

Development of information space of region: factors of digital divide

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Abstract: Development of information society in Russia has both natural advantages and real difficulties due to the geographical position and the area of our country, disparities in social and economic development of its regions. The achieved level of ITT development in Russia is accounted for most of all by the existing state policy aimed at formation and development of unified nationwide information space. However, the existence of a developed market of ITT-related goods and services with the supply being formed by the production of information telecommunication technologies sector companies is an essential prerequisite for further development of informatization of the Russian economy. The above stated stipulates that it is required to obtain reliable and proved quantitative data which allows for appropriate assessment of state and development of information telecommunication sphere in conditions of inter-regional differences in order to take feasible management decisions at the federal and regional levels. Methodological principles of assessment of the levels of region differentiation according to the information society development level are examined in the article. We have determined typological groups of regions according to the information telecommunication technologies (hereinafter - ITT) allowing for determining of structural trends in the development of ITT sphere in Russia. The results of the study can be used as a basis for further implementation of governmental measures for ITT sphere modernization and reduction for regional differences.

Key words: Information telecommunication technologies; Information society; Digital divide

1. Introduction

Due to successes in implementation of actions and legal regulation measures, Russia managed to progress significantly in most of the international rankings which evaluate readiness for information society and level of its development. However, consolidated indices and cross-country comparisons show that the IT-sphere in Russia is still underdeveloped, it falls behind the world leaders, and the potential of already existing infrastructures and technologies is not achieved. According to the International Telecommunication Union, in the year of 2015 Russia ranks 45th in the Information Technology Development Index (Measuring the Information Society Report, 2014). For certain indicators of ITT development, Russia is amongst world-leading countries. It is of key importance that one of such indicators is price affordability of information technologies which allows reducing the digital divide between different social strata of society. Bridging of the "digital divide" among constituent entities of the Russian Federation and prevention of isolation of individuals and social groups were one of the expected results of implementation of the Information Society (2011-2020), the Russian Federation government program ratified by the Government Resolution dated April, 15, 2014 under № 313 (State Program "Information

Society (2011-2020)", 2014). The indicator of "Reduction of differences among the Russian Federation constituent entities on integral indicators of information development" is considered the government program benchmark to evaluate attainment of the expected result. As of the end 2014, the level of differentiation of the Russian Federation constituent entities on integral indicators reduced from 4 times in the year of 2010 to 2.3 times in the year of 2014, which proves a high degree of effectiveness in solving the issue of digital divide. Therefore, it is highly possible that benchmarks of this indicator defined by the Strategy of the Information Society Development in the Russian Federation till 2015 (reduction of differentiation rate among constituent entities of the Russian Federation on integral indicators up to 2 times) (Strategy for the Development of Information Technologies Sector in the Russian Federation for 2014-2020 and till 2025, 2013; Dobrolyubova et al., 2015).

2. Analysis of informatization state level of regions

During the period of 2011-2014, the information technologies access indicators have risen significantly due to implementation of the measures of the Information Society (2011-2020), the Russian

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Federation government program aimed at creating information telecommunication infrastructure of information society. Readiness and interest of citizens for using Internet possibilities is shown in the trend data of the “Ratio of households with Internet access from their home PC” indicator. Values of this indicator went up from 41.3% in 2010 to 67% in 2014 (1.6 times), at the same time the growth of proportion of households with Internet access in the total quantity of households was even higher - 69.9% (Table 1).

According to the data of information society development monitoring, 67.0% of Russian households had Internet access from their home PC in 2014, being more than 1/3 higher than the level of the year 2010 with the value of 20.7%. At the same time, 64.1% of households had broadband Internet access, being 13.5% more than the previous year

(Monitoring of Information Society Development in the Russian Federation). Proportion of active Internet users in the Russian Federation in 2014 was 64.9%, being 1.3 times higher than the level of 2012.

According to the International Telecommunication Union (hereinafter - ITU), during the years of 2010 - 2014 the quantity of wireless broadband Internet access subscribers per 100 people of Russia grew up 100 times. The quantity of fixed line broadband Internet access subscribers per 100 people in 2014 increased by 41.8% in comparison with 2011, and amounted to 17.3 subscribers. A positive trend is also seen in regards of the quantity of mobile broadband access subscribers. During the years of 2011-2013, the indicator rose almost 1.5 times and amounted to 70.9% (47.8% in 2011, 63.3% in 2012) (Measuring the Information Society Report 2014).

Table 1: Trend data of Internet accessibility for households, %

Indicator	2010	2011	2012	2013	2014
Ratio of households with Internet access from their home PC in the total quantity of households, %	41.3	50.2	59.1	65.1	67.0
Proportion of households with Internet access in the total quantity of households, %	48.4	56.8	60.3	69.1	69.9

According to the Russian Federal State Statistics Service, the proportion of companies using broadband access to “Internet” information telecommunication network in 2014 was 81.2%, being 24.5% higher than in 2010. At the same time the ratio of companies using Internet access with the speed not less than 2 Mbit per second increased 2.1 times in 2014: from 22.4% in 2010 to 49.1% in 2014.

As for the development of information environment, there is a significant growth in the indicator of the level of museum materials preservation. As of the end of 2014, the proportion of digitalized museum materials amounted to 25.1% (being 22.9% in 2013, 19.6% in 2012).

The number of museum pieces included into electronic catalogue during 2010-2014 increased 1.6 times, its proportion in 2014 amounted to 11.0% of the total scope of museum funds (6.1% in 2011). The proportion of libraries providing access to library full-text electronic resources via Internet in 2014 was 5.9% of the total number of libraries (2.5% in 2011).

Significant results have been achieved in development of IT-industry in education and health care spheres. As of the end of 2014m there were 13 personal computers used for educational purposes per 100 students of state and municipal general education institutions, whereas in 2010 there were 6. The proportion of health care institutions using Internet in 2014 amounted to 97.2% of the total number of health care institutions (being 93% in 2010) (Partnership on Measuring ICT for Development).

Despite the positive trend of Russian regions development in general, the rate of differentiation of constituent entities on integral indicators of information development as of the end of 2014 is

estimated at 2.3 times (2.8 times as of the year of 2013) (Fig. 1) (Monitoring of Information Society Development in the Russian Federation).

In order to get a better assessment of inter-regional differences, values of core indicators should also be used apart from the integral indicator presenting an overall assessment of Russian regions differentiation on several indicators at once. Such an approach helps to find out the strengths and weaknesses of information telecommunication technologies in certain territories and regions. On certain indicators being part of integral indicator, the rate of differentiation of regions is considerably higher.

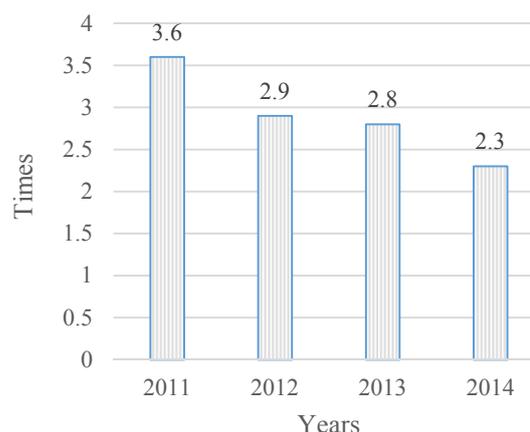


Fig. 1: Trend data of “Reducing the differences among constituent entities of the Russian Federation on integral indicators of information development” indicator for the years 2011-2014 in total in Russia

As of the end of 2014, the rate of differences on the number of personal computers used for

educational purposes per 100 students of state and municipal general education institutions is 12 times and the proportion of health care institutions using Internet in the total number of health care institutions is 1.8 times. The number of telephone sets including the public pay telephone sets per 100 people differs more than 40 times and the number of public Internet access points differs 19.3 times. The differentiation rate on "Proportion of companies using broadband Internet access" indicator amounts to 1.6 times. The difference in the rate of penetration of mobile (cell) telephone communication per 100 people differs 2.2 times. The differentiation on the ratio of households with Internet access amounts to 1.75 times.

At the backdrop of considerable regional differentiation there is a problem of "divide" between urban and rural settlements. The analysis of broadband Internet access services penetration rate shows that there are considerable differences of this indicator in urban and rural areas. The rate of

broadband access in cities reaches 95%, whereas in rural areas it is often not higher than 20%. In the last years the local telephone network digitalization rate in urban and rural areas has risen remarkably. While according to the data of 2010 the digitalization rate in urban areas was 83%, in 2014 it was 90.3% (rate of growth was 108%). Rural areas in the same time period were marked by an even quicker growth of digitalization rate: from 63.9% to 75.1% (rate of growth amounted to 117.53%) (Table 2).

Herewith, the proportion of rural population centers with telephone lines in the total number of rural population centers has reduced by 1.0% (from 90.1% to 89.1%).

Such differences in main indicators of communication and information development define in general the differentiation of information and telecommunication technologies industry development in regions and the unevenness of information society development in the scale of Russia.

Table 2: Trend data of telephone network digitalization in Russia, %

Indicator	2010	2011	2012	2013	2014	Rate of growth (from 2014 to 2010)
Local telephone network digitalization rate - total:	81.0	85.3	86.4	87.9	88.7	109.51
- in urban areas	83.0	87.6	88.5	89.7	90.3	108.80
- in rural areas	63.9	65.9	67.3	72.5	75.1	117.53

3. Factors determining the rate of differentiation of regions

Due to existing differences of information and telecommunication technologies sphere development, each region has its own potential for further development which defines the influence of ITT on social and economic sphere.

Grouping of regions by the rate of information society development can serve as a basis for carrying out further government measures for ITT sphere modernization and reduction of regional differences. The information society development rates typical for regions of Russia can be defined by allocating constituent entities which resemble most and by using classifying groupings on ITT sphere indicators under consideration. In the practices of statistics for such tasks the tools of cluster analysis are used, they allow to classify the objects of target population into groups with homogeneous composition by relating each unit of population according to the feature set so that the object is included into only one group.

Evaluation of the "Reduction of differences among constituent entities of the Russian Federation on integral indicators of information development" indicator is carried out on the basis of core indicators (broken down by constituent entities of the Russian Federation):

- Fixed telephone line density (including public pay telephones) per 100 people, pcs;
- Penetration of mobile (cell) telephone communication, pcs;

- Number of public Internet usage (access) points, for 10 000 people, units;
- Ratio for households with Internet access in the total number of households, %;
- Proportion of companies using broadband Internet access in the total number of companies, %;
- Number of personal computers used for educational purposes per 100 students of state and municipal general education institutions, pieces;
- Proportion of health care institutions using Internet in the total number of health care institutions, % State Program "Information Society (2011-2020)" (2014).

In order to split those 76 Russian Federation constituent entities which were left after excluding discordant observations (the city of Moscow and the city of St. Petersburg, Sakhalin and Amur regions) into homogenous groups, we used the method of k-averages to get three clusters containing 31, 8 and 37 regions respectively. When choosing the best way of splitting we took into account the values of statistic criteria (correlation of between-group and within-group variance), and also a possibility of carrying out content-related economic interpretation of clusters (Abdrakhmanov et al., 2015). Variance analysis results have justified the feasibility of such splitting.

As seen on Fig. 2, average values of information society development level indicators for the four clusters under consideration are enough differentiated, so that we can draw a conclusion that

splitting of regions into homogeneous groups have

been done in a correct way.

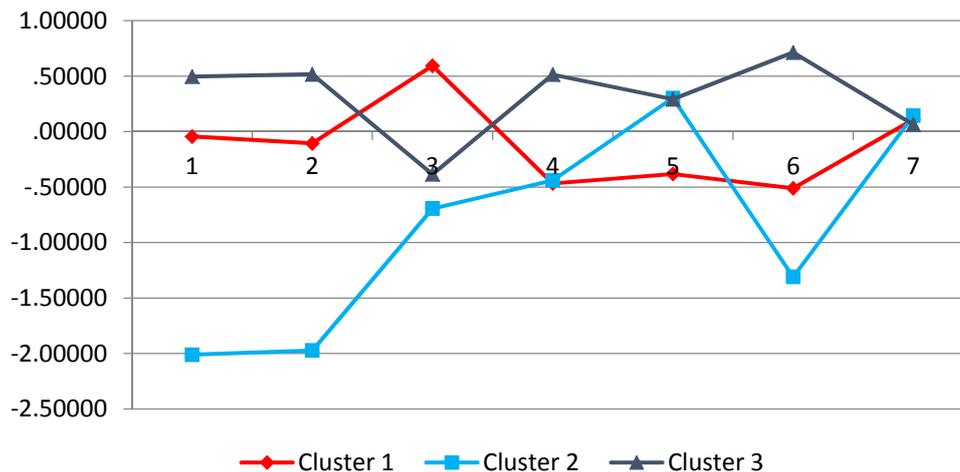


Fig. 2: Average values of information society development level indicators in 2014 in Russia broken down by regions into three clusters

As evident from the Table 2, regions of the second cluster are characterized by low in comparison with other clusters values of information society development level indicators. In three regions of the second cluster - the Chechen Republic (1.3), the Republic of Ingushetiya (1.5) and the Republic of Dagestan (1.8) - the number of fixed line telephone sets does not exceed 2 pieces per 100 people. Despite the low values of telephone set density, the Republic of Ingushetiya is the leader of the second cluster on proportion of households with Internet access; more than 71% of all households in this republic are connected to Internet, which can be compared to the average value of Internet penetration in the first cluster and is 10.4 percent points higher than the average cluster value. The highest telephone set density among the regions of the second cluster holds the Stavropol territory, where there are 19 telephones and public pay telephones for 100 people, which is twice as high as the average cluster value of providing the people of this region with fixed telephone lines. In the second cluster high values of cell communication penetration are typical for the Stavropol territory with more than 156 subscription contracts per 100 people, being 20% higher than average cluster value. Regions of the second cluster deviate in the rate of fixed telephone lines density not more than ± 6 subscribers, and in the rate of mobile telephone connection penetration not more than ± 13 subscribers from the average cluster value.

Also low values of numbers of public Internet access points are typical for regions of the second cluster, being 19 units per 100 000 people in average. The Republic of Tyva has the best results of this indicator having 34 public Internet access points per 100 000 people of the region and being equal to the average value of the first cluster, which features the highest value of public Internet access points. As for the level of accessibility of Internet for households, regions of the second cluster have an average of 65%, while the highest proportion is typical for the Republic of Ingushetiya (more than

71%) and the lowest - for the Republic of Dagestan (only 53% of households in Dagestan have Internet access). Regions of the second group deviate in the proportion of households Internet access not more than 8% from the cluster average value.

Along with that, regions of the second subset have a higher proportion of companies using broadband Internet access. 92.5% of companies in the Republic of Adygeya have Internet access, this being the highest value of this indicator in the second cluster, which is 12% higher than the average cluster level of ITT usage by companies. A high rank of ITT usage by companies in the second cluster is the Republic of Ingushetiya, 90.8% of the companies use broadband Internet access. Meanwhile, the numbers of PCs per 100 students of general education institutions in the Republic of Ingushetiya and then Chechen Republic are 3 and 4 units respectively, which is 3.7-2.8 times lower than in the Republic of Dagestan with the highest level of computer availability for students among the RF constituent entities in the second cluster. Regions of the second subset show the highest results in proportion of health care institutions Internet connection - 98%. All the health care institutions in four regions of the second cluster - the Republics of Adygeya, Dagestan, Ingushetiya and Tyva - use Internet. The lowest level of Internet usage in the health care institutions of the second cluster is in the Kabardino-Balkarian Republic (93.6%). Regions of the second cluster deviate in the level of PC availability in the education process not more than ± 3 units and in the level of ITT usage in the health care system not more than $\pm 2.6\%$ from the cluster average value.

The first cluster comprising 41% of the regions of the set under consideration takes an intermediate place between the second and the third clusters. The cluster average value of number of mobile subscriptions per 100 people of the region in the selected group is 23 subscription contracts being 3.6 times higher than the rate of the second cluster and amounting to 85.6% of the third cluster rate.

Deviation of the regions in the number of fixed line subscriptions is the lowest among all the clusters under consideration and is not higher than 17.8%. As for the density of the fixed telephone lines, 26% of the second cluster regions - the Republics of Kalmykiya, Altay, Buryatiya, Sakha, the Chuvash Republic, Zabaikalsky Territory, Kursk and

Astrakhan regions - do not exceed the level of the Stavropol Territory (19 subscriptions per 100 people), which belongs to the regions of the second group. The highest numbers of telephone sets and public pay telephone sets per 100 people in the first cluster are in Kostroma and Pskov regions - 29 subscriptions per 100 people.

Table 3: Average values of information society development level broken down by three clusters

Indicator	Cluster number		
	1	2	3
Number of telephone sets (including public pay telephones) of the public use telephone network per 100 people, pcs	23	9	27
Number of connected cell telephone network terminals per 100 people, pcs	170	130	184
Number of public Internet access points located in post offices per 10 000 people, units	3	2	2
Proportion of households with Internet access in the total number of households, %	64.4	64.6	70.7
Ratio of companies using broadband Internet access in the total number of companies, %	77.8	82.5	82.4
Number of personal computers per 100 students of general education institutions, pcs	10	7	15
Ratio of health care institutions using Internet in the total number of health care institutions, %	97.8	98	97.5

As for "Mobile network penetration" and "Number of public Internet access points" indicators, 16% and 61% of the first cluster regions on the first and the second indicator respectively do not exceed the maximal values of the second cluster, being Stavropol Territory in the first case and the Republic of Tyva in the second case. However, the first cluster average value exceeds that of the second cluster in such indicators as rate of mobile telephone network development (by 31%) and the number of public Internet access points (1.7 times). The highest numbers of mobile telephone subscriptions are in Smolensk region (198 subscription contracts) and Oryol region (191 subscription contract per 100 people), being 16% and 12% higher than the average value in this cluster. The lowest values of mobile network penetration are in Zabaikalsky Territory, the Republics of Buryatiya and Altay - 139, 145 and 147 subscription contracts per 100 people. At the same time the Republic of Altay has the highest number of public Internet access points both among the regions of the first cluster and in the country in general - 58 public Internet access points per 100 000 people. Tomsk, Kemerovo and Saratov regions have the lowest values in public Internet access points with less than 2 public Internet access points per each 10 000 people.

The first cluster average value of proportion of households with Internet access is almost equal to that of the second cluster and amounts to 64.4%. However, the average value of proportion of companies with broadband Internet access in the first cluster is considerably lower than that in the second cluster and amounts to 77.8%. While the minimal value of the proportion of the companies using broadband Internet access in the second cluster amounts to 67.9% (the Republic of Tyva), the minimal value in the first cluster is 62.3% (the Republic of Sakha). In the regions of the first cluster

in general the education institutions are better provided with PCs than in the regions of the second cluster. The following regions stand out as of this indicator: Volgograd region (14 units), the Republic of Kalmykiya (13 units), the Chuvash Republic, Orenburg region and Ulyanovsk region (12 units). Also unlike the second cluster, all health care institutions in nine regions of the first cluster use Internet. The first cluster regions deviate in the level of PC availability in the education process not more than 14% and in the level of ITT means usage in health care not more than 3.5% from the cluster average value.

The third cluster comprises 37 regions making 49% of the set under consideration and is marked by high indicators of information society development level. So, for example, in the number of telephone sets per 100 people the average value of the third cluster exceeds the second cluster average value 3 times and amounts in average to 27 subscriptions per 100 people. The highest fixed telephone line density have Chukotsky Autonomous District (40 subscriptions) and Murmansk region (39 subscriptions per each 100 people). These regions also feature a high level of mobile network penetration being 1.4 times higher than that of the second cluster regions and 8% higher than the first cluster regions - 184 subscription contracts per 100 people of the region. Regions with the highest mobile telephone network density are Magadan region (226 subscriptions), Krasnodar Territory (218), Tyumen region (208) and Murmansk region (206). At the same time, the number of mobile subscription contracts in Chukotsky Autonomous District and Kurgan region are considerably lower than the rate of the first cluster and the maximal value of the second cluster, being 159 and 141 subscriptions per 100 people.

As for the number of public Internet access points, the third cluster regions hold the middle position - 22 public Internet access points per 100 000 people, which is 16% higher than the indicator of the second cluster but making 69% of the first cluster regions value. The average value of proportion of households with Internet access in the third cluster regions exceeds the average value of the first cluster by 10% and of the second cluster by 9%. Madagan and Kaliningrad regions with 86% and 82% respectively hold leading positions of this indicator, the lowest value has Ivanovo region with 62%. The Republic of Kareliya and Sverdlovsk region lead in the proportion of companies using broadband Internet access with 91.9% and 91.4% respectively, while the cluster average level is 82%. The leaders of the third cluster of PC availability in education institutions are the Republic of Tatarstan (24 computers per 100 students) and Tyumen region (22 computers per 100 students). 100% of health care institutions in 27% of the third cluster regions use Internet. The Kamchatsky Territory with 79.2% has the lowest proportion of Internet use in health care institutions (Abdrakhmanov et al., 2015).

4. Prospective of region development

In order to eliminate digital divide and provide equal access to modern communication means on the entire territory of the country, the Ministry of Communications and Mass Media of the Russian Federation carries out works and improves the legal norms and regulation for development of communication networks of LTE and UMTS standards in small settlements as a part of universal service system reform (Ministry of Telecom and Mass Communications of the Russian Federation, 2014).

In order to solve the problem of providing modern communication services to people in small settlements in 2014 a reform of universal service has been initiated aiming at transition from the use of public Internet access points to individual subscriptions.

The Federal Law dated 03.02.2014 № 9-FZ "On Introduction of amendments to the Federal Law "On Communications" introduced a number of amendments to the Federal Law dated 07.07.2003 № 126-FZ "On Communications" aiming at extension of the list of universal communication services (Strategy for Information Society Development in the Russian Federation, approved by the President of the Russian Federation, 2008). It has set requirements for pulling optic fiber communication lines into settlements with population from 250 to 500 people in order to make individual broadband access service subscription possible at the speed not less than 10 Mbit/sec per household. It should be also noted that a state-regulated subscription tariff for broadband access at 10 Mbit/sec will be set lower than the average market rate in order to provide high affordability of the service to all sections of the population. Providing access to modern

communication services is the most critical issue. Federal executive bodies have defined the priority list of constituent entities of the Russian Federation which are in the highest need for modern communication means providing.

As the result of universal service reform, more than 200 000 km of optic cable should be pulled in order to make modern communication services accessible in more than 13800 small settlements with the total population of more than 5 million people.

Development of modern radio technologies of LTE and UMTS standards allow for effective solution of the problem of digital divide providing broadband internet access services for people living in small settlements where it is difficult or not feasible to build fixed broadband Internet access networks. Statistical data show a high rate of UMTS networks penetration in towns with population more than 10 000 people and a considerable rate of penetration of LTE standard networks. The LTE and UMTS standard communication networks penetration rate in settlements with the population less than 10 000 people is at the moment very inconsiderate. LTE and UMTS standards communication networks in such settlements are built in the areas belonging to large cities agglomeration. According to the Ministry of Communications and Mass Media of the Russian Federation, the average rate of LTE and UMTS standard communication networks penetration in settlements with the population less than 10 000 people does not exceed 10-12% of the number of such settlements (Klochkova and Ledneva, 2014).

In 2013-2015 the Ministry of Communications and Mass Media of the Russian Federation have carried out a complex of works aimed at improving legal regulations and norms in order to speed up the process of implementation of LTE and UMTS standards modern radio technologies in settlements with the population less than 10 000 people. The decisions of the State Radio Frequency Commission taken in 2013 and 2014 have stated a principle of technological neutrality of using the radio frequency spectrum for radio frequency bands in ranges of 450/900/1800 MHz. It allowed communication providers to implement modern radio technologies of LTE and UMTS standards in the bands of radio frequency spectrum that they already had and where outdated standards were developing. This initiative is of high demand on behalf of communication providers and helps to eliminate digital divide.

High costs of communication networks construction and high risks that investments will not pay back pose a considerable barrier for communication network development in small settlements. One of the means of communication provider costs reduction is a joint use of communication means which helps to save a lot on construction and operation of communication means and to reduce the payback period of the projects to acceptable levels. In order to solve this problem, in 2014 the Government of the Russian Federation and the Ministry of Communications and Mass Media of

the Russian Federation have set a possibility of joint use of radio access networks (RAN Sharing) for base stations of all standards (GSM/UMTS/LTE). Therefore, mobile providers can now cooperate when building communication networks and reduce capital and operation costs, that being especially important in present economic conditions when constructing communication networks in small settlements.

Therefore, implementation of initiatives to speed up the penetration of LTE and UMTS standards communication networks in small settlements prove to be of high interest on behalf of mobile providers to such regulation approaches taking into account that they bring positive effect in solving issues of both state and business. It should be mentioned that more than 26% of the total population of Russia (or 37 mln. people) live in settlements with the population less than 500-10000 people, making the issue very topical and its solution in part of elimination of digital divide very critical. A joint work is needed here on behalf of the state to pull the optic fiber lines to the settlements with the mentioned above population and on behalf of the mobile providers to join in construction of low-power base stations of LTE and UMTS standards. Implementation of the mentioned above measures will help to eliminate digital divide in the Russian Federation.

5. Conclusion

The conducted analysis shows that the accumulation of regions is characterized by a considerable degree of differentiation in information society development. Each region has its own potential for further growth of ITT influence on social and economic sphere due to existing peculiarities of ITT sphere development. However, as the ITT infrastructure complex is formed by the ITT sector production, it is likely that different levels of infrastructure development and ITT use are correlated to corresponding levels of ITT sector development. Identifying such a correlation will help to broaden the understanding of the process going on in the industry under consideration.

As the analysis has shown, the broadband Internet access in cities is considerably higher than in rural areas. The reasons of low penetration of broadband Internet access in rural areas are the absence of optic fiber lines which connect small settlements with cities and regional centers; construction of fiber optic lines and mobile communication networks of LTE and UMTS standards in small settlements are in most case not feasible for communication providers; low rate of penetration of LTE and UMTS standard mobile networks, which is connected with large investments including providing power and construction of access roads.

Providing modern communication services to the population is one of the key tasks of the state policy. Solution of this task will eliminate the digital divide,

that is will provide modern communication means (fixed and wireless broadband Internet access, telephony and IP-TV) to people living in large cities and small settlements. Development of broadband Internet access networks is a powerful driver which allows for implementation of ITT in all sectors of economy and therefore brings positive effect in speeding up the implementation of modern production technologies, raising the quality of the production, creating new working places and thus to growth of the Gross Domestic Product (GDP).

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