MOBILE SERVICES IN BALTIC STATES: DEVELOPMENT TO IMPROVE SUSTAINABILITY AND QUALITY

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Abstract. Mobile communications is a booming sector nowadays, while the average revenue per user is decreasing year over year. Such tendency could create a significant risk factor for development and sustainability of mobile services in Baltics too. Development trends of the Estonian, Latvian and Lithuanian mobile markets, their demand and supply individualities, drivers, challenges and risks are analysed in the article. Predicted development scenario (till 2020) shows the growing demand for mobile services and their increasingly active usage. Operators' challenges and several risks for supply sustainability have recognized; they have to be prevented timely by operators as well by governments and regulators.

Keywords: mobile communications, data transmission, mobile phone networks, mobile services, mobile phones, smartphones.

JEL classifications: L63, L86, L96.

1. Introduction

A rather paradoxical situation is developing in the mobile communications sector that gives us a previously unprecedented opportunity to communicate anywhere and at any time.

On the one hand, it is a booming sector nowadays. Four sequential generations of technology has evolved from circuit switched low quality analogue voice network to digital packet switched broadband technology that ensure secure voice, messaging and data communication services. More and more people use mobile services, the global compound annual growth rate (CAGR) of mobile subscriptions in the last decade was near 20%, to near 6,5 billion by end-2012. Annual growth of total mobile traffic is even more rapid – around 60% in the last years. Development of broadband technologies and increasing shift to data-intensive Internet applications (TV, audio-video, gaming, social networking, etc.) in mobile environment generated an avalanche growth of mobile data traffic; its CAGR is more than 100% over the last 5 years. Mobile penetration (MP) in Europe exceeds the global indicator by more than 50%, Europe's mobile broadband (MB) penetration is threefold the global figure (EC 2012, ITU 2012). The traffic per device is higher than the global one, it is even twofold for middle and high range smartphones (UMTS 2011).

On the other hand, average revenue per user (ARPU), which is one of the basic indicators for mobile operators that show their financial welfare, globally has decreased by 19% between 2007 and 2011. Although total revenues of mobile market are increasing (global CAGR was more than 6% over the last years) due to strongly increasing number of subscriptions and rise in data revenue, this indicator also can not be evaluated as sustainable one. Developing markets grew 12% annually, while developed markets (where penetration is quite near to saturation) – 2,8% only. Voice ARPU is near to flat or even decreasing, data revenue can not compensate these losses yet. European ARPU has fallen even by 20% at the same time due to additional strong regulatory measures initialized by the European Commission (gradual decrease of roaming and interconnection tariffs). This tendency will continue in the coming years, global mobile subscriptions would grow at a CAGR of 7,3% till 2016, while mobile revenues at a 6,3% only; low income customers have become an overwhelming majority of new subscribers.

Market development in the Baltic States is analogous to global trends; table 1 shows the basic indicators of Baltics mobile markets. Mobile data traffic in Lithuania grew at CAGR of 107% in the last 5 years. At the same time revenues and ARPU of mobile operators have declined sharply, e.g., more than by 30% between 2007 and 2012 for Lithuanian operators, although share of revenues from data transmission (GPRS, EDGE, UMTS) has increased from 2,6% till 6,7%. Mobile ARPU of Latvia and Lithuania were among the lowest three in EU in 2010.

Table 1. Basic indicators of Baltics' mobile markets.

	Penetration rates, % of population				ARPU in mobile communications, 2010 (EUR)
	Mobile, October 2011	Mobile broadband, January 2012	Dongles, January 2012	M2M SIM cards, 2011	
Estonia	134%	42,0%	10,7%	3,3%	278
Latvia	158%	29,7%	5,1%	2,2%	71
Lithuania	152%	29,6%	7,9%	2,3%	61
EU27	127%	43,1%	8,1%	5,2%	221

Source: Digital Agenda Scoreboard 2012.

Such tendencies could create a serious risk factor for development and sustainability of mobile services in Baltics – scant investments in network infrastructure and possible decrease of quality of communications and services.

The aim of the current study is to analyze development of mobile services, to evaluate future customers' demand for them and on this base to identify operators' challenges and to forecast sustainability of supply of the mobile services in the Baltic States.

It has to be mentioned that there are incomplete, fragmented, incompatible and even contradictory statistical data on Baltic mobile markets in various sources – national statistics and regulators' data, surveys made by operators and specialized companies, etc. Data of official sources are much more conservative in comparison with self-esteem of operators, while specialised consulting companies are in between of them. Our analysis and forecasts are mainly based on official EU and Baltic State statistics, on information from national regulatory authorities (Konkurentsiamet 2012, SPRK 2012, RRT 2012) as well on conclusions and forecasts of independent experts (e.g., UMTS, Analysis Mason, Maravedis-Rethink, Wireless Intelligence). Data from Baltics' mobile operators, other companies connected with mobile business (e.g., Akamai, Panda Networks) as well from polls organized by PR companies (e.g., GFK, C&R, SKDS), are used as illustrative information.

2. Demand

Generally accepted key factors, which influent development of mobile communications (e.g., increasing connection speeds, supply of advanced mobile devices, more and richer offer of media content and applications), of course are valid in the Baltics too. Nevertheless number of regional individualities makes some specific aspects as contributors of growth (drivers), while some aspects are insignificant, but some of them even braking ones; hereto both current situation and dynamics of development have to be evaluated to assess sustainability of the mobile market.

2.1. Consumers' assessment

Consumers' evaluation of the mobile market, their satisfaction with provided services is a principal factor for assessment of change and development of demand for services. Exactly low (even alarmingly low) satisfaction of consumers with the mobile and Internet services in many EU countries is a substantial indirect evidence of existing problems: 45% of ranking

assessments are in the third ten among 30 various services of general interest, financial, transport and entertainment services; consumers of 4 countries evaluated mobile services as the worst services in their country (DG Health 2012). It becomes clear that satisfaction with current level of services really will discourage the new consumers in some countries.

Direct consumers' evaluation of MB services is not provided, but it can be created using the both assessments of mobile and Internet services:

- development of mobile market characterises level of general preparedness of society for mobile services; people, who already use mobile services and who would benefit of further functional development, is the base for potential MB consumers; the real numbers are slightly misrepresented due to M2M connections (*Internet of things*);
- situation in fixed Internet services market shows the real necessity of society, its motivation for and accept of Internet services; since the MB is considered first of all as tool for access to Internet, it actually shows share of population who potentially could become the MB consumers.

Therefore to assess MB services the normalized MB market performance indicator is created using an integrated variable, which combine mobile market and Internet market indicators:

$$MPI_{MB} = 0{,}01*MPI_{mob}*MPI_{int}$$

where:

MPI_{MB} – normalized MB market performance indicator;

MPI_{mob} – mobile market performance indicator;

MPI_{int} – Internet market performance indicator;

0,01 – the coefficient of proportionality.

There is a distinctive relationship – reduction of MB market performance indicator when MB penetration increases (fig. 1). This correlation is not very strong, nevertheless it exists. Really it shows lower assessment of systems, which capacity become inadequate to their load (e.g., due to insufficient investments in the infrastructure and therefore low quality of services provided); such situation poses some risk factor for sustainability of mobile services in future.

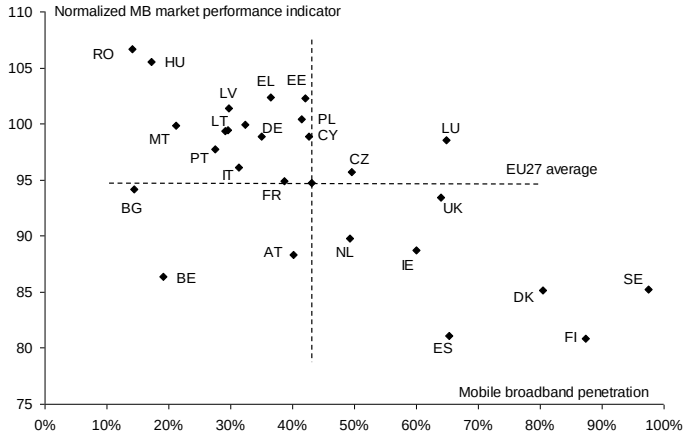

Fig. 1. Combined normalized MB market performance indicator, 2012.

Source: authors' own study

Baltic countries stand out against the EU27 average level quite well due to assessments of mobile telephone services that are 9-14 ranks above the EU27 average. Nevertheless evaluating services, which are provided by mobile operators, only 11% of Latvian users (10% of Estonians, 17% of Lithuanians) fully agreed that the Internet speed corresponds to what was promised by operators.

2.2. Drivers and problems

The most critical driver from demand side is a sharp evolution and usage of mobile equipment – smartphones, media tablets, dongles (PCs, laptops, notebooks), M2M devices. 4G consumer devices are becoming available for affordable prices. Sales of smartphones more than tripled in Lithuania and grew two thirds in Estonia in 2011; Latvian mobile operators have announced rise in smartphone usage in 2012 S1 compared to 2011 S1: LMT by 78% and Bite Latvia by 50%. Number of mobile-connected laptops and tablets in LMT network grew by 51% in 2011. M2M were 2% of all active Lithuanian mobile subscriptions in 2012 Q2, during the half-year their number increased by 9%. LMT also has noticed more then 50% growth of M2M applications for business customers in 2011.

A real fixed/mobile convergence has been started. Data on numbers and types of mobile terminal equipment, which was sold to consumers, show a large number of consumers, who use them for access to Internet in fixed location; e.g., 24,8% of WiFi connections in Latvia are made by means of mobile phones, 15,3% – by smartphones.

All basic e-services are well developed in Baltics, including mobile access – e-governance, e-banking, e-healthcare, e-education, etc. Specialized m-services (e.g., m-parking, m-positioning, m-tickets) also are widespread, Estonians are indisputable leaders in usage of them.

When looking on impact of MB applications/services, which are associated with advanced devices, it is critical to evaluate actual use of these services. Mobile Internet traffic grew 2,3-fold in Lithuania and tripled in Estonia in 2011. Number of mobile Internet users grew by 23% in 2011 (LMT), but the amount of mobile data doubled in each 8 to12 months in last years (TELE2 Latvia). 77% of smartphones in Estonia, 72% in Latvia and 76% in Lithuania were connected to mobile Internet at least once a week in 2012.

Nevertheless a lot of subscribers do not use capacity of devices in full. Younger generation is the most active user of new opportunities in the Baltics as elsewhere; e.g., around 50% of 15-24 years old people are using mobile Internet in Lithuania, while only few percent of people over 50. Advanced applications are used by no less than 40% in the age up to 39 years of polled smartphone users in Latvia; the number falls more than twice in older age groups.

At the same time around 30% of smartphone users exploit only basic functions like voice calls, SMSs, address book and camera. Lithuanians are the most active users of voice and message services in Baltics, they are the most active messengers in the whole EU too; nevertheless figures have decreased for 13% voice and for 9% SMSs per subscription in the last 4 years. At the same time Estonia has shown the growth of mobile minutes by 17% in 2012 Q1 in comparison with 2011 Q1.

Mobile usage is strongly affected by availability of local content that is based on use of national languages. Lack of the national content and advanced applications, which are highly requested by majority of mobile users, is a serious development breaking factor. As Latvian phenomena should be mentioned the fact that the most used social networking application in mobile phones in Latvia is the locally developed site *draugiem.lv* (57% of polled users) with *Facebook* in the second (51%) and *Twitter* in the third (25%) position.

In the context of heavy network usage it is worth to mention several socioeconomic factors that reduce the potential demand for advanced mobile applications in Baltics. Global and European economic prognoses are not optimistic still, which is an alarming signal for very small (total Baltic GDP was only 0,53% of EU27 GDP in 2011) and extremely open (total export and import of goods and services was 152% of GDP of Baltic States in 2011) economies. Purchasing capacity of users is a factor, which, of course, influent the customers willingness to use charged services.

Estonia was the most successful among the Baltic States during current economic crisis, naturally level of income and savings of Estonians is the highest, while, e.g., in Latvia around two thirds of users of mobile applications are exploring only free applications and have never purchased them. Use of charged applications by one third of mobile users highly depends on their income level: 15% of users of income group up to 200 EUR/month in comparison with 47% of income group of 600-850 EUR/month.

Demographic processes also have a strong impact. An active emigration during the last years due to economic crisis in Baltics' economies is a noteworthy individuality in these countries in addition to low birth rate and ageing of population in all Europe. According to official statistics Latvia has lost near 12% of population since 2005. Even more significant reduction relates to persons of active and under active labour force – the most active users of advanced services. Analogous situation is in Lithuania (more than 10% reduction) while losses in Estonia are much less pronounced (2%).

Mentality of population is one more affecting factor. It is not a secret that Scandinavian countries are the global mobile communications leaders. Estonian mentality is very near to Finnish one and composition of Estonia's indicators currently are the most similar to Finland's ones – high ratio of MB vs mobile users, rapidly growing comparatively high mobile traffic.

3. Supply

3.1. Drivers

A new demand in practice is created when an access to network is given (see, e.g., EC 2011). Therefore from the supply-push side network development policy of operators, their investment policy has a critical importance. On the other hand frequency assignment depends on telecommunications policy in the country and its compliance with national development strategy (BEREC 2012).

The 2,6 GHz spectrum has been auctioned in all 3 Baltic countries (Karnitis et al. 2012); it is already applicable for LTE deployment in Estonia and Lithuania, in Latvia spectrum will be available from 2014. An auction was held in Latvia, while strategy of the Estonian and Lithuanian NRAs was beauty contest that is not a typical process for this band. Payments for spectrum were quite adequate to current mobile market situations (number of MB subscriptions, ARPU), nevertheless Latvia's operators invested more in spectrum licences (fig. 3). In all three countries major mobile operators have symmetric portions of GSM, UMTS and LTE spectrum that are sufficient to deliver qualitative MB services.

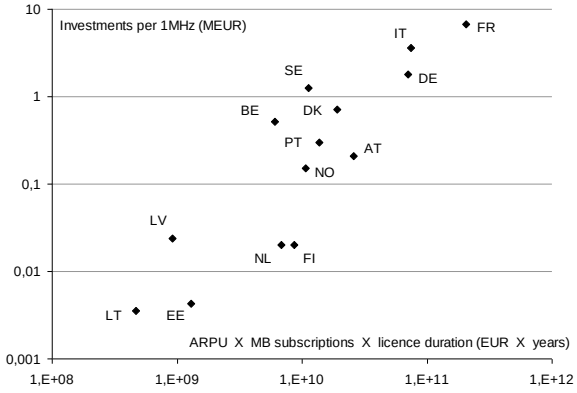

Fig. 2. Europa's 2,6 GHz auctions; investments in spectrum licences.

Source: authors' own study

3G and 4G technologies will maintain the leading positions in Baltics mobile markets. Expressive market consolidation and/or arrival of new competitive local players is not observed and not expected. Impact of alternative wireless technologies (e.g., CDMA, WiMax, satellite-based) is low. There is only one remarkable WiMax provider in both Estonia and Lithuania; only one operator is developing country-wide mobile Internet access in Latvia by exploring CDMA2000 technology. Migration of these operators to LTE is unlikely in the near future. At the same time the social networking and incoming of global over-the-top content providers

(OTTs) is changing the whole value chain and will have remarkable impact on broadband markets.

National and local governments are keen to support 4G roll-out (Gruber 2011, Ooterghem et al. 2009). There is a positive impact of MB on economic activities – e.g., business mobility, remote monitoring of processes, not speaking on increasing productivity due to time savings when information is searched or any Internet application is used.

3.2. Challenges

Quality of mobile services is one of the main reasons for dissatisfaction of customers and the key challenge for operators. Therefore the Baltic NRAs are conducting regular quality control nevertheless methodologies are different so a direct comparison is impossible.

E.g., NRA of Latvia takes measurement of real download and upload speeds, latency and jitter. 45,1% of tests, which were performed throughout territory of Latvia in 2011 4Q, showed download speed over 2 Mbps (fig. 3), nevertheless indicators of three mobile operators were very different – 79%, 38% and 18% correspondingly; at the same time only 16,7% of tests showed speed over 4 Mbps. Operators, of course, pay more attention to the major cities, consumers' density and traffic here is much more profitable and motivating; measurements show 65,2% over 2 Mbps and 21,7% over 4 Mbps. Supply of medium-size regional centres actually is on the country's average level, that would not be adequate for cities, which concentrate business entities as well educational and public institutions and which the Latvian National Development Plan for 2014-2020 defines as development centres. All abovementioned relate in full to the upload speed too.

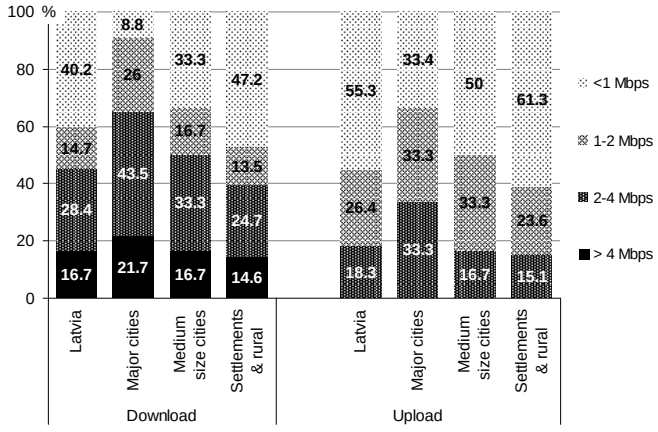

Fig. 3. Download and upload speeds in Latvia, 2011; percentage of measurements.

Source: authors' own study

Improvement of communications capacity is a key challenge for operators nowadays. Upgrade of infrastructure, deployment of 4G networks throughout the territory is the basic tool; 2,6 GHz band as well 800 MHz band will be exploited for this task; 800 MHz would become available in Baltics in 2015 after migration of Radio Navigation Services from this spectrum in Russia and Byelorussia. Measurements of Estonian NRA confirm efficiency of 4G technology – tested download speed is increasing till 20-30 Mbps.

Current high prices for 4G services in Baltics is another challenge; e.g., *TeliaSonera* partly owned operators charge flat rate 27-29 EUR/month while *TeliaSonera* tariff in Sweden is only 5,80 EUR/month. Such prices would be unaffordable for majority of customers and would become a strong breaking factor: total average spending for mobile communications and Internet (including fixed Internet) in Latvia in 2011 was 13,20 EUR/month, even consumers of 5th quintile (having the highest personal income) spent only 18 EUR/month in average.

An ongoing parallel fixed fibre expansion has to be mentioned as serious potential source of impact on roll-out of mobile networks (Schejter 2010, Thompson & Garbacz 2011). EU broadband policy pushes investments in optical access networks (FTTH and FTTB) and in addition requires supporting also availability of unbundled metallic access lines. This takes place in parallel to the EU radio spectrum policy that supports high-speed MB (LTE) roll-out.

Very high fixed Internet speeds have been already achieved in Baltics due to intensive deployment of fibre networks. Especially it relates to Latvia, Internet test surveys regularly rank it among global leaders since 2008. Continuing successful implementation of national-wide core and/or middle mail optical network projects in all three countries may cause different scenarios and business models affecting mobile demand and future investments in the MB networks. At the same time impact of fixed network should not be evaluated as real threat to sustainability of Baltics' mobile markets.

3.3. Risks

There are significant technological peculiarities and differences between metallic or fibre solutions on the one hand and wireless solutions for broadband access to Internet on the other hand. It has to be understood that mobile access never will be able to compete with quality of fixed broadband networks. Currently service providers do not explain advantages and disadvantages of wire and wireless technologies to consumers, it would be one of reasons for low satisfaction of consumers with mobile services provided (DG Health 2012). It has to be done to escape confusions and decrease dissatisfaction; c*ritical mass* of incompetent and unhappy customers would become a significant risk factor for mobile market development.

Regular multi-annual measurements allow recognition of several serious risks of quality of service degradation in the near future; the control will be continued and even expanded for early detection of quality risks, for promotion of sustainability of mobile services.

Mobile networks that are upgraded from 2G to 3G and somewhere from 3G to 4G still have some bottlenecks due to existing gap between increasing usage of the network on the one hand and its extension on the other hand; particularly it takes place in metropolitan areas with high penetration of users in one cell. The real density of customers increases, especially it relates to users of high speed terminal equipment (dongles and smartphones), who are downloading large files (e.g., movies); at the same time the number of customers, who could be served by the base station in any particular cell, remains the same as before. It means that the base station and channel between the base station and switching/controlling equipment will be deployed for the relatively long time; connection of other users of this cell may be worsened and their download speed decreased. Advanced network configuration, small cells and fibre connections have to become the standard solutions.

Typical proportion of download and upload speeds for the MB access is around 2-3 (see fig. 3) with the tendency to increase slightly when the download speed is increasing. A characteristic problem is operators' desire to use the scarce frequency resource to connect customers as much as possible; providers emphasise the high download speed without the adequate increase of upload speed; e.g., a lot of Estonian NRA measurements show 4G upload speeds, which are lower than 1 Mbps (abovementioned proportion in this case is more than 20). The result is high level of asymmetry between download and upload speeds; such situation becomes critical first of all for content-creative applications (e.g., educational and health care services, social networking, on-line gaming).

One more risky issue for the MB supply is actual high level of latency (up to 500 ms) and especially jitter, which sometimes is up to 200-300 ms depending on traffic in comparison with 1-5 ms for fibre and xDSL solutions. This feature really does not influence quality of downloaded content from different sources or surfing on Web sites. Problems would be emerged by the jitter over 50 ms for applications, which ask for correct sequence of packages (ITU 2008), e.g., *frozen* picture or not synchronised picture and sound using different types of IP TV (LMT has reported that video applications generate 30% of total traffic nowadays), distorted sound using Skype, etc.

4. Demand growth projections – sustainability

Forecasting mobile markets is done on a regular basis (e.g., Krizanovic, Zagar & Grgic 2011, Zarmpou, Vlachopoulou & Patsioura 2011), it asks for reliable market data. Although a variety of institutions are publishing various statistical data on the mobile communications development, official statistics has not stabilized yet. The NRA of Lithuania is the only institution in Baltic States that regularly provides reports on the sector containing a lot of statistical data since 2002, but, unfortunately, reports do not contain analysis of trends. Some kind of mobile statistics for Latvia and Estonia is available since 2009 in the best case, but statistics for mobile broadband even later.

There are several possibilities for modelling development of mobile markets (see, e.g., Arvidsson, Hederstierna & Hellmer 2007). We are using a sigmoid model because cumulative number of mobile subscriptions in general grows over time according to a sigmoid (S-shaped) curve. The sigmoid model, which is based on the Gompertz function (that can be appropriately parameterized), provides sufficient flexibility for predicting MP (e.g., Rouvinen 2006, Zheng Yan 2009). Therefore, based on the study of past trend and the market development scenario, we are applying Gompertz distributions to forecast the mobile and the MB subscription growth.

The problem is in the small number of input values and large number of output values (middle-term prediction is necessary to evaluate sustainability) that could cause the *over-learning* of models. In addition processes and trends are distorted by the economic crisis. Therefore to raise potential forecasts benchmarking also is applied, especially for the forecast of the MB development.

4.1. Penetration

The current MP in all Baltic States is above EU27 average level (table 1); even more, that of Latvia and Lithuania ranks in the first five among EU Member States. At the same time only Estonian MB penetration is near the EU27 average number, while both Latvia and Lithuania are lagging behind. Naturally Estonian mobile traffic is the most intensive one in Baltics.

Analysis of development of Lithuanian mobile market shows that the MP trend surprisingly well corresponds to the ideal S-curve, especially in the pre-crisis period (fig. 4). There is slowdown since 2007 (before crisis!) instead of earlier rapid growth, which is a characteristic feature of gradual entering in the saturation phase. Approximation of the real development trend with the ideal sigmoid function demonstrates the MP level about 170% that would be achieved around 2016. The crisis has resulted in loss of 2,5-3 years of development, the further development would slow down too. So we can predict achievement of 170% level till 2020.

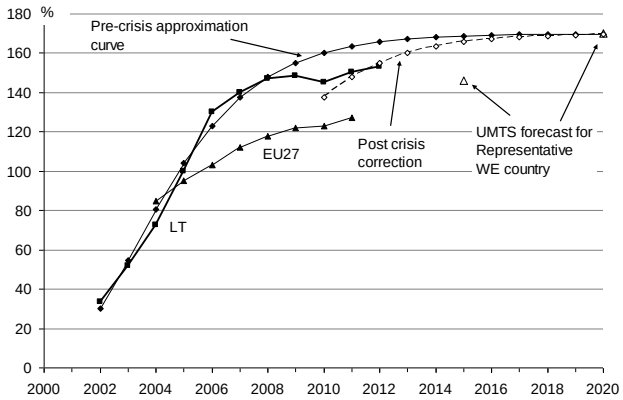

Fig. 4. Mobile penetration forecast until 2020.

Source: authors' own study

Latvian figure is slightly over Lithuanian one, but differences between the two countries really do not exceed the level of statistical dispersion. There is no reason to predict another future for Latvian mobile market.

Prognosis of UMTS for so-called Representative Western European (WE) country coincides with our forecast – 170% level for the MP in 2020. But there is much lower initial position of WE country (125% in 2010), which actually is average EU27 indicator. The forecast would be evaluated as very optimistic one; currently increase of the MP is slowed down on the level 150-160% only in leading EU countries. Although WE country is and some time will be in the growth phase, implementation of this forecast asks for an increase in the rate of growth, which is highly unlikely; 150-155% would be more realistic figure for 2020.

Situation of Estonia is only slightly above the EU average, the country also is in the growth phase still; there is no doubt that Estonia will achieve the saturation phase, but later than its Southern neighbours. 160% for 2020 would be a credible and acceptable figure.

Reliable MB penetration statistics is available for the last several years only, therefore indirect approach will be used. Continuing described combined methodology and comparing the MB penetration with the MP and fixed broadband penetration in the EU countries we are obtaining a line of general relevance (fig. 5). In this case the saturation is far still, it could be at the MB penetration level 90-100%. All Baltic States are in the S-curve growth phase still.

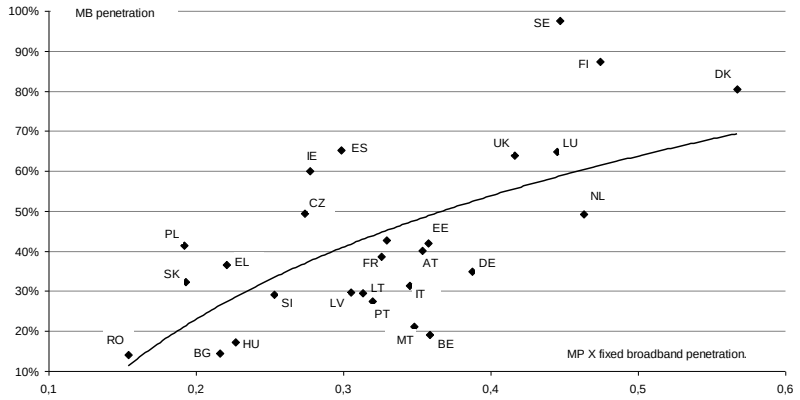

Fig. 5. Mobile broadband penetration; EU countries.

Source: authors' own study

Estonia's trump card is take-up of fixed broadband in households, as well experience of wider usage of e-government and e-commerce services by society, while acceptance of mobile services is higher in Latvia and Lithuania. Taking into consideration ongoing fixed Internet development projects, demographic (aging society) and economic (quite low GDP and personal income level) reality, the fixed broadband penetration S-curve shows its increase by 6-8% in each Baltic State. It means that MB penetration gap with the line of relevance will be reduced. Our prognosis is 65% MB penetration for Estonia and 60% for Latvia and Lithuania in 2020.

4.2. Devices and traffic

Mobile traffic trends show that the growth continues in Baltics as well as in Europe and around the world, e.g., the mobile traffic in Lithuania has doubled in two years. Future projections differ by growth rates (CAGR 60-90%); some slowdown factors appear, but there are no signs on approaching saturation phase.

There is no reason to forecast huge traffic differences among three Baltic States, nevertheless projected slightly various penetrations and some individualities in the structure of equipment exploited are affecting traffic. Most traffic as elsewhere will be generated by the genuine broadband devices – dongles and smartphones.

The global tendency will take place in Baltics too – upgrade of handsets, usage of smartphones instead of middle- and low-range phones, increasing proportion of smartphones in the total range of equipment. On the one hand predicted larger increase of the MP in Lithuania and especially Estonia is a process-stimulating factor in comparison with Latvia; on the other hand a comprehensive mobile take-up in Estonia will involve in the mobile market mainly lower-income customers who will use phones; the growth rate of smartphones as a whole will be lower in Estonia (fig. 6).

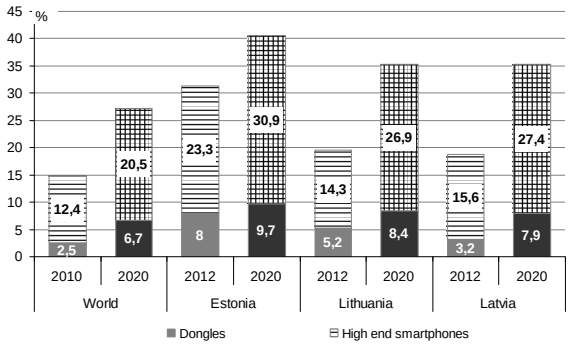

Fig. 6. Mobile broadband devices as percentage of total number of connected devices.

Source: authors' own study

Use of dongles is underdeveloped in Latvia due to very strong impact of economic crisis on purchasing capacity of the population (reduction by 20-40%). Recovery of economy has been started now; it means that we can believe in rapid growth of dongles' usage. Latvia could be the only Baltic State where the ratio *dongles vs smartphones* will increase; a convergence of these ratios will take place very near to projected representative WE country level (1:3,2).

The dongles will be used by professionals and active users therefore we can forecast the medium generated traffic in 2020 – around 15 GB/month/subscriber. There would be a difference in smartphone usage; the current situation shows that many owners do not use their smartphones actively because of pure motivation, lack of skills or low purchasing capacity for charged services. Our prognosis – less than medium level of usage, around 5-6 GB/month/subscriber.

Internet of things will be represented by two categories of equipment; currently we have lack of data on their use practices in Baltics, therefore our prognosis will be more conservative in comparison with the forecast for WE country (UMTS 2011):

- high traffic devices (e.g., online video monitoring and control systems) could generate continuous data flow up to 3 GB/month/subscription;
- traffic of M2M devices that are connected periodically (e.g., radio frequency indication systems, data acquisition equipment) would be much lower – around 100 MB/month/subscription.

The current dynamic development of applications and growth of M2M subscriptions show the high probability of density of both categories of devices in 2020 that are near to the global prognosis (UMTS 2011) – around 7-8% for each category.

Middle-range handsets and small number of low-range ones will continue to represent the largest group of equipment – near 45% of devices in Estonia as well 50% in Latvia and Lithuania. We can forecast quite active their usage by comparatively skilled owners; the generated traffic would achieve 2-2,5 GB/month/subscription.

The voice traffic will not increase significantly. Current communication habits (around 150 min/month/subscription) generate around 75 MB/month, the similar number would be real in 2020 too.

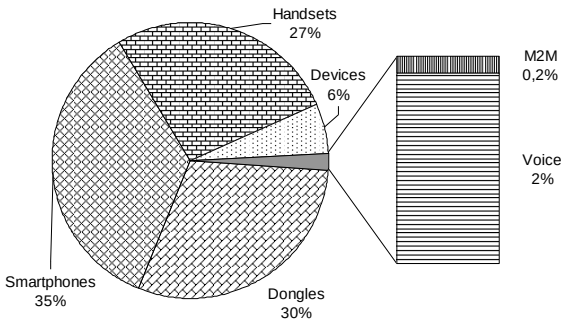

Fig 7. Distribution of Lithuanian mobile traffic by device, 2020

Source: authors' own study

Overall mobile traffic structures in Baltic States could be projected as quite similar, the forecast for Lithuania is shown on fig 7. The traffic forecasts are summarized in the table 2.

Table 2. 2020 mobile traffic forecasts:

	Monthly traffic per subscription	Total monthly traffic
Estonia	4,4-4,6 GB	9-10 PB
Latvia	4,0-4,2 GB	14,5-16 PB
Lithuania	4,1-4,3 GB	20,5-22 PB

Source: authors' own study

In total analyzing trend in 2012 we have slightly reduced previous forecast for Baltics (Karnitis et al. 2012) to CAGR around 45-50%. Our assumptions may prove to be more or less accurate, some minor differences may appear in scenarios related to the level of demand, its structure, the growth rate and other secondary indicators. However it is clear that in general there are no doubts on demand sustainability

5. Sustainability of supply

Mobile communications are available in Baltics during last 20 years. Mobile operators have proven their ability to provide services that meet the growing demand, including two transitions to new technologies. Currently technological development has emerged giant new features that are enticing to customers. The sector consequently is entering in the next transition, qualitative changes in the service delivery (IP services and data transmission becomes a major issue instead of voice) will be its major hallmark. But it is a common knowledge that any transition asks for much greater attention to challenges and risk factors, it relates in full to mobile sector to secure supply sustainability (fig. 8).

A strong incentive for customers to use mobile services is caused by availability of the local content in the national language; it amounts up to 80% of the total traffic. Mobile operators really can only stimulate creation of the content, while other companies and public institutions are the main actors in the creative work. Another substantial content issue is availability of all advanced applications (e.g., mobile cloud computing, M2M applications, etc.).

Qualitative ubiquitous delivery of the content primarily depends on the infrastructure. An optimal planning of the network (e.g., small cells in populated areas, reasonable frequency distribution for download and upload traffic, sufficient capacity of channel to switch, etc.) is the first step to ensure the smart usage of available scarce frequency resource and return of

investments. Transition to advanced technologies (LTE as well LTE-advanced in future) will be necessary very soon to provide transmission of forecasted gigabyts. It should be mentioned that only upgrade of base stations to 4G without network optimization will be a risky approach, the desired effect will not be achieved.

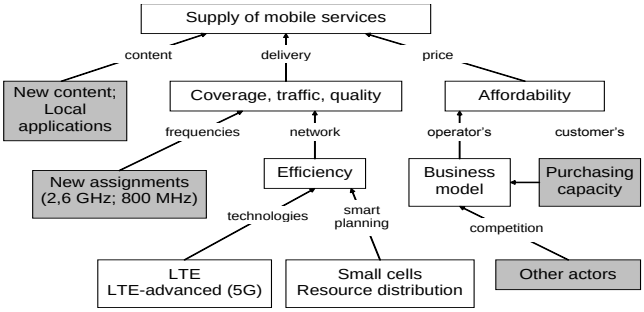

Fig. 8. Potential challenges and risks for sustainable supply of mobile services; external factors are colored.

Source: authors' own study

Traffic forecasts indicate necessity for new frequency bands (especially for 4G), projected traffic growth cannot be served by means of existing bands. Baltic NRAs with frequency allocation for wireless communications have created a favourable climate for development of services; all three NRAs are among the most successful five in this activity in the EU, only use of 800 MHz band has delayed because of abovementioned reason.

The introduction of affordable business models will be a big challenge for operators, transition to 4G requires for their review in difference with transition to 3G, which was carried out without significant changes in business practice. The deployment of 4G network will ask for huge investments (it is evaluated necessity of around 200M EUR in Estonia and 300M in both Latvia and Lithuania for 100% LTE deployment) while the purchasing capacity of population does not rise so fast. As already indicated, prices for current 4G offers are much higher than real household spending for communications services. Low desire to spend larger share of income would become a serious risk factor, especially if quality of services is not enough high.

Conclusions

The market of mobile services in the Baltic States is developing dynamically. Each new technological generation offers new possibilities, while the current strong competition is forcing operators to use any of these options. As a result increasing solvent demand is met, consumers' assessments of services' availability, quality and price is above EU27 average level. There are no radical differences among Baltic States now, mid-term forecasts do not identify such in future too.

Analysis shows that demand and usage (mobile and mobile broadband penetration as well traffic) growth will continue in mid-term (projections till 2020), appreciably risks for demand sustainability are not identified. Global and local socioeconomic factors could have a minor impact on development pace and on purchases of advanced applications, but the general trend will remain.

Supply-side sustainability risk is slightly more serious. Currently the mobile ARPU is low that would create problems for huge investments, which are necessary for transition to 4G technology. Especially it relates to Latvia and Lithuania, it is difficult to assess the ARPU, which is significantly less than 100 EUR, as reliable base for sustainable development. Design and implementation of the appropriate business model becomes a priority for operators. We are sure that this fully feasible task for operators will be performed and risk factor avoided.

Reliable statistical data on mobile communications are needed for more accurate analysis of tendencies including early identification of sustainability risks. The common interest and task of government, regulators and operators is to activate the data collection and gathering.

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