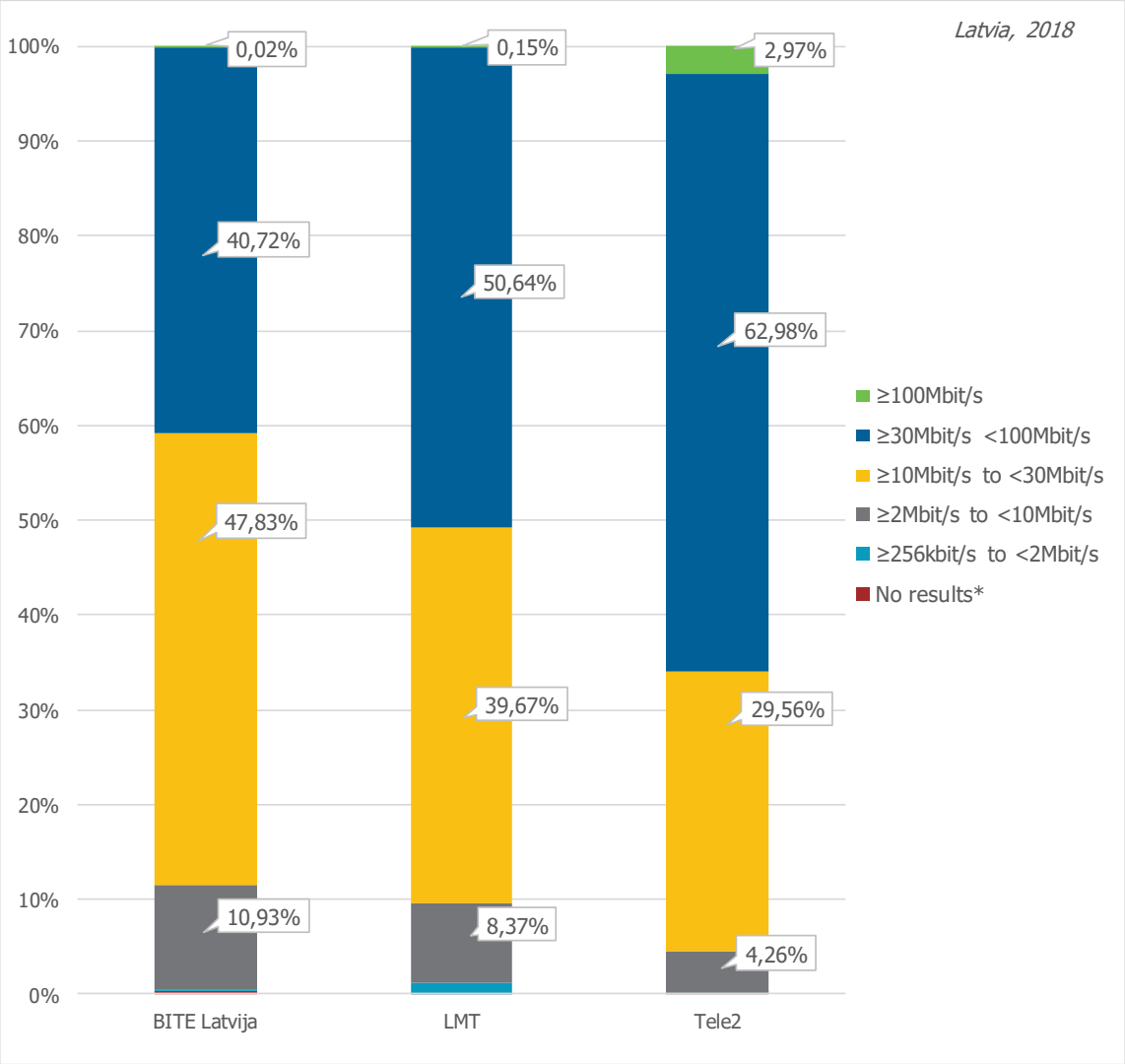



From analysing the measurement results of 2018, it can be concluded that the average download speeds in networks with 4G connectivity of all three mobile operators are provided in excellent quality. Compared with the previous year, this parameter's indicators have either increased or remained stable. Assessing the measurement results, it can be seen that some locations have high connection speeds: the quality measurements have recorded a maximum download speed of 100.76 Mbit/s in the *BITE Latvia* network, 110.49 Mbit/s in LMT network and 123.85 Mbit/s in *Tele2* network. Maximum upload speed, as observed in the quality measurements: *BITE Latvia* network - 47.40 Mbit/s, LMT network - 55.19 Mbit/s and *Tele2* Network - 47.18 Mbit/s. Assessing individual measurements, it can be seen that connection speeds are ever growing, and download speeds over 30 Mbit/s and over 100 Mbit/s are available more and more often. This shows that mobile operators are still continuing to develop and deploy 4G technologies for mobile electronic communications networks, identifying the development of technology generations and gradually approaching the Digital single market development goals of the European Digital Agenda on access to fast and ultra-fast internet[4].

Taking into account the availability of 4G connectivity, in 2018 there were less and less locations, where measurements were performed using the 3G technology.

[4] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "A Digital Agenda for Europe" - COM (2010) 245, 26.8.2010.

*Figure 9. The percentage distribution of 2018 download speed measurements in Latvia*

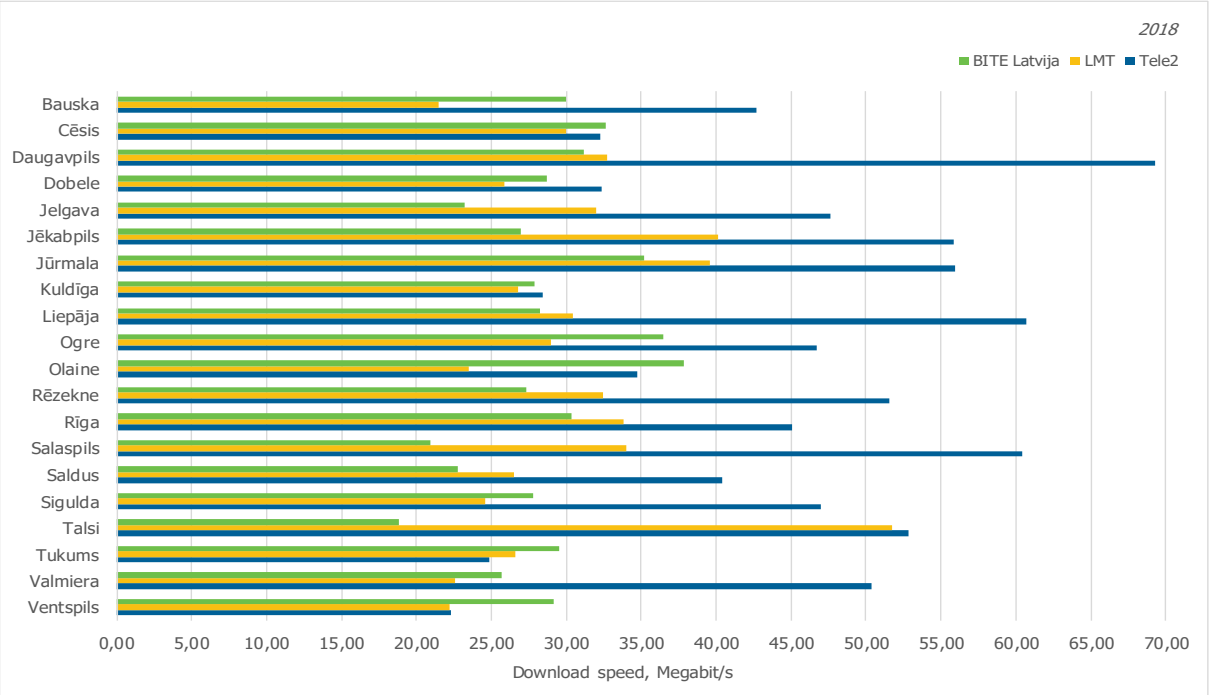



** No results - locations, where internet service was unavailable during the performance of measurement due to unstable or non-existent mobile electronic communications network coverage*

Looking at Figure 9, it can be concluded that in 2018 only a small part of the average download speed measurements were below 10 Mbit/s. Therefore the average 4G download speed in the networks of all three mobile operators exceeded 10 Mbit/s in 90% of cases. Download speed below 2 Mbit/s was observed in a negligible amount of measurements (*BITE Latvia* - 0.22%, LMT - 1.12% and *Tele2* - 0.13%). Looking at the measurement results, it can be concluded that download speed over 100 Mbit/s has been observed in up to 3% of the measurements. The information submitted by operators on the number of mobile internet connections at different speed ranges and the factual connection speed provided to users in line with contracts shows that, overall, 40% of mobile internet connections in Latvia have access to connection speeds over 100 Mbit/s. Therefore, when comparing the information provided by the mobile operators with the results of the Regulator's measurements, it can be concluded that some mobile operators indicate connection speeds that are only actually achievable in some cases.

The connection speeds and the connection technology used in the measurements can be viewed in more detail for each particular measurement site on the Regulator's website in the 2018 random sample measurement section.

*Figure 10. Comparison of download speed measurement results by population in the major cities of Latvia*




Assessing the average connection speed by population in the major cities of Latvia and comparing these results with previous years, a trend of increasing average connection speeds can be observed. In most cities the average download speed in the networks of all three mobile operators was over 20 Mbit/s, which is a very good indicator, and, taking into account all other quality parameters at the specific location and time, such a download speed indicator was sufficient for most online services.

The average download speeds in individual regions and cities of Latvia can be viewed in the infogram published on the Regulator's website.

## 5.2. Results of connection speed serial measurements

In addition to performing random sample measurements, the Regulator performs internet service quality supervision over a prolonged period, thus ensuring the evaluation of quality indicators depending on the time of day. The Regulator continuously performs serial measurements in mobile electronic communications networks in several locations in Latvia for at least one week, reflecting the changes in the internet service download speeds in the specific location. Serial measurements describe the overall stability of the internet service, and show the quality indicator, including the change of the download speed depending on the load intensity at different times.

All 2018 serial measurements of internet service in mobile electronic communications networks in various locations in Latvia can be viewed in more detail - average values for each hour for one calendar week - on the Regulator's website, in the 2018 serial measurements section.

Analysing the results of the serial measurements for the year, it can be concluded that in most cases the same tendency of a decreasing connection speed in the second half of the day can be observed, thus the highest download speed values can be observed in the time period from 00.00 to 6.00, while the lowest download speeds - from 18.00 to 24.00.

## 5.3. Overview of packet loss ratio, latency and jitter measurements

In addition to connection speed, other internet service quality parameters also significantly affect the use of the service. Therefore, under the effect of high packet loss ratio, latency or jitter indicators, use of the service can become cumbersome or even impossible. In addition,

highlighting the development of new technologies and introduction of services that are quality-sensitive and require a guaranteed quality, the low quality parameters of these services are becoming critical. The overview of the 2018 quality measurement results did not include 3G measurement indicators due to their relatively low number, which do not describe the average quality indicators in Latvia as a whole. However, evaluating certain measurement results, it can be concluded that the minimum latency is about twice as high for 3G measurement results than for 4G, whereas average jitter is 3 or up to even 70 times higher than in the 4G network.

### 5.3.1. Packet loss ratio

Transmitted data unit, i.e. packet loss ratio is a parameter which describes the ratio of lost packets to the total amount of transmitted packets. Packet loss most commonly occurs due to overload of the electronic communications network or its individual pieces of equipment.

A low packet loss ratio indicator is significant to user applications, which are very sensitive to packet loss or sequence change, for example, voice or data streaming (real time video viewing, gaming, video conferences) applications. For example, to ensure an online audio or video transmission without observable interference, the packet loss ratio must not exceed 1%.

*Table 4. Average packet loss ratio in 95% of measurements in 2018*

| Data transmission technology | Average packet loss ratio (%) | | |
|---|---|---|---|
| | BITE Latvia | LMT | Tele2 |
| 4G | 0.00 | 0.00 | 0.00 |

Similar to the previous year, the average packet loss ratio in 2018 in 95% of measurements in the networks of all three mobile operators is 0%, thus providing services without packet loss. However, in rare cases (less than 2.5% of all measurements) the packet loss ratio reaches very high values - in 2018 the following maximum packet loss ratio was observed using 4G connectivity: *BITE Latvia* network - 75%, LMT - 83%, *Tele2* - 87%, which means that use of the internet service with such a high packet loss ratio would be significantly impaired.

### 5.3.2. Latency

Latency is a parameter, which describes the time lag between requesting information and receiving it.

Latency describes the ability of an electronic communications network to react. The Regulator measures this by measuring the time necessary for the data packets to travel from the mobile device connected to the network termination point of the electronic communications network to the measuring system connected to the Latvian internet exchange point and back.

Low latency is important for user applications that require the reception of information with as little delay as possible, such as video conferences, voice transmissions, online gaming and data streaming services. For comparison - latency, i.e. time delay, of less than 150 ms is almost unnoticeable to the human ear. If latency exceeds 300 ms, voice transmission quality becomes unsatisfactory and perception of the conversation can become considerably more difficult. At the same time, a higher latency does not directly affect, for example, the sending of e-mails or downloading of files.

*Table 5. Average latency in 95% of measurements in 2018*

| Data transmission technology | Average latency in milliseconds | | |
|---|---|---|---|
| | BITE Latvia | LMT | Tele2 |
| 4G | 26.83 | 23.93 | 40.65 |

In 2018, the average latency has remained similar to the previous year and are consistent to the technology. Latency may also reach very high values in certain cases. In 2018 the following maximum latency was observed when using 4G connectivity: *BITE Latvia* network - 55 ms, LMT - 51 ms and *Tele2* - 68 ms, which is two times lower than the previous year. Therefore it can be concluded, that even in the case of the maximum latency, it will not affect the use of the majority of internet services.

Latency is one of the parameters, which is defined as very significant in the development of new technologies and the introduction of services provided via these technologies. It is expected that the development and implementation of different innovative internet-based services will require a one-way latency below 10 ms. Looking at the minimum latency values of the 2018 measurements, it can be concluded that they are becoming lower. In 2018 the following minimum latency values were observed: *BITE Latvia* network - 19 ms (2% of all 4G measurements), LMT - 12 ms (3% of all 4G measurements) and *Tele2* - 24 ms (2% of all 4G measurements). Thus, it can be concluded that, in rare cases (up to 3% of all measurements), very low latency is provided, thus marking the progressive development of next generation technologies.

### 5.3.3. Jitter

Jitter is a parameter that describes the variation of the time lag between sending and receiving data packets.

On the transmitting side, data packets are transmitted at a steady interval, but due to the limited throughput capacity of the electronic communications networks, such as overload, routing changes, packet loss, etc., this flow may become uneven and the time delay between data packets may vary. Therefore, the more uneven the time lag between the data packets, the worse the quality of the received service.

Low jitter is essential for applications whose exact performance depends on the packet delivery sequence in a guaranteed time interval, such as real-time applications (video, games, etc.), interactive services, video streaming, etc. High jitter affects the reception of an internet service, causing, for example, voice transmission interference, picture distortion, and temporary interruptions. For comparison - voice transmission quality deteriorates if jitter exceeds 30 milliseconds.

*Table 6. Average jitter in 95% of measurements in 2018*

| **Data transmission technology** | **Average jitter in milliseconds** | | |
|---|---|---|---|
| | **BITE Latvia** | **LMT** | **Tele2** |
| 4G | 5.77 | 2.55 | 2.38 |

Analysing the results of the jitter measurements, it can be concluded that the average jitter is provided at a level that does not affect the quality and reception of the service. Very high jitter values have only been observed in rare cases and measurements, reaching the maximum of 4900 ms in the *BITE Latvia* network, LMT - 414 ms and *Tele2* - 335 ms. As a result of jitter, i.e. packet delay variation, the sequence of incoming packets differs from the sequence of outgoing packets, which, in the case of low jitter is solved by accumulating packets in the buffer memory, where they are arranged in the original sequence. However, in the case of high jitter, packets are discarded when the buffer overflows, packets become missing, and the original packet sequence cannot be restored. As a result, data transmissions become disrupted, for example, distortions of the TV picture or voice transmission, and the use of the service becomes difficult.

Looking at the 2018 jitter measurement results, it can be seen that 30 ms jitter is only exceeded in 3.6% of measurements in the *BITE Latvia* network, 1.5% - in the LMT network and 3.1% in the *Tele2* network.

## 6. Summary of internet service quality

Analysing the 2018 measurements of internet service quality, it can be observed that quality indicators keep improving, and the availability of 4G keeps increasing. Compared to the previous year, 2018 shows ever increasing connection speeds, with the majority of measurements falling into the speed category over 10 Mbit/s. Compliance of the upload speed with the requirements of the Regulations on a general authorisation is also observed, i.e. the minimum guaranteed connection speed of the mobile internet service is not lower than the lowest limit of a broadband connection - 256 kbit/s. The measurement results show that in all measurement sites in 2018 where mobile internet service was available, download speeds over 256 kbit/s were provided. Furthermore, in 2018 average download speeds over 100 Mbit/s was observed not only in individual measurements, but in individual locations. Overall, in 2018 download speeds over 100 Mbit/s in mobile electronic communications networks of operators was recorded in 1.04% of cases. On the other hand, the information submitted by operators on the number of mobile internet connections at different speed ranges and the factual connection speed provided to users in line with contracts shows that, overall, 40% of mobile internet connections in Latvia have access to connection speeds over 100 Mbit/s. The operators also state in the quality declarations that they provide mobile internet service connection speeds in the range of ≥100 Mbit/s to <200 Mbit/s. However, it should be taken into account that the connection speed ranges stated in the quality declaration must describe the actual maximum connection speed, which the mobile operator can provide to the user. Therefore, when comparing the information provided by the mobile operators and the results of the Regulator's quality measurements, it can be concluded that some mobile operators indicate connection speeds that are only actually achievable in some cases. In addition, certain mobile operators in their quality declarations indicate much lower quality indicators than observed in the Regulator's measurements. For example, it is stated that the average latency of the mobile internet service is 400 ms, and average jitter is 260 ms. Such average quality indicators of the mobile internet service would suggest that certain online or other latency-sensitive services would be virtually unusable. The Regulator emphasises that the quality parameters reflected in the quality declarations must be real indicators of describing the performance of the electronic communications network.

However, more than half of all download speed measurements in 2018 exceeded 30 Mbit/s. In addition, such quality parameters as latency, jitter and packet loss ratio are provided at excellent quality. In this manner the mobile internet quality indicators mark the further development of technology, both by improving and expanding the existing 4G technologies, as well as by providing a suitable platform for the gradual transition to the latest 5G technology. The 5G technology generation is also a sequential improvement of existing technologies and their performance indicators, increasing the technical capabilities of the network and implementing various new technological solutions. There are currently ongoing discussions about various 5G deployment models, application options, mobile network architecture, and innovative services that could be provided via such networks. However there are also multiple factors due to which the precise 5G deployment scenario is currently unknown. Thus, a drastic and comprehensive change of mobile technologies and implementation of revolutionary services and functions is not expected. However, one can expect a gradual development of the 4G technology generation, implementing, among others, new solutions, that will theoretically allow one to reach gigabit internet connection speeds. However, it should be noted that in order for the user to be able to receive the service with the appropriate quality indicators, the user's terminal must be equipped with the necessary components capable of providing the appropriate indicators, e.g., gigabit internet connection speed.

# IV Supervision of open internet requirements

In line with the provisions of the Open Internet Access Regulation and BEREC Guidelines (BoR (16) 127), the Regulator ensures compliance with the open internet principles and supervises the compliance of internet access services provided by merchants with the provisions of the Open Internet Access Regulation. In order to ensure the supervision of open internet provisions, the Regulator sets the minimum quality requirements for internet services, provides the technical supervision of service quality, analyses user complaints, as well as performs the merchant survey on compliance with the provisions of the Open Internet Access Regulation.

## 7. Minimum quality requirements

The minimum requirements for internet services in Latvia were introduced before the Open Internet Access Regulation came into force, and are still in force. It is required that, in providing a fixed internet service, the merchant must provide the user with a minimum guaranteed connection speed now lower than 20% of the maximum connection speed stated in the contract. The minimum guaranteed connection speed must be available to the user permanently throughout the day. Therefore, the requirements of the Regulation to indicate the minimum and maximum connection speed in the contract was implemented in Latvia in advance. In addition to the minimum and maximum connection speeds, the Regulation requires merchants to indicate the normally available connection speed in the contract. In 2018 the Regulator made amendments to the Regulations on a general authorisation, including all the explanations for all the speeds contained in the Regulation, i.e. the time period during which the user must be provided each connection sped type, as well as how the connection speed values should be displayed. Thus, it has been defined that the minimum guaranteed connection speed is the speed below which the connection speed may not drop throughout the entire day. The normally available connection speed is the average connection speed, which is constantly available throughout the entire day. Whereas the maximum (advertised) connection speed is the average connection speed that is available to the end-user constantly throughout the day, except for peak hours[5]. In addition, the Regulations on general authorisation state that the merchant may indicate the normally available and maximum advertised connection speed both as a numerical value or a range. In the opinion of the Regulator, as well as taking into account the serial and random sample measurements of internet service quality performed by the Regulator, significant deviations of the connection speed are possible throughout the day, thus, connections speeds indicated as a range often provide a better understanding of the factual quality indicators of the available service. If the merchant indicates the maximum (advertised) connection speed as a range, the requirement is that the maximum guaranteed connection speed is 20% of the upper range of the maximum (advertised) connection speed. However, if the normally available connection speed is indicated as a range, the range values may not be lower than the minimum guaranteed connection speed.

As regards the mobile internet service, in addition to the requirements set out in the Open Internet Access Regulation to indicate the maximum design and advertised connection speed, the Regulator has also set out the minimum requirements for the mobile internet service in the Regulations on general authorisation. The merchant must ensure that the minimum guaranteed speed of the mobile internet service is not lower than the lowest range of a broadband connection speed, i.e. 256 kbit/s.

[5] Usually evening hours, when the internet service is used by the largest number of users.

The aforementioned amendments to the Regulations on general authorisation entered into force 1 April 2019.

## 8. Technical quality supervision and conformity of measurement results

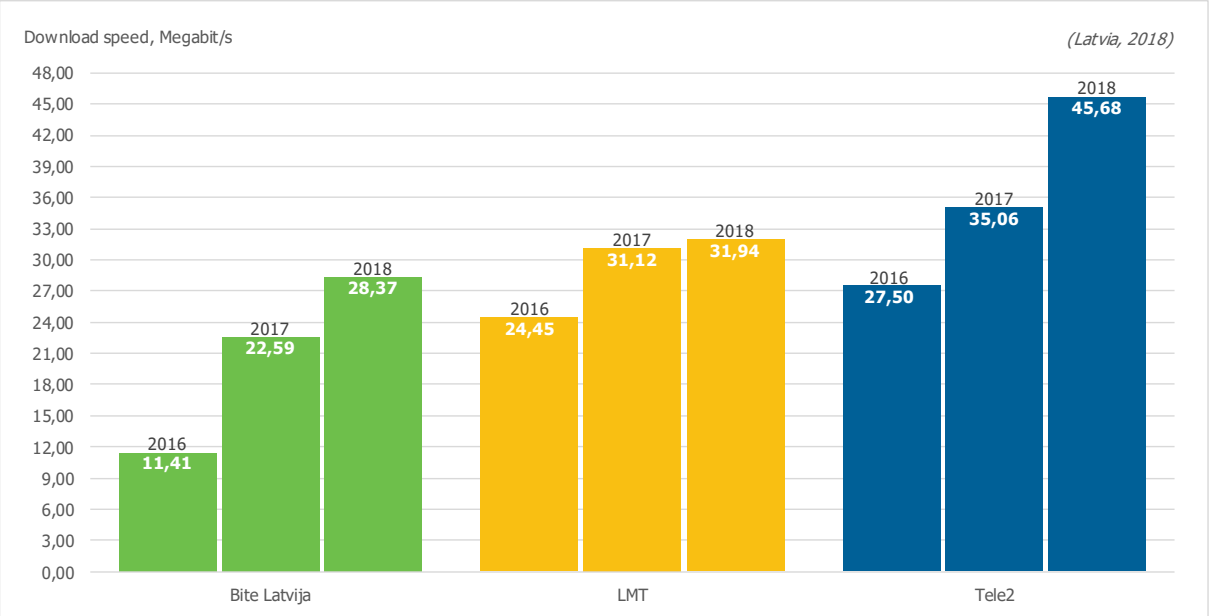
The Regulator performs the supervision of internet service quality using the internet control system ITEST, which provides the possibility to perform internet service quality measurements to assess the connection speed and other quality parameters. The Regulator performs constant mobile internet service measurements throughout the year, covering the entire territory of Latvia as evenly as possible.

Fixed internet service quality measurements are only performed in the case of complaints. Taking into account that optical networks are widespread in Latvia and 58.6% of fixed internet connections are provided with connection speeds over 100 Mbit/s, as well as that the Regulator only receives a few complaints on the quality of fixed internet service quality annually, measuring the quality of fixed internet services in Latvia is not necessary.

In addition, users may also use the Regulator's internet control system ITEST to check the compliance of internet service quality. Measurements performed by the users, however, are only informative in nature and are not legally binding, but the user may turn to the merchant in the case of problems with the measurement results. If the user is unable to find a solution with the merchant, a complaint must be submitted to the Regulator, who will provide objective measurements by connecting the Regulator's terminal in the premises of the user, thus ensuring that the user's devices do not affect the measurement results. Measurements are performed between the electronic communications network termination point and the Latvian internet exchange point.

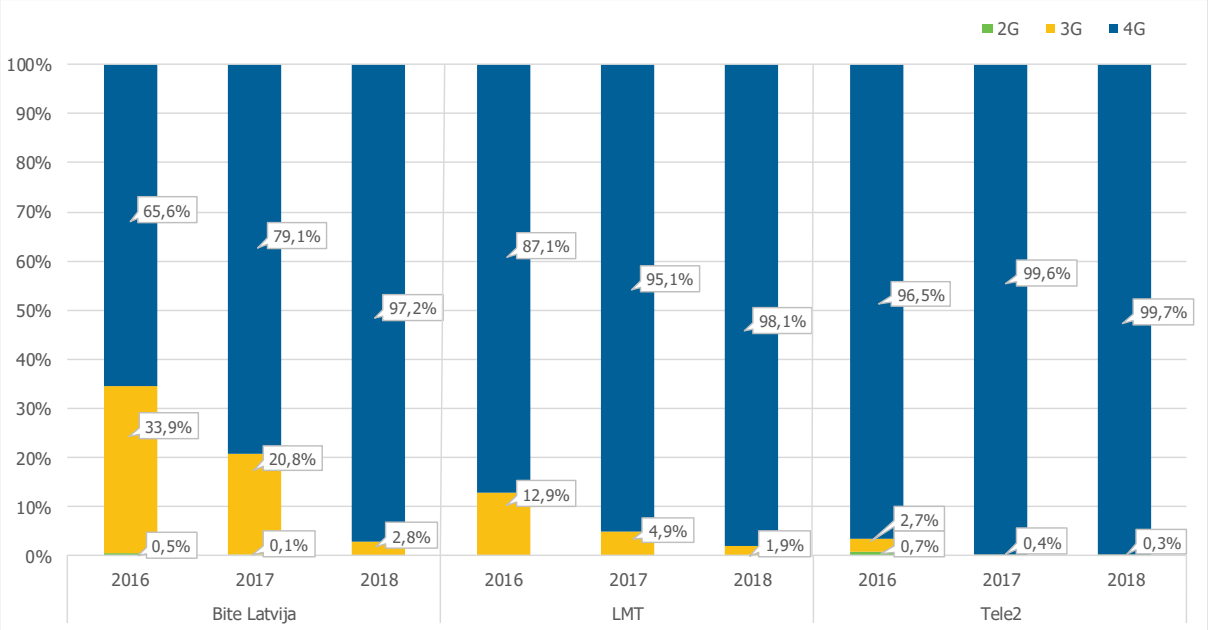
Evaluating the quality measurement results, it can be concluded that mobile internet quality indicators improve year by year, and merchants provide ever increasing connection speeds and availability of the 4G technology.

*Figure 11. Comparison of average download speed measurements by year in Latvia*



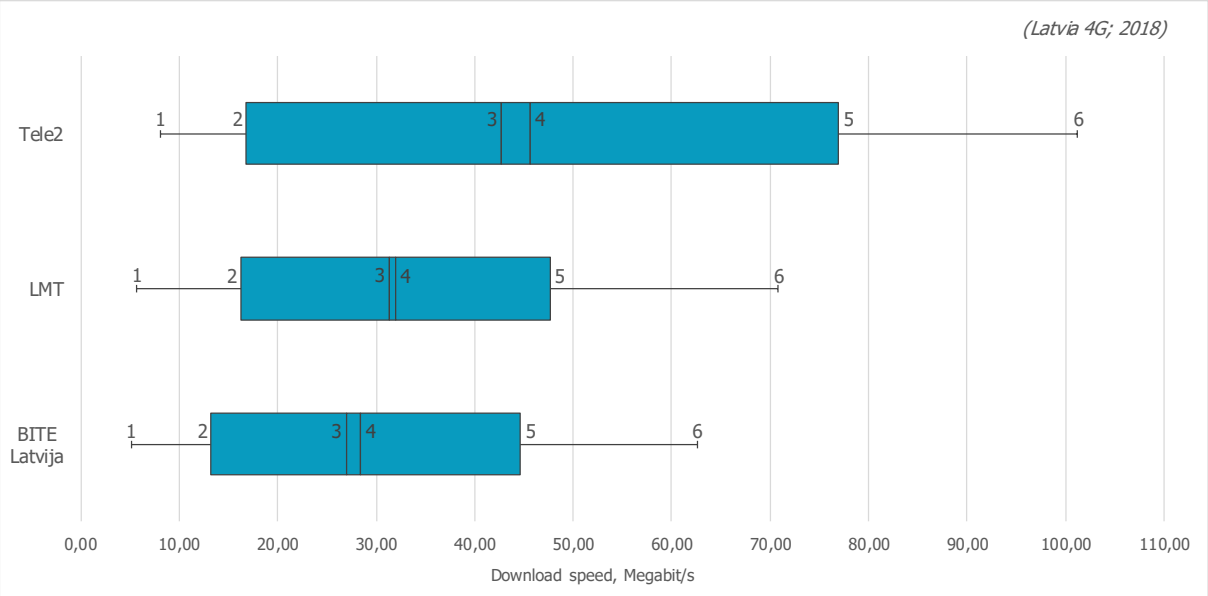

Comparing the measurement results over a three-year period, it can be concluded that the average download speeds as well as the spread of the 4G technology are increasing every year. In 2018 the majority of measurement sites for all three mobile operator networks had 4G connectivity. In addition, in approximately 90% of cases the available connection speed was over 10 Mbit/s.

*Figure 12. The percentage distribution of download speed by data transmission technologies in Latvia per year*




Each year shows increasing factual 4G data transmission speeds, in individual locations, even exceeding 100 Mbit/s on average. However, there are still locations where a significant drop in connection speed down to 2 Mbit/s or below is observed, especially in border areas. In order to reflect the connection speeds available to users as objectively as possible, when analysing the measurements in Latvia overall, 2.5% of the results with the highest and critically low connection speed values were discarded, covering 95% of all performed measurements. Considering that connection speeds in a mobile electronic communications network vary greatly, to provide insight into the factually available connection speeds, detailed analysis of measurement results is performed, and the most commonly available speed or download speed range, which was observed and covers 68% of all measurements, is determined. In addition, the maximum and minimum download speed was also determined, which indicates the range variation at which the connection speeds may vary. The aforementioned analysis only covered the results of mobile internet 4G measurements.

*Figure 13. Comparison of download speed measurements in 95% and 68% of measurements*




1 - minimum download speed in 95% of measurements;

2 - minimum threshold in 68% of measurements, i.e. in most commonly available download speeds;
3 - download speed median in 95% of measurements;
4 - download speed arithmetic average in 95% of measurements;
5 - maximum threshold in 68% of measurements, i.e. in most commonly available download speeds;
6 - maximum download speed in 95% of measurements.

The shaded cell in Figure 13 shows the most commonly available download speed range, i.e. value distribution in 68% of measurements, thus allowing to observe ranges at which the download speed is normally achievable or available in networks of various mobile operators.

In a more thorough study, the minimum, maximum and most commonly available download speed values were analysed, as well as average download speed values and their medians were determined (Table 7). The median is the distribution midpoint of the measurement results, i.e. the value by which one half of the measurement results is lower, and the other half - higher. The measurement results obtained in the networks of all three mobile operators show, that the median value is lower than the arithmetic average. Thus, it can be concluded that measurements yielded individual high download speed values, which resulted in increased average values. The lower the difference between the median and average value, the more even the distribution of download speed values.

*Table 7. 4G connection speed quality indicators in 95% of measurements*

| Quality indicator | BITE Latvia | LMT | Tele2 |
|---|---|---|---|
| Average download speed, Mbit/s (4) | 28.37 | 31.94 | 45.68 |
| Median, Mbit/s (3) | 26.93 | 31.28 | 42.68 |
| Minimum download speed, Mbit/s (1) | 5.13 | 5.70 | 8.09 |
| Maximum download speed, Mbit/s (6) | 62.67 | 70.79 | 101.22 |
| Most commonly or normally available download speed range (in 68% of measurements), Mbit/s (2),(5) | from 13.22 to 44.65 | From 16.23 to 47.66 | From 16.81 to 76.92 |

Evaluating the obtained quality indicators, it can be concluded that the normally available internet service download speed in the mobile networks of all three mobile operators is over 10 Mbit/s, whereas the minimum download speed, not counting the 2.5% critically low measurement results, is over 5 Mbit/s. It can therefore be concluded that the high rates of mobile internet quality indicators are provided, and there is a tendency for them to improve every year.

## 9. Analysis of internet service user complaints

In 2018, the Regulator received five complaints about the quality of internet services, which is 9% of all the complaints received by the Regulator in 2018. In the majority of cases the complaints about the internet service quality were related to an incompliant connection speed at a specific time period, and the main purpose of the complaint was the user's desire to receive compensation for the time period when the service was not available. In the majority of cases an agreement between the user and the merchant was reached, therefore the complaints were withdrawn. Only in the case of one complaint did the Regulator perform an extraordinary quality check of the provided service, finding that the internet access services was provided in compliance with the concluded contract. In 2018, like the previous years, no complaints were received on open internet violations. The Regulator therefore concludes that users are satisfied with the quality of the received internet service or are able to reach a mutual agreement with the merchant in the case of problems.

# 10. Results of the survey of electronic communications merchants

## 10.1. Supervision of commercial offers

Analysing the information provided by the operators, the Regulator concludes that, as in previous years, one of the Latvian mobile operators (*BITE Latvia*) offers users the opportunity to use content services without accounting for data usage (*zero-rating* applications):

- social apps;
- voice and text message services;
- traffic and navigation apps.

*BITE Latvia* notes that, as the user reaches the data cap of the selected tariff plan, just as with all other services provided on the internet, usage of the *zero-rating* application becomes limited. The Regulator has so far not received any complaints or questions from users or other merchants about the option offered by *BITE Latvia* to use content services without it counting towards the data cap.

## 10.2. Traffic management measures

Evaluating the answers provided by the merchants, it can be concluded that 16% of all merchants that provide internet services, apply traffic management measures primarily by, similar to 2017, blocking certain ports. Results of the survey indicate that, compared to the previous year, the number of merchants that perform port blocking has decreased by 3%. However, analysing the information submitted by the merchants on blocked port numbers, it can be concluded that the trend form the previous year has remained. The most frequently blocked ports are:

- **port 25** - blocked by 5.6% of all internet service providers in Latvia;
  This port is used by the *Simple Mail Transfer Protocol* to transmit electronic mail. Port 25 is blocked to prevent spam mail, i.e. dissemination of large amount of unsolicited messages, which can be initiated by, for example, a computer infected by malware.
- **ports 135 -139** - blocked by 4.4% of all Internet service providers in Latvia;
  These ports are used for communication by applications and computers. The ports works in a connectionless mode, i.e. any information being broadcast over the network is accepted, if directed at these ports. Therefore these ports are often used to transmit various malware.
- **port 445** - blocked by 2.5% of all internet service providers in Latvia;
  Used for file sharing. This port is also often used maliciously, as it is unprotected against remote access, allowing computer hackers to install and activate applications without the user's knowledge.
- **Other ports** - in addition to the aforementioned ports, merchants have also indicated 36 other ports or port ranges, that are blocked for security reasons, to prevent the spread of malware.

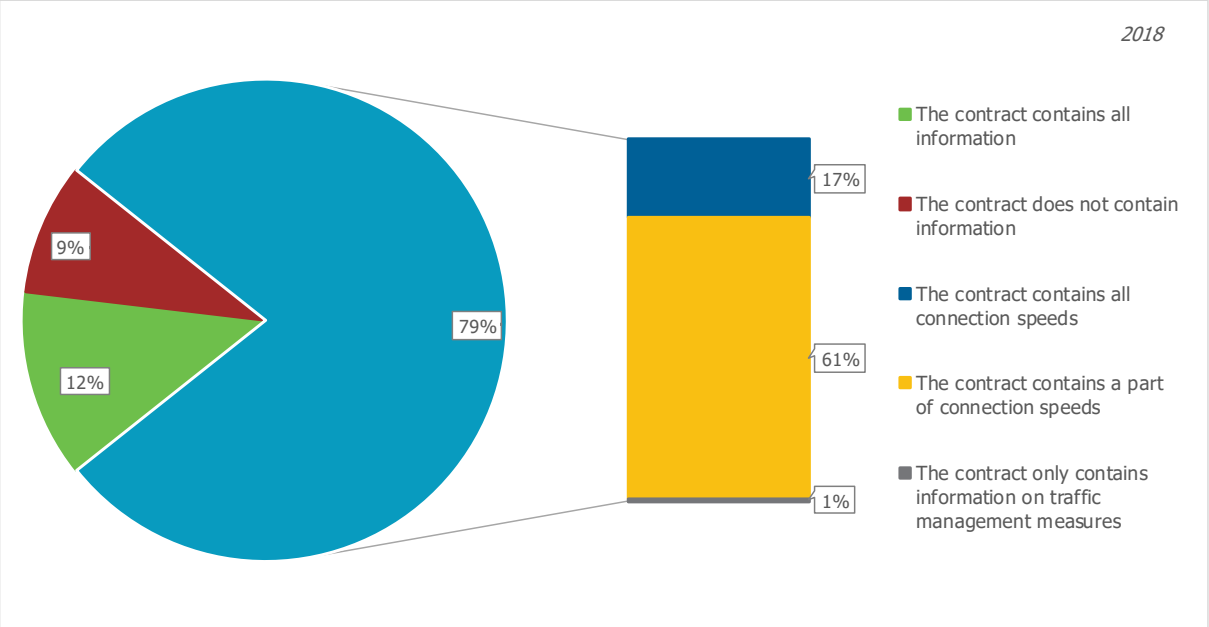
Internet service providers more often configure the electronic communications network parameters and ensure the transmission of data and interaction between devices by using other, more secure ports. Therefore the user's use of the internet service is normally not affected by the blocking of the aforementioned ports. However, sometimes the aforementioned ports may be necessary for using some specific service, in which case the user must contact their internet service provider and request permission to the specific port. Certain merchants have informed the Regulator that blocking of the corresponding ports for the specific connection is terminated at the request of the users. In addition, several merchants have noted, that the aforementioned ports are blocked temporarily when monitoring security threats and the spread of malware, including when following information of the Information Technology Security Incident Response Institution (*CERT.LV*).

### 10.3. Information included in contracts

Analysing the results of the merchants' survey on the inclusion of information set in the Open Internet Access Regulation in the contract with the user, it can be concluded that the majority or 91% of merchant contracts have indicated the necessary information. 12% of merchants indicate that the contracts contain all the information required by the Open Internet Access Regulation, both on the applied traffic measures and all the required connection speed values, while 79% of the merchants indicate that the information in the contracts is included partially. The partially included information includes cases where contracts indicate all types of connection speeds, but do not include information on traffic management measures (17% of merchants), because no traffic management measures are applied. Cases when the contracts contain part of the specified speeds (61%) - most commonly the minimum guaranteed and maximum -, whereas the rest of the information specified by the merchant is available on the merchant's website, thus ensuring the compliance of the contract with the provisions of the Open Internet Access Regulation. As well as cases when the contracts do not contain connection speed values, but contain information on traffic management measures (1%).

In 2018, compared to the previous year, the amount of merchants, which have not included the information required by the Open Internet Access Regulation in the contracts, has significantly decreased (in 2017 - 29% of merchants, in 2018 - 9% of merchants). The Regulator continues to evaluate the information contained the merchants' contracts and websites, and requesting the merchants to rectify non-compliance should such be found.

*Figure 14. Comparison of merchants' replies to the survey on the inclusion of information required by the Open Internet Access Regulation in the electronic communications services contract*




## 11. Penalties

Electronic Communications Law states that the Regulator supervises to ensure that the requirements regarding non-restriction of the data flow speed and data volume laid down in laws and regulations are conformed to in providing the internet access service, and that these requirements are included in the contract.

The Regulator may issue a warning or impose a fine on a merchant for a violation of the provisions on data flow speed or data volume in providing the internet access service laid down in the laws and regulations in accordance with Article 158.[6] of the Latvian Administrative Violations Code, and for not concluding a contract with the user, or not including the information required by the laws and regulations in the contract concluded with the user in accordance with Article 148.[1] of the Latvian Administrative Violations Code.

## 12. Summary of the supervision of open internet requirements

In 2018, when supervising the implementation of the Open Internet Access Regulation, the Regulator has not detected any violations in the activities of merchants. The low number of user complaints shows that, overall, users are satisfied with the quality of received services, or are able to resolve the problem without the involvement of the Regulator. Furthermore, taking into account that no complaints have been received for three years about violations of traffic management requirements, it can be concluded that internet service providers do not apply discriminatory traffic management measures, therefore the consumer rights set out in the Open Internet Access Regulation are not violated. Evaluating the quality measurements performed by the Regulator, it can be seen that mobile internet quality indicators, as well as service penetration, continue to rise, thus ensuring that increasingly more users have access to high-speed mobile internet. Mobile internet quality measurements have shown that the download speed in more than half of measurements exceeds 30 Mbit/s. In addition, in locations where mobile internet service was available, download speeds below 256 kbit/s were not observed. Therefore, it is concluded that mobile operators ensure quality indicators in accordance with the requirements of the Regulations on general authorisation, that the minimum guaranteed connection speed of the mobile internet service is not lower that the lowest threshold of a broadband connection. In addition, when analysing the information annually submitted to the Regulator by the merchants, including the survey on compliance with the provisions of the Open Internet Access Regulation, it can be concluded that more than half of fixed internet service connections have available connection speeds over 100 Mbit/s. Therefore, the merchants are able to ensure that even the minimum guaranteed connection speeds are high and sufficient for the use of the majority of internet-based services. In addition, when evaluating merchant contracts and information published on their websites, the Regulator has observed that a part of the fixed internet service providers provide a higher minimum guaranteed connection speed than set out in the Regulation on general authorisation. The majority of merchants in their contracts and websites provide clear information to users about the internet service quality indicators, and the aforementioned minimum quality requirements of the Regulator impose and obligation for the merchants to provide the level of quality set out in the contract. In addition, it can be concluded that the traffic measures applied by the merchants are applied for the protection of the users and the network, and do not adversely affect access to the internet service, as well as, in providing specialised services, internet service quality indicators are not affected. The Regulator continues to evaluate the information contained in merchant contracts and published on websites, so as to ensure the availability of clear, understandable and transparent information to the users.

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Chairman R. Irklis