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Conference Paper

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22nd European Regional Conference of the International Telecommunications Society (ITS): "Innovative ICT Applications - Emerging Regulatory, Economic and Policy Issues", Budapest, Hungary, 18th-21st September, 2011

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: Brusić, Igor; Kittl, Jörg; Ruhle, Ernst-Olav; Žuti, Vladimir (2011) : Ordinance on technical requirements and conditions of use of optical distribution networks of the Croatian regulatory agency - Analysis and outlook, 22nd European Regional Conference of the International Telecommunications Society (ITS): "Innovative ICT Applications - Emerging Regulatory, Economic and Policy Issues", Budapest, Hungary, 18th-21st September, 2011, International Telecommunications Society (ITS), Calgary

This Version is available at:
https://hdl.handle.net/10419/52167

22nd European Regional ITS Conference
Budapest, 18-21 September, 2011

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Ordinance on technical requirements and conditions of use of optical distribution networks of the Croatian regulatory agency – Analysis and Outlook

Abstract: In September 2010 the Croatian regulatory agency (HAKOM) put in force the ordinance on technical requirements and conditions of use of optical distribution networks. With this ordinance the Croatian regulatory agency is looking over the rim by proposing a rather technical approach for the rollout of optical access networks which will have significant influence on the deployment of next generation access networks (NGAN) in Croatia. The ordinance stipulates the requirements that have to be fulfilled in developing, planning, designing, building, using and maintaining optical access networks. Some of the main issues are the obligation of a point-to-point architecture, the focus on open access and the incorporation of municipalities in planning fibre distribution networks. In this way the agency is following a path which is unique in Europe and which is incorporating new players for building the optical network infrastructure. For Croatia an additional aspect is related to the expected accession to the European Union by mid 2013, putting the Government into the position of receiving financial support provided by the structural and cohesion fund of the EU in the amount of 7.6 billion Euros.

JEL codes

Keywords: optical access networks, next generation access (NGA), regulatory framework, passive infrastructure, fibre to the home (FTTH)

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1. INTRODUCTION

Over the last decade several studies have demonstrated the economic benefits of enhanced information technology infrastructure investment and usage. Röller and Waverman (Röller, 2001) found that about one third of the per capita GDP growth could be attributed to telecommunications infrastructure investments. The OECD study "Broadband and the economy" issued May 2008, emphasises that the impacts of broadband on the economy are more significant than the impact of electricity, steam engines and information technology in the past. This is confirmed by further studies (OECD, 2011):

> Some economists have found that investment in broadband Internet access directly correlates to growth in GDP and gains in productivity. For example, the World Bank found that in low and middle income countries every 10 percentage point increase in broadband penetration accelerated economic growth by 1.38 percentage points, significantly more than in high income countries and more than for other telecommunications services.[16,17] McKinsey & Company suggested that a "consensus" view was that a 10% increase in household penetration of broadband boosted GDP by 0.1% to 1.3%.[18] The variation was accounted for, to some degree, by differences in the methodologies used, for example, measuring penetration in terms of individuals and households.
>
> Booz & Company found that a 10% higher broadband penetration in a specific year correlated to 1.5 per cent increase in labour productivity growth over the following five years.[19]

At the third international IT-Summit of BMWi (Federal Ministry of Economics and Technology in Germany) in November 2008 the strategy paper "Broadband of the future" (BMWI, 2008) described broadband as engine of the transformation of economy and society. The Connected Nation report "The Economic Impact of Stimulating Broadband Nationally" from February 2008 (Connected, 2008), shows the advantages of the rollout of broadband in rural areas and states that an increase of broadband penetration in the U.S. of only 7% would result in 2.4 million new jobs. Applying the results of the Connected Nation report would mean that for every percentage point increase in broadband penetration employment is projected to increase by 0.2 to 0.3%. Last but not least, the OECD report "The role of communication infrastructure investment in economic recovery" from May 2009 (OECD, 2009), has addressed the role of investment in communication infrastructure as part of efforts to accelerate economic recovery. By this it is clear that broadband networks and the relevant infrastructure can contribute significantly to the economic and social evolution and development of a region.

It is important to point out, that there is no consensus on the definition of "broadband" which is opening the door for different interpretations of goals and ways

to achieve them. At the same time customers of services are not only requiring high speed, but also flexibility in connecting to the access network with additional capability of selecting the service operator of their choice. In the EU and the U.S. the term broadband is primarily tightly connected to the transmission capacity whereby the choice of transport technologies is usually regulated in a technology-neutral way. In Japan studies about broadband are focusing on user experience. This includes not only ultra-high speeds, but also seamless connectivity between all devices, people, and network objects; support for distributed creativity from anyone, anywhere; and a well-skilled population that has access to applications and devices for a wide range of needs (Berkmann, 2010). Therefore it is not surprising that the different broadband strategies are sometimes heading in different directions if compared on a worldwide scale, having different objectives and differing in success. An overview is provided by Ruhle et al. (Ruhle, 2011).

On the other hand, in the competitive environment of the telecommunications sector, investment in future-proof fibre-based access networks will only be undertaken if a positive business case materializes. Therefore, the less densely populated regions like rural areas are increasingly being neglected by traditional telecom providers which will start a downward circle – businesses and residents will move to better supplied (urban) areas, so that the rural areas become even less attractive for investments and thereby decoupling the region in terms of competitiveness. Taking a closer look on the facets of different business models which could be possible for building optical distribution networks, it can be concluded that telecommunication companies and other private investors are very limited in considering external effects for the economic development of the region in their business case calculations. As opposed to this, the local government has clear advantages from the economic development of the region if an optical distribution network is rolled-out. Therefore, the business case of the local government is a different one, shortly described by listing the main points in Table 1. These longer-term aggregated supply-side effects can improve the productive capacity of the entire economy as an improved foundation for commerce and communication (OECD, 2009).

1. Value proposition	2. Value chain structure	3. Revenue model
▪ What are the benefits of FTTH for the community ? ▪ The supply of broadband infrastructure as an essential factor for the economic and social community development ▪ Prevents the migration of companies and favours the return of young people after their training or study ▪ Prevents the decay of prices of real estate and construction areas ▪ Is an advantage over communities without fibre	▪ What benefits are offered in which markets? How and in which configuration will the performance be created (product-/market-strategies)? ▪ Passive infrastructure is offered to all network operators with the same conditions ▪ Non-discriminatory access to the subscriber for all service providers ▪ Every subscriber can use services of any provider in any combination	▪ How is money earned? ▪ Direct revenue through rental of lines (Dark Fibre) ▪ Connection fees of subscribers ▪ Revenue-sharing models with service providers ▪ Indirect revenues (stable value of properties, reduction of migration, business settlements) ▪ CO2-emission trading (low power consumption, teleworking, micro-trenching)

Table 1: Local governments' business plan considerations for optical distribution networks

The indirect revenues for local governments like the stable value of properties, the reduction of migration and new business settlements can not be monetized in the same scale by any traditional operator. This is already clear for infrastructure like the electricity grid, water and wastewater infrastructure, schools or roads, but it is not yet the case for communication infrastructure.

Governments in Europe actually are seeking to increase private sector investment in high-speed broadband networks and many have reviewed their legal and regulatory frameworks to ensure they are appropriate for the levels of investment necessary to achieve their policy goals.[1] Some governments, citing the importance of broadband, have recently invested public funds to address the aforementioned important communication market limitations. These investments fall into two general categories: extending access to unserved/underserved communities and upgrading networks with very-high-speed lines capable of supporting competitive services in regions and municipalities. One risk of governments investing in telecommunications is that they tend to have to choose winners in the market (OECD, 2009). Another important fact the OECD study about the role of communication infrastructure investment is stating, is that once one network is built there is a relatively low chance of another infrastructure-based provider entering the market given the financial advantage already awarded to the incumbent via government funding. Therefore, the governments need to carefully consider their decisions to ensure competition in the

[1] See extensive information in (OECD, 2011): National Broadband Plans, OECD Digital Economic Papers, No. 181, OECD Publishing, http://dx.doi.org/10.1787/5kg9sr5fmqwd-en.

market, but the construction of the next generation access network is also a unique chance for generating new business models with new players. In a similar way the European Commission report from 2009 is stating that high-speed broadband is not just to support faster content transmission, but will rather enable next generation internet, radical new services and business models. It will unlock the growth potential of SMEs, provide a platform for improved school systems, the diffusion of care to elderly people, and enable a huge range of environmentally sustainable ways of work, play and learning activity (EC, 2009).

Compared to the EU average broadband penetration of 26.6% Croatia has reached a penetration of 18.68% in the first quarter 2011 according to HAKOM and ranks between Slovakia and Latvia in the lower ranks of European penetration. The following graph shows the broadband penetration rate in EU27 in January 2011.

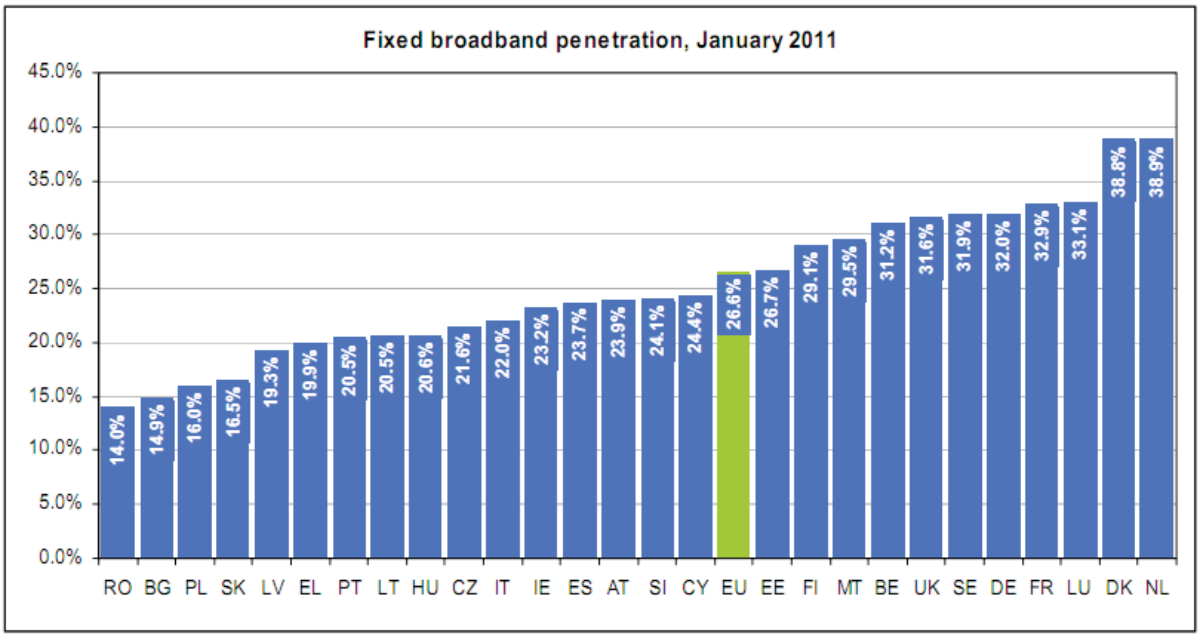

Figure 1: Broadband penetration rate in EU27 (Communication Committee, January 2011)

Considering the late start of broadband development in the Republic of Croatia[2] the last years showed a huge improvement and growth rates well above the average growth rates in the European Union. The government of Croatia has recognised the significance of broadband for growth and development of knowledge and economy in general (RH, 2003).

[2] In 2003 there were only 4.400 broadband internet connections and a density of only 0.01%.

2. HAKOM REGULATION FOR OPTICAL ACCESS NETWORKS

In 2010 the Croatian regulatory agency (HAKOM) has put an ordinance on technical requirements and conditions of use of optical distribution networks in force (HAKOM, 2010). By this ordinance the Croatian regulatory agency is proposing a rather technical approach for the rollout of fibre networks stipulating the requirements that have to be fulfilled in developing, planning, designing, building, using and maintaining an optical access network. The ordinance refers strictly to optical networks in the part connecting the premise with the first concentration point.

2.1. General statements

All provisions of the ordinance on technical requirements and conditions of use of optical distribution networks are in accordance with the ordinance on technical conditions for duct systems (HAKOM, 2010_2) and together are building the framework for optical network deployment. The aforementioned ordinances are containing terms that have to be applied already in the early phase of the elaboration of documents for spatial planning and thereby involving the local government (municipalities). This is in accordance with international recommendation given by organizations like ITU-T (ITU, 2011) and the European Commission (EC, 2002). The local governments in Croatia are responsible for elaborating these plans and besides environmental protection it is also necessary to include the possibility for rolling out telecommunication infrastructure.

After the liberalization of the telecommunication market and when most of the former state-owned operators (incumbents) became predominantly private businesses, operators are investing only in economically sustainable areas with a short payback period on capital. Therefore the probability for rolling out optical infrastructure by operators is the key indicator for investment.

Electronic communication infrastructure and related equipment as well as electronic communication networks, thus fibre distribution networks, can be deployed as integrated community infrastructure. Fibre optic networks can be built in parallel with power grids or other networks. It is necessary to take care only of the physical protection of fibre optical cables whereby the distance between the optical cables and other infrastructure are minimal.

Just like with other municipal infrastructure, local government law and local (regional) governments are obligated to care about electronic communication infrastructure when making plans for spatial planning. In the part relating to electronic communication infrastructure it is necessary to consider the capacity (i.e. duct capacity to accommodate the cable) in accordance with a planned capacity of electronic communication networks, primarily fibre optic networks.

The spatial plans of the municipality must include a forward-looking view of the deployment of electronic communication network infrastructure in the area and based on the principles of open network access and the flexible concept of optical distribution networks. These plans must be renewed and amended at least every five years. Spatial plans must have provisions that are prerequisites for the development of fibre optic distribution networks in order to improve the quality of community life, the economy and the preservation of nature and the environment.

Units of local government and local (regional) governments as well as operators must plan the capacity and the coverage area of the optical distribution network. The capacity must be balanced with the needs of the built and planned residential and commercial buildings in the area covered by the physical planning document on areal (regional) or local level. Buildings are also communal facilities such as traffic lights, transformer stations, pumping stations, observation cameras and similar. During the planning process it is essential to connect all buildings or structures to the fibre optic distribution network, covering the whole area in such a way that it is not necessary to expand network capacity in a period of not less than 5 years.

2.2. Content of the Ordinance

The ordinance contains 20 articles divided in five parts – general provision, development and planning, technical requirements, use and maintenance and the final provisions. The general provision part of the ordinance emphasizes that optical distribution networks are an important element of the electronic communication infrastructure and thereby "*its development, building, use and maintenance are in the interest of the Republic of Croatia"* (Article 1.2). The ordinance not only applies for planning and building new optical distribution networks but also in the reconstruction or upgrading of existing network infrastructure.

According to the ordinance the municipalities are obligated to take account of the purpose of buildings and of the planned number/capacity of separate units from

the aspect of end users of electronic communication services. For this reason the local plans of space organization must have a perspective deployment plan, which has to be based "*on the principles of open network access and elastic concept of the optical distribution network, respectively updated and supplement at least each five years*" (Article 4.4). According to the same item *"each invest in electronic communication infrastructure must be in accordance with the aforementioned plan. Preliminary opinion on the aforementioned plan is given by the Croatian regulatory agency for post and electronic communication (abbreviated by HAKOM)."*

One of the main points of the ordinance is in Article 3, which states: *"the segment of the optical distribution network must be built based on the point-to-point architecture"* (Article 3.3) and extends in Article 4 that "*for each user a capacity of at least 1,2 fibres have to be planned*" (Article 4.7). At this point it is necessary to emphasise that the ordinance is regulating only the distribution part of the network, shown in Figure 2.

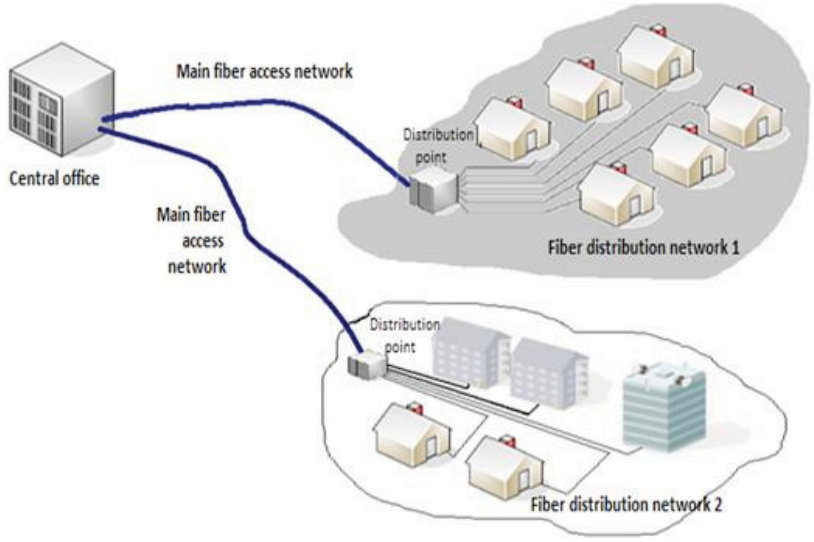

Figure 2: Optical distribution network

Concerning the space for the distribution node, as the first point where all fibres coming from the premises have to terminate, the size has to be planned in a way to enable the accommodation of all passive equipment like splitters, CWDM multiplexers and similar. Additionally Article 6 states: "*if the network subject of the optical distribution network is at the same time also the service operator, then he has to enable the operators to accommodate equipment and optical cables for reaching up to 50% of optical fibres of the optical distribution network*" (Article 6.4). Investors intending to build an optical distribution network onto an area larger than 1 sq km or

connecting more than 100 users, have to make their intention public "*60 days before the beginning of construction works in a public accessible way*" (Article 8.1). If there is interest by some other operator (defined as customer operator in the ordinance) to use the planned network, the customer operator has to express his interest within 30 days after the publication. Thereby the customer operator has to state the planned capacity of the connecting cable and the space necessary for housing the equipment. The customer operator will begin paying a rent for the increased space immediately after the optical distribution network begins to be used by any operator (Articles 9.1 – 9.4). Article 18 in the chapter about use and maintenance is regulating the financing part of the expansion by defining that "*financing of the expansion of the distributing node (accessing node) is ensured entirely by the owner of the optical distribution network*" (Article 18.6).

Besides defining the ITU standards G.652D and G.657 for the affirmative usage of single-mode optical fibres and restricting the usage of direct buried cables, the ordinance is also recommending the usage of microducts and is giving a table of recommended duct diameters in accordance with the number of planned fibres (Table 2).

Cable capacity	Outer cable diameter (mm)	Duct type (max. outer diameter mm)
up to 24 fibres	≤8,0	MD 16/12* (16)
from 24 to 48 fibres	≤11,5	PE 20 (20)
from 48 to 96 fibres	≤13,5	PE 25 (25)
from 96 to 192 fibres	≤18,0	PE 32 (32)

*MD=microduct

Table 2: Recommendation of duct type according to planned cable capacity

One of the last items of the ordinance on technical requirements and conditions of use of optical distribution networks is Article 20.2 which states "*optical access networks started to be constructed before this Ordinance and in time of entry into force of this Ordinance are not finished, must be finished according to the rules of this ordinance. This obligation is applied 30 days after the day of entry into force of this Ordinance*."

Other HAKOM ordinances of importance for NGA are the ordinance on manner and conditions of access and shared use of electronic communications infrastructure and associated facilities (HAKOM, 2008), the ordinance on technical conditions for electronic communication network in business and residential buildings (HAKOM,

2009), and the ordinance on technical conditions for duct systems (HAKOM, 2010_2). In the remaining part of the paper we are going to analyse only the ordinance on technical requirements and conditions of use of optical distribution networks.

3. ANALYSIS

The ordinance has been prepared with the purpose of facilitating the rollout of optical fibre networks in the distribution part of electronic communication infrastructure and to grant regulatory certainty to market players. However, some aspects have to be analysed in more detail. On the one hand they are influencing investments and on the other hand they are treating optical distribution networks as information infrastructure of the society that cannot be left to the free market. Therefore it is important to understand the intention of the regulatory agency, which has guided the elaboration of the regulatory framework.

3.1. Critical review

The first critical issue is the way the ordinance has been worded by focussing on specific optical access network issues and technologies. It seems that all provisions are very specific for fibre optic networks and thus may lack neutrality as regards the technology to be used. Further, these specifications have not only economic impact on the investing company, but are also a technical pre-decision which limits the freedom of operators to go for other solutions instead of FTTH. From a European perspective especially FTTC and FTTB are alternatives, which may be looked at by other operators. The situation in Croatia and other adjacent countries in South Eastern Europe might be different because of the specificities of existing copper network infrastructure. Thereby FTTC is not really an option because of the non-existence of street distribution points.

From the classical standpoint, investments are determined by the technical solution that is being deployed. Thereby in countries where FTTC and FTTB are an option a trade-off exists between the best technical solution and the costs that it requires to deploy such a technical solution. This means that the more fibre is deployed the higher the quality and the capability of the network, but also the higher the investments. Therefore, it can be clearly stated that an FTTC solution is cheaper than FTTB and cheaper than FTTH. However, FTTC is also less capable of providing (ul-

tra-high) broadband than FTTB and FTTH. With this classical trade-off the stakeholders have to decide which way they would like to invest. This approach follows the idea of the ladder of investment. The question thereby is whether additional investment can be afforded and whether the users will be willing to pay a higher amount for a better quality service/network. In an economic situation determined by competition it usually is the decision of the investor to choose a specific technical solution and to follow a certain business perspective.

By omitting distribution networks other than optical networks, e.g. wireless broadband networks, the technical requirements and conditions of use of other broadband networks not based on optical systems are not covered by the ordinance. Therefore, due to the specific technologically focused wording of the ordinance broadband networks based on other technological means (e.g. WiMAX) can be seen as preferred technologies with reduced risk regarding investments. Thus the ordinance contains a certain risk that new networks will not be based on optical fibre but rather on mobile networks or fixed wireless networks as the ordinance may increase investment risk, decrease return on investment, or lead to delayed financial flows for networks based on optical fibre.

From an operator standpoint the chosen approach may also partly go in the direction of over-engineering because it demands considerable investments from the operators. In doing so, it does not incentivize rollout by operators. The determinations may have a detrimental effect in the sense that neither the potential first movers nor second movers enter this market.

Article 3.2 of the ordinance determines that the possible point of interconnection shall be the distribution node. Derived from this there is no option for sub-loop unbundling of optical access networks. Such approach sets the conditions for a second entrant that tries to share the infrastructure of the investing operator. It could be that the new entrant has no other option than to build out its own network until the distribution node.

The ordinance gives specific time frames for operators to coordinate a rollout in a certain area with announcement and responding time frames. In practice, such approach is difficult to implement as operators willing to co-invest will have to raise budgets for the rollout and make a technical planning for the rollout within a very short time period.

There is a tendency of the ordinance of over-engineering the planning of optical access networks. Especially the obligations to provide certain infrastructure to competitors limit the incentives to invest in such networks. Interestingly enough that the ordinance can impose obligations on other authorities with regard to the planning process of the operator concerning the capacity and space for nodes, it determines in Article 4.4 that each investment in electronic communication infrastructure must be in accordance with a plan of “space organization” that has to be based on the principles of open network access. The term “open access” is not defined by the ordinance. Nevertheless, the plan foresees an obligation for the investing operator that they have to share their infrastructure with other operators according to these principles. The investing operator has the risk but no guarantee that other operators may use the infrastructure and enter into competition with the investing operator. Such competition will limit the revenue streams of the investing operator but is giving advantage to investors with a different business model like municipalities or some combination of public private partnership. At this point it is noteworthy that governmental support and EU funds can only be invested into open access networks.

The ordinance determines in Article 5.7 that a minimum of 1.2 fibres have to be planned for each end user. The concept of spare capacity is generally an internationally accepted planning concept and is a reasonable planning procedure. Although normally an operator always includes some spare capacity in the distribution network, the determination of at least 1.2 fibres for each end user could somehow limit the freedom of the investor. On the other hand, the investment into the optical cable represents only a very small share of the cumulative costs, whereby the main part of the cost is civil engineering costs, which have to be done anyway.

Many provisions contain a number of statements as regards what infrastructure an operator has to take into consideration when designing such networks as regards the open access principle. This circumstance and the fact that the ordinance is designed in a symmetric way for all operators irrespective of their market position (e.g. dominancy) could refrain smaller operators from investing in such networks as any obligation of sharing of the installed infrastructure could administratively overburden such operators. Further, the need for additional investment combined with no guarantee to recoup such investments by sharing of the facilities could detain not only small operators from rolling out FTTH-infrastructure.

Also the rollout obligations are very strict. The ordinance requires a time horizon of the operators of 5 years as it determines a period of at least 5 years without additional interventions to increase the capacity, neither by active nor passive equipment, without knowing the demand from end users (Article 5.9). By such an approach the ordinance limits the option of a step-by-step rollout in areas. In combination with Articles 5.2, 5.3, and 5.5, where the operator has to install a capacity that matches all planned capacities for residential businesses and other industrial facilities in the area, the planning becomes rather complex because the planning has to consider step-by-step rollout of the infrastructure.

All these obligations create an additional investment already in the initial planning for an area especially in combination with the point-to-point rollout obligation. The dimensioning of such a network in the first planning round without taking into account an actual deployment of a service over years would mean that the initial investment for the site preparation has to be significantly increased.

The last critical aspect of the ordinance is laid down in Article 20.2. This article obliges all operators to finish already started construction works according to the ordinance. If the operator has designed completely different network architecture the whole business case needs to be re-designed. This obligation requires re-planning of ongoing construction works and thus could lead to a full stop of the rollout.

3.2. Statements of the regulator

3.2.1. Historical review of market liberalization

The telecommunication sector has recorded an unprecedented development in the last 15 years, putting the society in front of new challenges – the transformation of the sector in line with the technological revolution. On the path of neoliberal economic concepts and with a desire to improve the management of this area in terms of rationality and competition, the telecommunications business is liberalized, the market opened and incumbent operators in Europe have been largely privatized. The aim of the privatisation has been to advance, improve and generate competition between service providers, whereby the ultimate aim was the satisfaction of citizens, businesses and other institutions. Regulatory agencies have been established with the task of governing the relations between the key players in the process – service providers and service users as well as between operators in the market. The main objective of the Croatian regulatory agency (HAKOM) is the betterment for all actors

in the value chain, and especially customer satisfaction, for which the transformation of the sector has primarily been done.

By regulatory measures HAKOM defines the requirements of minimal standards of services that have to be fulfilled by each service provider on the market.

New technologies have enabled the development of a large number of new services based primarily on broadband. In the Republic of Croatia the main bulk of this task is left to private initiatives of companies present on the market whereby the incumbent operator is at the very forefront of the development of broadband access. Active operators have managed to build network resources that cover the needs of the Croatian economy and the public sector for such services based on access via the copper network and xDSL (Digital Subscriber Line) technologies. The access network based on copper lines is owned by the Croatian Telekom (HT) and used by other operators by utilizing unbundling of subscriber loops whereby the prices are set be the regulatory agency. A small portion of this market is provided by 3G and 4G mobile networks by the use of radio spectrum.

However, the real challenge in the fixed network is the transit from the existing, capacity limited copper based transmission media to the new, virtually unlimited optical media. This is not only a challenge for Croatian operators but also for the regulatory area. In most of European countries there is great support for regional development through various forms of incentives by the state that determine the direction of development. In the Republic of Croatia there is no direct incentive for investment and development of open access optical access networks that would enable non-discriminating infrastructure access for all service providers and free choice of providers for the end user.

3.2.2. Practical implementation of fibre-based networks in Croatia

Practical realisations of optical networks in Croatia have shown that there is no coordination between the investors and also that the variety of used technology and implemented architectures is unrewarding. For the regulatory agency it is clear that there will be only one optical distribution network, by the same logic as there is no second gas, water, electricity or other communal infrastructure. Therefore every investor in this area has to be in accordance with the plans of physical planning that predict the construction of such networks and accordingly secure spatial, energetic and other requirements. With rationally constructed objects of this type, the investors

will get their return on invest within a rational time by renting their facilities to service providers. There is no investment risk but only long-term return on capital, which is a common term for communal infrastructure in towns and villages.

It is evident that in many new urban areas the investment in this kind of infrastructure is lacking because telecom operators believe that such investment will not pay off. The truth is that neither infrastructure in cities and villages is built with repayment of capital invested by five or less years. It is always a long-term investment, whereby for telecommunications networks the depreciation life is 25 years. Local authorities have already noticed such behaviour from the incumbent and other operators and are taking steps towards the formation of public companies with the task of developing information infrastructure in their cities like in Zagreb, Varaždin and Rijeka. The latest example is the City of Krk (Brusic, 2010). Opening this area to the market and competition has shown to be an illusion, because of the danger of too much emphasis on profitability as a driver of new companies, in areas that by their very nature cannot be subject to market principles.

When planning the construction of an access network (outside plant) of a settlement in towns and villages it is reasonable to invite the cooperation of all operators (network and service) that wish to appear on the market. The benefit stems from the fact that the network constructed in this way, will be available to all operators, and the burden of investment, or ROI, is distributed to all parties in the chain. This approach is even more significant when one takes into account the fact of the durability of this infrastructure, i.e. a long period of return of invested capital. The regulatory agency provides only minimal time for the publication of the intention to invest. The construction part of home installation is under the jurisdiction of the investor in the building and a renewal of installations in old buildings can also reach an agreement on joint investment by several operators. All elements of the optical access network, as street cabinets and associated facilities, must find their place in space. Other types of urban infrastructure have the same problem. This is the reason why all these plans have to be taken into account as an integral part of resource management of areas in towns and villages. If some owners of previously built networks are planning to upgrade them and the upgrade is occurring by introducing elements that have not previously existed, it is necessary to seek an amendment to the planning documentation. Possible problems in the realisation of the integrated approach by local government arise from a misunderstanding of the issues, inadequate communication and lack of pro-

fessionalism of staff from both sides in the dialogue. The capacity of the planned optical distribution network stems from the size of the defined area, the number and structure of the service users, the types of services, technology development and the exploitation of the network planning period. Subsequent extensions are the result of improper planning.

3.2.3. The new framework conditions for fibre-based networks in Croatia

Concerning the rollout of optical distribution networks the prevailing opinion is that this area should be left to the free market, but this view is not considering the fact that optical distribution networks are the information infrastructure of the society. Therefore, the regulatory agency is building its regulatory framework for optical distribution networks on the following four pillars:

First, choosing the technological basis for new access networks, which should satisfy the information needs of society in the future, may not be the exclusive right of one company. By its nature, private operators are looking to achieve their particular interests in the market, which are contrary to competition, as well as long-term interests of society. Therefore, the task of HAKOM on behalf of local communities is directing the development of this type of infrastructure towards common good. The selection of promising access technologies for cities and municipalities, which would replace the inadequate access network based on old information technology (PSTN, symmetrical copper pair etc.) is a difficult question. On the technical horizon optical technologies and 3G/4G mobile networks are very promising. At this point, in terms of fixed access networks, the regulator is recognizing optical networks and by the new ordinance he is trying to edit the regulatory framework by primarily taking care of the interests of the community.

Second, relying on spatial planning documents of local governments, the regulator stressed the sense of building the information infrastructure of society: access network infrastructure is planned and built only in towns and cities where the leadership of local communities is determining it. The same principles apply to other types of infrastructure like transport, electricity, water, sewer, gas etc. Currently local governments are establishing public companies with the task to manage this infrastructure in the interests of citizens by planning, building and operating it.

Third, giving a particular telecom operator the freedom in choosing the areas for construction of new networks, the choice of technological solutions and the choice

of network topology pose a risk to local communities, customers and market competition. The operators are governed by their partial and short-term interests, whereby the development of broadband access networks and services is not covered by binding concession agreements nor is it part of the universal service obligations. Therefore, the task of the regulator is primarily guided by the interests of the residents of local communities.

Fourth, by this approach the Republic of Croatia is aware of the importance of "the most important infrastructure of the 21st Century", not leaving its development to chance (private interests) or disorganization.

3.2.4. Comments on the ordinance

Concerning the topology of the optical network, the ordinance is defining two parts – the optical distribution network and the main fibre optic network. The main fibre optic network is linking the local exchange of the operator with the distribution nodes whereby the choice of technology and topology is left to the operator. This approach is enabling to maximal utilize the advantages of optical fibre concerning range and bandwidth. Some telecommunication operators will certainly use the possibility of merging metropolitan and access networks by long-reach passive optical networks (PONs). Such networks include the use of optical amplifiers to maximize the signal strength, bandwidth range and number of branching. By the usage of long-reach PONs urban networks are bridged and access levels are determined at the end node of the core network. This approach allows the elimination of local or remote switching hubs, which will certainly contribute to reducing maintenance costs.

As it is necessary to reduce multiple environmental devastations, and also to connect all buildings and structures in the planned area, it is necessary that the investor announce his intention of construction. In his announcement the investor must clearly indicate the area included, the beginning and the planned date of completion and the type of space that will be locating all distribution facilities. This announcement of construction is enabling to adequately plan the size of the space in a distribution node, based on the interest shown by operators who want to use the distribution network. Furthermore, the announcement will allow the beneficiary for in time planning of the extension of his own main fibre optic network to the announced distribution node. The entire process must be harmonized in the interest of the community

that gave the concession to private companies tasked with providing services to the community and developing this sector in the country.

NGA will not be developed by infrastructure competition and it is unlikely that several infrastructure operators are building several networks on the same area. This is not even possible when it comes to the new market where one operator has “won” by building “his” network and afterwards, by the force of regulation, is ordered to give equal access to its use by his competitors at economical prices. We must reconcile the fact that most likely competition will occur at the service layer and not at the physical layer.

If the consequence of this ordinance is the stopping of the process of developing NGA infrastructure, the state will be forced to re-establish public enterprises owned by local governments with the task of meeting the needs of the community. Another option is to expand the scope of universal services with a range of NGN services, forcing operators with prevailing influence in the market to provide these services to citizens, accepting that obligation when signing the concession contract.

4. COUNTRY BENCHMARK

Also other European countries have enacted some rules with regard to the rollout of fibre-based networks.

In **Germany** legal provisions on the deployment of infrastructure are regulated by the respective federal states. There are no national provisions that deal with a deployment of fibre optic infrastructure in specific. Rather, the federal states and the municipalities have developed their own provisions, which are applicable for the deployment of infrastructure in general. It is important to note that the specific provisions are related to investors that receive subsidies from the states for network rollout and thus cannot be seen as a general requirement for any time of NGA deployment.

The state of Baden-Württemberg (one of the 16 federal states) determines in its specific technical rollout concept for subsidies that the use of standardized ducts has to be evaluated. There is a standardized duct system described in the rollout concept that has to be installed whenever possible. The deployment is independent of already existing plans for the implementation of an optical fibre network.

Further, subsidies in Baden-Württemberg, following the European competition rules, require a technology neutral approach. Thus, the use of such type of ducts shall allow for the provision of any type of cable-based network.

The state of Schleswig-Holstein sees local municipalities as primary investors for the rollout of duct systems in their region. But also private firms or both, municipalities and private firms may jointly invest in local infrastructure. Regional governments may financially incentivize private firms in order to close the efficiency gap. Primary goal is that ducts shall be offered for rent as well as for sale by local municipalities in order to foster infrastructure rollout (Schleswig-Holstein, 2011).

In **France** three different classes have been developed and different provisions as regards access to infrastructure respectively deployment of infrastructure have been determined (Toledano, 2010). The main aspects in the French regulation are:

- Access to civil works infrastructure has to be granted to all operators (e.g. ducts and poles).
- Infrastructure sharing in the last mile is promoted. This includes shared investments.
- In less densely populated areas, the last mile has to be shared so that all operators can connect to the building.

Furthermore, the space inside the building (in-house cabling) of newly furnished properties is to be shared by the operators. All operators that have connected homes must provide offers, which specify the technical as well as economic terms for sharing the in-house facilities:

- Information on already equipped buildings and already existing shared access points
- Terms and conditions of deployment of dedicated fibre or flexible access point
- Access terms for dedicated/shared fibre
- Terms and conditions for access of associated facilities

Residents of the connected buildings must be able to choose their broadband operator without regard of the “building” operator. Accordingly, this is a “right of access” to in-house infrastructure for third operators.

Further, local authorities can impose an obligation on operators to give access to its network in a transparent, objective and non-discriminatory manner. Incumbents – based on an SMP decision – have to provide access to their ducts at cost oriented tariffs, and have to publish a reference offer for duct access. The offer must comply with some “key principles of engineering” which are to be worked out in advance.

There are also technical guidelines in **Switzerland** issued by the federal department of environment, transport, energy and communications (Switzerland, 2010). These guidelines have been triggered by the rollout plans of fibre networks of a number of energy utilities (which have established a joint platform openaxs) on the one hand as well as the incumbent operator (Swisscom). These guidelines represent an agreement on technical interfaces. The technical guidelines are not on the same level of detail as in the ordinance in Croatia. The guidelines rather serve to achieve a standardized rollout although the guidelines have no legal basis.

The guidelines refer to the fibre characteristics (monomode fibre), the building entry point (splicing compatibility, colour coding of the fibre, bending radius, careful installation recommendations), ducting, the number of fibres for in-house installations (4 fibres per household) and the connection box (protection and operating temperature).

In 2009, **Austria** introduced new regulations on infrastructure sharing (§ 8 TKG): All owners (not just telecommunications companies) of ducts and poles have to provide access to their infrastructure, whenever it is economically and technically reasonable and feasible. This provision was introduced to making available the passive infrastructure of non-telecom operators such as utilities for the purpose of rollout of broadband networks. The right of infrastructure sharing also comprises the utilization of operative equipment and grants access to the affiliated buildings and installations. This right is not a general right to the whole infrastructure of a company but describes only an access right to a specific duct, fibre or other facility. The right of access has to be requested for each single line/facility. Therefore, such obligation does not replace/substitute access obligations under SMP designation.

Further, there are specific access rights concerning network equipment and functions based on significant market power (§ 41 TKG). Incumbents may be obliged to provide access to their networks not only under the aspect of cable infrastructure sharing, but also with respect to higher level services, i.e. utilization of the incumbent’s network as a platform for competitors to offer their own services.

The latest market analysis in Austria undertaken by the national regulatory authority (M 3/09, 2010) showed that alternative network operators have significant disadvantages regarding economies of scale, collocation at the street cabinet or the central office and regarding backhauling when rolling out NGA-networks. Such asymmetries in the rollout justify additional obligations on the incumbent.

Countries like **Australia**, **New Zealand**, **Qatar**, **Korea**, **Japan** and **Singapore** have chosen a completely different way with regard to the fibre rollout. In these countries, it is mainly a monopoly or state owned operator that undertakes the building of the infrastructure. In some countries the operator is additionally separated into an infrastructure and a service company, whereby the open access concept for service providers is widely implemented.

5. CONCLUSION AND OUTLOOK

Next generation access based on fibre optic infrastructure is putting a large challenge on each country, their telecommunication market, and the national regulatory agency. The intention of the Croatian regulator is to define a framework for the deployment of this new infrastructure whereby the specific national environment and the future development of the Croatian telecommunications market has to be taken into account. In Croatia there is no direct incentive for investment and deployment of optical access networks. The regulator is aware of the fact that in the competitive environment of the telecommunications sector investment in future-proof fibre-based access networks will only be undertaken if a positive business case materializes. Because of the importance of telecommunication infrastructure for the economy of Croatia and considering the trend by which the capacity of the existing copper based network is reaching the end of the lifecycle, the regulatory authority is of the opinion that the rollout of the new fibre-based distribution network can not be left to the interest of the private market only and requires state intervention.

The intention of the Croatian regulator by putting in force the ordinance on technical requirements and conditions of use of optical distribution networks is to create the foundation for rational long-term investments in the deployment of a common distribution network used on an equal and non-discriminating basis. Thus, the Croatian regulator is envisaging pure infrastructure investors and municipalities that are rolling out fibre-based networks on an open access basis.

According to the regulatory agency municipalities and towns will build their own local infrastructure, calling this approach “integrated infrastructure“ by which the rollout of telecommunication infrastructure would take place in parallel with other construction work for community utilities and infrastructure. In this sense the regulator is looking for the governmental/municipal investments in infrastructure. Hereby HAKOM is aware of the fact that each national regulatory agency has the task of finding a good compromise between encouraging efficient (private) investment and promoting market development.

With this approach, HAKOM intends to limit the problems with vertically integrated operators by fostering open access infrastructure and is in parallel enabling competition on the service level. Infrastructure based competition is not on the agenda of the authority, it rather sets clear signs for long-term investments with a single monopoly infrastructure. Hereby, it follows to a certain degree the approaches chosen in Australia with its state owned national broadband network plan but hands over the investment burden to its municipalities. The authority is intentionally increasing the technical standards for the rollout of fibre-based networks in order to ensure a future proof network.

Current economic downturns present serious challenges but can also be viewed as opportunities for structural reform and targeted investment in strategic areas such as broadband. Parts of recommendations given by the ITU-T and EC are concerning steps to promote infrastructure sharing, whereby the local authorities should be encouraged to support and facilitate the deployment of new and the sharing of existing infrastructure. Future infrastructures need new interoperability standards and the ordinance is setting some of them.

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