AVAILABILITY OF NGA MARKET POTENTIAL INDICATORS IN THE WESTERN BALKANS

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Abstract:

Broadband residential access to next-generation networks (NGA) with bit-rates greater than 100 Mbps is critical in terms of data volume growth and approach to the gigabit networks implementation. Reliable demand forecasting of the required bandwidth for the residential market is a necessary input for the successful planning of the communication network resources. This paper investigates and compares the availability of the data suitable to be used as market indicators for several Western Balkans countries related to the application categories. This study could be useful for the market potential estimation and development of the NGA demand forecasting model.

Keywords:

NGA, market potential, socio-demographic factors, planning, forecasting.

INTRODUCTION

In the last few years, the world is rapidly transforming towards new technological forms related to the use of intelligent technologies, cloud infrastructure, thus creating a smart environment adapted to modern life demands. Although 5G technologies are widely implemented and 6G solutions are under research and development, the residential market still highly depends on fixed Next Generation Access Networks (NGA). The EU Digital Agenda [1] has practically reached its goal, regarding the facts that overall fixed broadband coverage for the EU27 reached 97.4% at the end of June 2020 (i.e. more than 186.8 million of EU households had access to at least one fixed broadband access technology), the average coverage (availability) of NGA services including VDSL, VDSL2 Vectoring, DOCSIS 3.0, DOCSIS 3.1 and FTTP reached 87.2% of households, while overall FTTP/DOCSIS 3.1 technologies currently capable of supporting gigabit speeds reached the coverage of 59.3% [2].

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It is expected that new user demands will affect the residential market regarding future access speeds up to 300Mbps, 1Gbps or higher until 2030 [3], [4], [5]. At the moment, there are a lot of test programs related to the implementation of 5G technologies to the Fixed Wireless Access (FWA) at the residential market [6]. However, global events in the last few years have affected FWA technology that is not yet ready for widespread implementation [7]. In addition, the new generation of WiFi technology, including WiFi 6 (2.4 GHz and 5 GHz) and WiFi 6E (6 GHz), based on IEEE 802.11ax [8], gives comparable enthusiasm [9], as well. Accordingly, there are several works related to FWA and WiFi 6, which could be considered as more suitable solutions [9], [10].

It is clear that the COVID-19 pandemic affected the global social way of life. The lockdown throughout Europe, as well as in the rest of the world, erased the line between business and residential users and shifted the Internet services closer to the residential part of the market. Accordingly, the general requirements for residential access networks were changed instantly in terms of higher speeds and more symmetrical access networks to provide advanced applications, such as HD and UHD video streaming, video communications, cloud-based applications, as well as Virtual Reality (VR) and Augmented Reality (AR) games. In such conditions, the overall environment of households is becoming of great importance. Accordingly, there is a need to modify the traditional forecasting models depending on the forecasted broadband market potential. Also, it should be identified how the usage of different applications and demographic households structures affect the bandwidth demands.

The broadband NGA technologies (FTTPs and DOCSIS (3.0 and 3.1)) remain the main technologies at the residential market regardless to the traditional WiFi technologies are widely used (ranging from IEEE 802.1n to IEEE 802.1ac).

Although the Western Balkans (WB) countries raising the number of households with broadband access, it will take additional time before percentages corresponding to the EU's Digital Agenda targets will be reached. Reliable forecasting of the required bandwidth for the residential market is highly important for successful network planning of all communication resources. This paper points out the need for development of new market potential models. Therefore, the key parameters necessary for the residential market potential at the WB region are considered.

This paper aims to analyse the residential telecommunication market of the Western Balkan and to investigate the availability of the relevant data for the NGA market potential model. Accordingly, this paper discusses the relevant market indicators related to the applications that would be used by residential users. The relevant sources of data related to these indicators will be considered.

The rest of the paper is structured as follows: a brief review of the relevant literature is given in the Section 2 including two important approaches for assessing the NGA residential market potential. Section 3 considers the availability of relevant market indicators for the WB countries followed by a brief summarized discussion. Finally, the concluding remarks are given in the last section.

2. A BRIEF LITERATURE REVIEW

2.1. MARKET POTENTIAL

The optimal capacity planning of broadband NGA infrastructure should be based on the forecasted traffic demand for the residential telecommunication market. The broadband market potential has to be considered as the main forecasting parameter since it reflects the entire size (i.e. upper limit) of the market for a given set of telecommunication services and applications for a specific time horizon.

The market potential represents all the possible residential users during the longer time horizon. The size of the market potential is probably the most critical element in forecasting matters. It could be considered as a composite parameter, because it includes different indicators, ranging from the number of households, demographic population structure, such as birth rate, gender, education, economic rate of households, up to the presence of competitions at the market, etc. Most of the forecasting models in literature imply the constant market potential, which means that the availability of broadband services remains unchanged throughout the entire life cycle. However, it is not relevant for the telecommunication infrastructure because of its expanding during the time according to the investment planning strategies. Various approaches could be considered in terms of market potential, such as those given below.

From the mathematical point of view, different assumptions are governing the shape of the market potential. In some papers, the market potential is presented as the exponential function of time [11], [12], while a

dynamic market potential is introduced by [13]. Some works introduce a variable structure of the market potential [14], [15], [16], [17]. In some cases, it is exogenously determined as a function of observed variables [14], [15], [16], [18], [19]. Some efforts are necessary for the correct specification of the main drivers (price, number of households with special facilities, number of competitors, number of retailers, threshold probabilities, etc.) and suitable transformation in order to obtain a reasonable correspondence with the adoption process scale. Moreover, there is a model that gives market potential as a function of the external and internal market factors, such as socio-economic factors, changes in population, marketing activities, etc. [14].

2.2. SELECTION OF APPROACHES FOR ASSESSING THE NGA BROADBAND MARKET POTENTIAL INDICATORS

This subsection gives some approaches for assessing the NGA broadband market potential indicators. In order to identify and select target applications and structure of digital services, the socio-economic characteristics of each country should be considered. For example, before launching of new services telecommunication operators should target customers with higher incomes and stronger educational backgrounds in order to minimize time to return on investment. The starting point for demand forecasting is behaviour of the end-users. How much broadband demand depends on the structure of digital services? Looking at the household level as the point of interest regarding the NGA broadband market potential, the approaches applied in UK and Australia attracted the attention [20], [21]. These reports consider the required bandwidths of applications used in fixed locations. The forecasting model for bandwidth demand combines the various applications with user profiles, which are further combined into various household types (Table 1).

Another approach presents the WIK market potential model that encompasses a slightly wider set of applications [22]:

- Basic Internet,
- Home office/VPN,
- Cloud Computing,
- State of the Art Media and Entertainment (4k, 3D, HD)…,
- Progressive Media and Entertainment (8k, …),
- Communication,
- Video Communication (HD),
- Gaming,
- E-Health,
- E-Home/E-Facility and
- Mobile Offloading.

Both approaches recognize certain types of applications as the main indicators of broadband demand increase including cloud-based applications, gaming, VR/AR, video streaming, telemedicine and file management, as well. It is expected that the bandwidth requirements for the most attractive applications will grow at an annual rate of around 30%, including future e-health applications together with telemedicine services [22], which are likely to require more advanced forms of connectivity including additional bandwidth, service quality and reliability.

The WIK model considers the use of mobile technologies to provide broadband connections to households, also. Along with applications, it recognizes the following six user profiles [22]:

- Sceptical outsider,
- Occasional user,
- Professional user,
- Trend user,
- Home office user, and
- Avant-gardist user.

Primary	Secondary	Web	Low bandwidth
Internet TV (SD, HD and 4K) HD video calls YouTube etc. Streamed gaming / HD interactive	Cloud storage Content downloads P2P / BitTorrent Mobile OS downloads Software downloads Non-HD video calls Content uploads	Surfing, excluding the use of video sites such as YouTube	Covers a range of applications not explicitly treated, including e-metering and other machine-to-machine, online radio, online gaming, etc.]

Table 1 - Statistical analysis results.

These profiles are ranging from older persons, who very rarely use the Internet and computers and express negative attitudes towards the use of modern information and communication technologies (thus have minimal bandwidth requirements), up to users with innovative digital equipment having strong abilities and skills to work with software and hardware, including heterogeneous structure of persons, from professionals with a high level of professional education to younger people who spend a significant amount of time in gaming applications, which have extremely high bandwidth requirements [22].

It has to be noted that none of these approaches take into account technical constraints, in terms of the required bandwidth regarding the infrastructure.

The economic constraints related to the explicit willingness of the end-users to pay additional bandwidth were not taken into consideration, as well. Having in mind the abovementioned, as well as the fact that the average GDP of the WB countries is at the level of 35.6% of the EU27 GDP average [23], the authors find out that these constraints could be the main gap to massive NGA adoption. These conclusions are partly aligned with the findings presented in [24], regarding the economic aspect. Therefore, the authors started a broad research in order to develop a new model of the NGA broadband market potential, such as one given in [22], but tailored for the particular economic constraints and user willingness regarding the usage of various applications at the broadband residential market in the countries of the WB region. Among two presented approaches, the authors also find out that the approach for market potential model presented in [22] gives more suitable indicators of various applications needed for broadband demand forecasting in the countries of the WB region.

In order to examine broadband applications by identifying some important factors that influence the decision to adopt broadband services, the first step of this broad research and the aim of this paper is to investigate the availability of the relevant data in different WB countries that could be used as suitable indicators for the new model of the NGA broadband market potential, tailored for the WB region.

3. INDICATORS AVAILABILITY IN THE WESTERN BALKANS COUNTRIES

In order to meet essential requirements for development of NGA broadband market potential model for the WB countries, this paper considers the availability and applicability of the relevant indicators listed in Section 2. Generally, development of the broadband market potential at the national level in each WB country at least could be based on three statistical databases sources: national statistical office, telecommunications national regulatory authority, as well as the European statistical office – Eurostat [25].

In this chapter, an analysis of national data repositories is performed, regarding the possibility to be used as statistical data sources for abovementioned indicators. The analysed results are presented in Table 2 for each country. The Eurostat source is noted along with the corresponding data indicator that exists in the Eurostat database. Datasets marked with *2 sign were published in 2018 only, while datasets marked with *3 sign were published in 2020 for the first time. Datasets and sources marked with the * sign are proposed to be adopted as the data source. Datasets and sources marked with (!) sign are proposed to be revised and enriched with some additional data, while datasets and sources marked with (!!) could be possibly relevant to be used as Digital Economy and Society Index (DESI) indicator. DESI is a composite index that summarises relevant indicators on digital performance and tracks the evolution of EU member states in digital competitiveness. DESI consists of 5 components: Connectivity, Human capital, Use of Internet, Integration of digital technology and Digital public services [26].

All DESI indicator abbreviations are used according Methodological note (2020) [27].

3.1. ALBANIA

Along with the Eurostat, in Albania there are two national data repositories, which are available to be used as data sources:

- The Institute of Statistics (INSTAT) [28] and
- The Electronic and Postal Communications Authority (AKEP) [29].

Results of telecommunications market analysis in Albania (Table 2) show that INSTAT Reports were identified as the primary data source for five indicators.

Reports related to Cloud Computing indicator could be proposed to be used for the DESI 4a1 indicator complement, as well. Also, in the case of two indicators, INSTAT Reports were recognized as complementary data sources. There is a possible lack of data sources related to some indicators.

3.2. BOSNIA AND HERZEGOVINA

Beside the Eurostat, there are two federal data repositories which are available as data sources:

- The Agency for Statistics of Bosnia and Herzegovina (BHAS) [30] and
- Communications Regulatory Agency (RAK) [31].

Results of telecommunications market analysis (Table 2) in Bosnia and Herzegovina show the lack of data that are related to the Basic Internet indicator, although RAK Annual Report contains only implicit data (items 35-40). For other indicators, Table 2 gives the datasets that could be used as available data sources. BHAS Report related to Home office/VPN indicator could be proposed for DESI 3b4 and 3c3 indicators complements, as well. RAK and BHAS repositories are incomplete data sources for some indicators (marked with (!) sign in Table 2). There is a possible lack of data sources related to the Mobile Offloading indicator.

3.3. MONTENEGRO

Beside the Eurostat, there are two national data repositories which are available as data sources:

- The Statistical Office of Montenegro (MONSTAT) [32] and
- Agency for Electronic Communications and Postal Services of Montenegro (EKIP) [33].

The results for telecommunications market analysis in Montenegro (Table 2) are obtained with limited accuracy. Although there is a lack of annual reports, corresponding data could be obtained from January reports. For most indicators EKIP could be proposed as a relevant data source (with limited accuracy). Corresponding data could be obtained from the Research Section of the EKIP repository.

Country / Indicator	Albania	Bosnia and Herzegovina	Montenegro	North Macedonia	Serbia
Basic Internet	AKEP (Annual Reports), INSTAT Reports	RAK (Annual Report, items 35-40) (!)	EKIP	AEK Annual Report, BCO (Connectivity indicators in DESI aligned format), MAKStat	DESI (1b1,1b2)
Home office/VPN	Eurostat: ISOC_IW_HEM (I_WHDAY) (*2), INSTAT Reports	BHAS Report (3b4, 3c3* (!!)), Eurostat: ISOC_IW_HEM (I_WHDAY) (*2) ISOC_EC_IBOS, ISOC_EC_CE_I (*3)	MONSTAT reports (3b4, 3c3, 5a4* (!!)), Eurostat: ISOC_IW_HEM (I_WHDAY) (*2), ISOC_EC_IBOS, ISOC_EC_CE_I (*3)	MAKStat, Eurostat: ISOC_EC_IBOS, ISOC_EC_CE_I (*3)	DESI (3b4, 3c3, 5a4*) Eurostat: ISOC_IW_HEM (I_WHDAY) (*2) ISOC_EC_IBOS, ISOC_EC_CE_I (*3)
Cloud Computing	INSTAT Reports (4a1 equivalent only * (!!)), Eurostat: ISOC_CICCI_USE (2018, 2019)	BHAS Report (!) (4a1,4a4,4b1,4b2,4b3 equivalents (!!)), ISOC_CICCI_USE (2018-2020)	Eurostat: ISOC_CICCI_USE, ISOC_CI_AC_I*	MAKStat, Eurostat: ISOC_CICCI_USE, ISOC_CI_AC_I	DESI (4a1,4a3,4a4,4b1, 4b2,4b3*), Eurostat: ISOC_CICCI_USE, ISOC_CI_AC_I
State of the Art Media and Entertainment (4k, 3D, HD)…	INSTAT Reports	BHAS report (!)	EKIP	MAKStat, AEK Annual Report*	DESI (3b2, 3b3* (!))
Progressive Media and Entertainment (8k, …)	INSTAT Reports	BHAS report (!)	EKIP	MAKStat, AEK Annual Report*	DESI (3b2, 3b3* (!))
Communication	INSTAT Reports	BHAS report (!)	EKIP	MAKStat*	DESI (3b5)
Video Communication (HD)	INSTAT Reports	BHAS report (!)	EKIP	MAKStat*	DESI (3b4)
Gaming	/	BHAS report (!)	EKIP	AEK Annual Report*	DESI (3b2*) (!)
E-Health	ISOC_CI_AC_I (!)	BHAS report (!), ISOC_CI_AC_I (!)	EKIP (!), ISOC_CI_AC_I (!)	MAKStat, ISOC_CI_AC_I (!)	ISOC_CI_AC_I* (!)
E-Home / E-Facility	/	BHAS report (!)	EKIP (!)	AEK Annual Report*	DESI (4a4)
Mobile Offloading	/	/	/	/	/

Table 2 - Data sources for indicators in WB countries.

In the case of Home office/VPN indicator, relevant data could be obtained from MONSTAT and Eurostat as complementary data sources. MONSTAT Report related to Home office/VPN indicator could be proposed for DESI 3b4 and 3c3 indicators complements, as well. Also, Eurostat is proposed as the primary data source for Cloud Computing indicator. MONSTAT and EKIP repositories are incomplete for some indicators (marked with (!) sign in Table 2). Also, there is a possible lack of data sources related to the Mobile Offloading indicator.

3.4. NORTH MACEDONIA

Beside the Eurostat, in North Macedonia there are three national data repositories which are available as data sources:

- The State Statistical Office (MAKSTAT) [34],
- Agency for Electronic Communications (AEK) [35] and
- Broadband Competence Office (BCO) [36].

Results of telecommunications market analysis in North Macedonia (Table 2) were obtained from the national repositories MAKSTAT, AEK and BCO (for the first indicator). AEK could be proposed as the primary data source for two indicators (Gaming and E-Home/E-Facility) and MAKSTAT could be proposed as the single data source for two indicators (Communication and Video Communication). The other five indicators could use two repositories as complementary data sources as well as Eurostat. Also, there is a possible lack of data sources related to the Mobile Offloading indicator.

3.5. SERBIA

Beside the Eurostat, there are two national data repositories which are available as data sources:

- The Statistical Office of the Republic of Serbia (RZS) [37] and
- The Regulatory Agency for Electronic Communications and Postal Services (RATEL) [38].

Serbia fully completed data alignment to DESI and became also a member state of The International Digital Economy and Society Index (I-DESI). Hence, this repository is considered as the primary data source.

Results of telecommunications market analysis in Serbia (Table 2) were obtained mostly from the I-DESI data repositories throughout RATEL annual overviews. Five indicators were proposed to use single DESI indicators as primary data sources, while the other five indicators were proposed to use complementary DESI indicators, along with several Eurostat data sources (aligned with RZS repositories). Datasets related to DESI 3b2 and 3b3 indicators do not clearly distinguish application regarding Gaming (3b2 only), State of the Art Media and Entertainment and Progressive Media and Entertainment indicators, so it is estimated that they need some complementary data in order to improve accuracy. Similar situation is related to the E-health, where lack of data related to the telemedicine service is identified and it should be complemented with an alternative source of data. It is also identified total lack of data sources related to the Mobile Offloading indicator.

3.6. DISCUSSION

The analysis of data availability showed that no WB country has a repositories that fully align to all of the shown indicators. The research confirmed that most relevant data sources in each of the analysed countries are state national statistical offices and telecommunications national regulatory authorities, while North Macedonia has the third data source (BCO), as well. All WB countries collect and publish data in accordance with the adopted local and EUROSTAT methodologies. Additionally, Serbia fully adopted DESI methodology. In some cases, the collection of relevant data was partly hampered by the lack of English versions of the documents. A number of statistical datasets were discovered as possible sources of complementary data to certain indicators. These datasets are proposed to be used either in the purpose of indicators' quality enrichment and/or potentially in the purpose of DESI data alignment (these proposals are marked with a sign (!!)). It should be noted that during this research, the RCC report [39] related to the fulfilment of the criteria of WB countries for the application of DESI methodology was found. The report shows results, which are significantly aligned with the results of our research, regarding availability of DESI datasets by these countries.

The performed analysis of national data repositories found that data sources for few indicators are fully or partially unavailable. Unavailability is mostly related to "newer" indicators, such as Gaming, E-Health and E-Home/E-Facility. It could be caused at the early stage of service adoption by the "invisibility" of certain populations of users (like gamers [40]) who could be described as "innovators" in some forecasting diffusion models [41].

On the other hand, E-Home/E-Facility indicator data could be also deteriorated due to the effect of end-user resistance to the so-called "adoption of the IoT enabled smart-homes" [42]. It was also noticed that E-Health indicator data could vary among countries depending on Telemedicine service involvement [43].

An indicator that suffers the lack of data in all observed countries is the Mobile Offloading indicator that stands for WiFi-Offloading of mobile data [22]. This indicator could be significant since it could produce savings to mobile network operators regarding the CAPEX [44]. Further lookup at given statistics confirmed that there is no useful dataset that could be related to this indicator. In this situation, the model for defining behavioural patterns of smartphone users could be proposed in order to overcome this issue [45].

4. CONCLUSIONS

This paper is a part of the broad research considering the NGA broadband telecommunication market for the WB region. The main outcome is comprehensive review of relevant indicators availability for the WB's national statistic offices and telecom regulatory agencies. These indicators are necessary for market potential estimation and development of reliable NGA demand forecasting model. According to the obtained results, the observed national statistical repositories could provide applicable historical data for corresponding indicators. However, there is a lack of data regarding some "newer" indicators, as well as Mobile Offloading. The identified lack of data should be treated as the significant gap that should be bridged in future works, by discovering alternative data sources and/or ways to create them.

The importance of the broadband residential market especially arose in the COVID-19 pandemic circumstances when all online activities were mostly carried out over residential access infrastructure. Therefore, the reliable network planning activities becomes a priority task in order to meet future demand challenges.

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