

Overview of wireline access technologies in Kosovo

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Abstract - This paper provides an overview of the existing wireline access technologies in the Republic of Kosovo. In addition, the market share is presented as well as the impact that competition, government and the regulatory authority have on Kosovo's wireline market. In this market, there are three main players, followed by some local internet service providers. Copper-based networks, such as twisted-pair and coaxial cable networks, dominate Kosovo's wireline access topology. Even though FTTH is not new to Kosovo, its deployment has been very limited and expansion is related just to the connection of business clients. In the past two years, two of the main operators (IPKO Telecommunication and Telekom i Kosoves) have started with the deployment of FTTH, with gigabit passive optical network technology being the preferred architecture.

Keywords: Hybrid Fiber Coaxial Network, ADSL, Fiber to the Home, Point to Point links, Gigabit Passive Optical Network

1 Introduction

Kosovo is the youngest country in Europe, with a population of just under 2 million [1]. Kosovo is also the country with the youngest population in Europe, with around 50% of the population being under 30 years of age [1]. Kosovo has an average of 5.9 family members per private household, and a total of 297,090 households [1]. The demand for internet connections as a route to electronic communications and as a source of entertainment is high. In the Republic of Kosovo, based on the statistics of the Regulatory Authority of Electrical and Post Communications (RAEPC), today 73% of households use internet services, compared to the beginning of 2011, when the number was 45%. The reasons why 27% of households are not in a position to use internet services fall into several categories [2]. In some parts of Kosovo, because of geographical configurations, the deployment of the network is very expensive and its implementation is very difficult. Another reason is that significant numbers of families do not have the knowledge to use internet services. In addition, there is the price of these services, bearing in mind that in Kosovo unemployment is very high.

Figure 1 presents the number of internet users, the percentage of users versus the number of households and the growth of the number of users of the internet for the period 2011–2015. The market leader in Kosovo offering broadband services is IPKO Telecommunication, with a 47.84% market share, followed by Kujtesa with 24.37%. Telekom i Kosoves (Telecom of Kosovo) is third with 15.46% of the

market. The rest of the market is distributed among local internet service providers (ISPs) that operate in Kosovo [2].

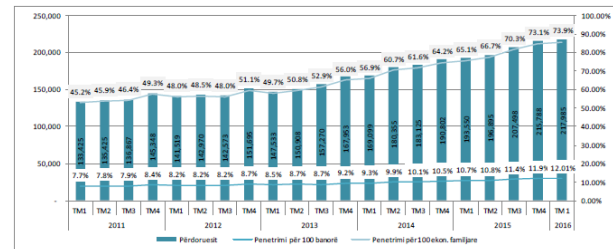


Figure 1. Number of user connections in Kosovo [2]

2 Wireline technologies in Kosovo

Kosovo's wireline access technology consists of different types of networks, the market share of which is presented in figure 2. The dominant technology is the Hybrid Fiber Coaxial (HFC) network, with most of the operators opting for this technology, followed by Asymmetric Digital Subscriber Line (ADSL). Recently, the main operators have started with Fiber to the Home (FTTH) technology for widespread use, where the preferred topology is a gigabit passive optical network (GPON). Over 74% of internet users are connected through the HFC network, followed by 18% of clients that use their services through xDSL lines. FTTH clients make up 2% of the total number of clients that use their broadband services through a wireline access network [2].

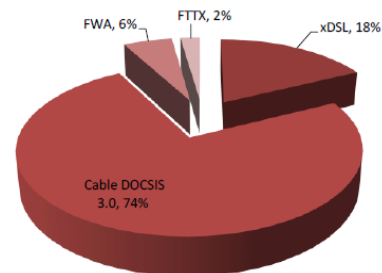


Figure 2. Market share based on technology

2.1 IPKO Telecommunication

IPKO is a telecommunications company founded in 1999, just after the war was over in Kosovo. For several years IPKO operated as a local ISP, offering internet services through wireless P2P links, dedicated for business clients. In 2005, IPKO started its first pilot project based on HFC, with the Data Over Cable Service Interface Specification (DOCSIS) standard. The

rapid expansion of the HFC network started after IPKO became part of the Telekom Slovenije Group.

Today, IPKO's main access technology is a hybrid network known as an HFC network, the topology of which is shown in figure 3.

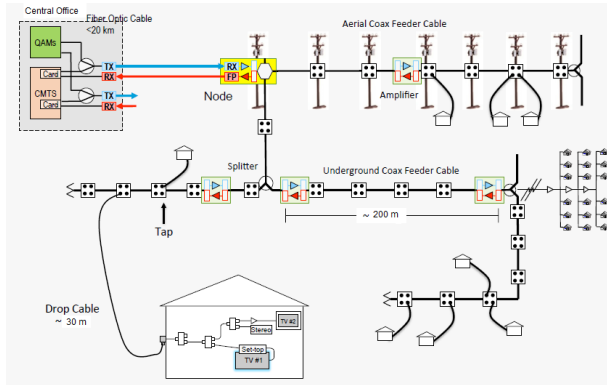


Figure 3. IPKO's HFC Network Topology

As the name indicates, HFC's access network consists of a fiber-optics part and a coaxial-cable part of the network. IPKO is using a standard where a pair of single-mode optical fibers is stretched from a Central Office (CO) to an Optical Node (ON) where an opto-electrical converter is placed. A 1310-nm transmission wavelength is applied on each fiber, for both downstream and upstream transmissions. The use of this wavelength is preferable since the optical signal has a lower banding loss at a lower transmission wavelength. Angled physical contact (APC) connectors are used at the CO and ON locations. All the other fiber joints are made by fusion splicing. A Fabry-Perrot (FP) laser is used for the optical transmission and photodetectors (PDs) are applied for receiving the optical signal.

In the coaxial part of the access network, an RF signal is used for the transmission of data, with a frequency range of 5–65 MHz for the upstream communication and 85–1000 MHz for the downstream communication. In figure 4 the current and planned RF spectrum of IPKO is presented.

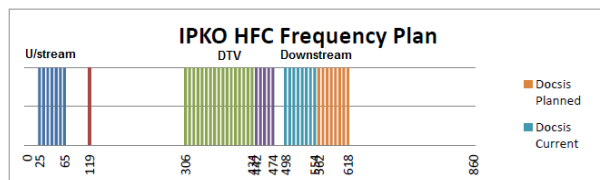


Figure 4. IPKO current frequency spectrum

Because of the attenuation introduced to the electrical signal by the coaxial cable and the passive components used for splitting/combining of the signal, RF amplifiers are used. IPKO applies an internal recommendation of not using more than three RF amplifiers in a cascade, because of the signal degradation. On average, 8 RF amplifiers are used per one ON.

The standard that enables the technical possibility of offering data services through a HFC network is DOCSIS. The implementation of version 3.0 of DOCSIS has allowed IPKO to improve the capacities offered to its clients in both the upstream and downstream directions. This was made possible by introducing a feature called channel bonding. A Cable Modem Termination System (CMTS) is located at the CO. At the client's premises cable modems for internet and VoIP communications, and Set-Top boxes for DTV services, are installed.

From 2007, IPKO has started offering FTTH connections in the form of P2P topology for its business clients. A single fiber is laid from the CO to the client's premises. Simple wavelength division multiplexing (WDM) has enabled the transmission of both wavelengths in a single fiber, where a 1310-nm wavelength is applied for the upstream direction and a 1550-nm wavelength is applied for the downstream direction. This technology was limited to business users mainly because of the costs of the connections. The capacity provided through the FTTH solution goes up to a few Gbit/s in the upstream and downstream directions.

From 2014, as part of the strategy to gradually upgrade the HFC network, IPKO has started with the deployment of a FTTH network for widespread use, as shown in figure 5. This project is still ongoing and with limited capacities.

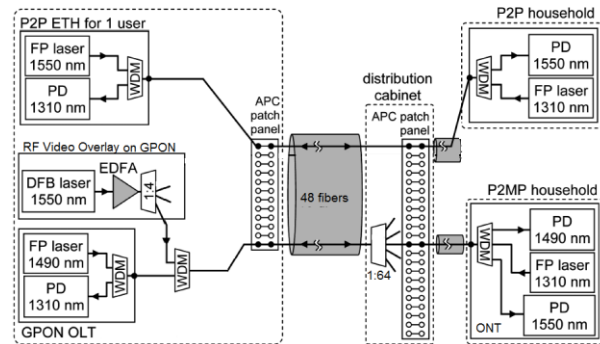


Figure 5. IPKO's FTTH solution

With respect to its FTTH technology for residential users, IPKO opted for point-to-multi-point (P2MP) with GPON topology. Because of repeated problems with power electricity, IPKO had to invest in power back-up solutions and in human resources, in order to offer uninterrupted and high-quality services to its clients. This led to many maintenance works on the HFC network, leading to increased expenditure for the company. This had an impact on IPKO, which led it to choose a passive optical network for its future network. One other reason to go with PON, specifically with GPON, is that in the future there is a possibility for a gradual migration from a HFC network to a GPON network.

For the deployment of GPON, IPKO decided to use a single fiber from the CO to the distribution cabinet, where a 64-port optical splitter is used. From the

distribution cabinet, a single fiber is laid to each potential client, up to 64 GPON household.

IPKO is using GPON with time division multiplexing (TDM-PON). In the downstream direction the data is transmitted at a wavelength of 1490 nm, through the broadcast mode, and in the upstream direction it uses a 1310-nm wavelength. By applying an 'RF video overlay' it is possible to add video content to the broadcast services. The use of video content implies the use of APC connectors.

2.2 Telekom i Kosovës TK

Telekomi i Kosovës (TK) is a public company. The roots of TK are the former Post, Telephone and Telegraph (PTT) of Kosovo, established in 1959. Because PTT offered Plain Old Telephone Service (POTS) through a copper-based twisted-pair network, TK as a company that derived from PTT Kosovo inherited PTT's assets, and consequently also its copper-based twisted-pair network. This fact was deterministic for TK upgrading its access network by deploying ADSL technology.

TK's ADSL network topology uses a twisted pair in the distribution part of the network to connect users to a DSL Access Multiplexer (DSLAM), which is located in the CO or in the field, based on network coverage.

A physical connection between the CO and the DSLAM, for the case when DSLAM is installed in the field, is implemented in two forms, which are shown in figure 6. When fiber optic is available from the CO to the DSLAM, the connection is made through fiber optic, but when there is no such option available, it uses a microwave link to connect the DSLAM with the CO. From the DSLAM to the DSL modem, twisted-pair cables are used for the connection.

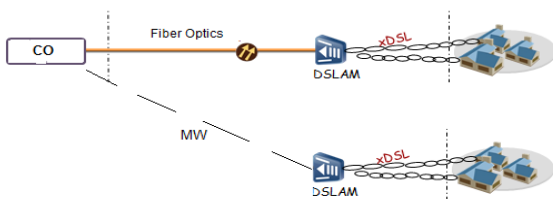


Figure 6. TK's ADSL simple topology

An ADSL network is used to connect the residential clients. TK is implementing a P2P topology with an FTTH architecture for business users. This has enabled TK to offer greater capacity and higher-quality services. For the connection of fiber optics at the CO patch panel and at the households, physical contact (PC) connectors are used. For the transmission in the upstream and downstream directions, the same wavelength of 1310 nm is engaged, since a dedicated fiber is available for each direction. However, this solution was restricted to business clients.

TK's strategy to upgrade its wireline technology from ADSL to VDSL has undergone drastic changes that led TK to start with the deployment of FTTH for

residential clients. TK's choice was P2MP topology with GPON, a similar solution to that chosen by IPKO.

Reducing the cost of maintaining the network and lowering the electricity consumption are just two of the reasons that encouraged TK to begin with GPON deployment. In addition, GPON is a future-proof topology, which will enable TK to offer High-Speed Internet and HD and UHD TV channels. For this topology, TK decided to use two step-split ratios, with the first level at the central office, with a split ratio of 1:4, and the second level, at the distribution cabinet, with a maximum splitting ratio of 1:16.

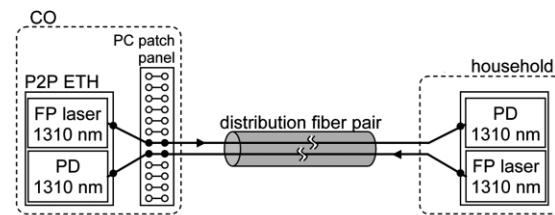


Figure 7. TK's P2P solution for business clients

2.3 Kujtesa

Kujtesa was established in 1995 as a small IT company that offered IT solutions, starting from PCs, printers, etc. After the war in 1999, Kujtesa was re-established and started its activity as a local ISP in Pristina, connecting business clients, using wireless P2P links. Kujtesa's first experience with wireline technology was when they started offering Analog TV to some parts of Pristina through a coaxial network. Kujtesa started with the modernization of its network by offering internet services on top of the Analog TV. Afterwards, Kujtesa continued its investments in the access part of the network by deploying fiber optics, which enabled the migration from a coaxial network to a HFC Network. This paved the way for an increase in capacity and high-quality services, as well as greater coverage of the territory.

Today, Kujtesa is one of the three main players in Kosovo's wireline market. Their main access technology is HFC technology, which is used to offer various commercial products, with a notable product being Triple Play, Internet, VoIP and DTV services.

The HFC topology deployed by Kujtesa is similar to IPKO's case, where a pair of single-mode optical fibers is dedicated from the CO to an ON, as shown in figure 3. Since there are two physically separated fibers, the use of the 1310-nm transmission wavelength is applied for downstream and upstream connections. A Fabry-Perrot (FP) laser is used for the optical transmission, and photodetectors (PDs) are applied to receive the optical signal. The frequency spectrum of Kujtesa is presented in figure 8. Kujtesa is using the standard DOCSIS 3.0 for data transmission [5].

As in the optical part of the access network, in the coaxial part there are many similarities between

Kujtesa's and IPKO's configuration of the network. Kujtesa also applies the internal recommendation of not using more than three RF amplifiers in a cascade.

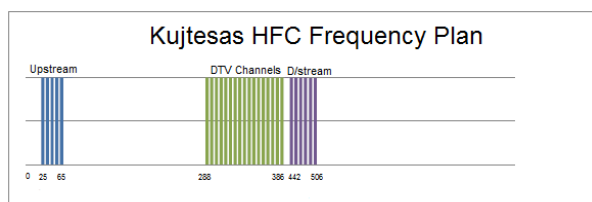


Figure 8. Kujtesa's HFC Frequency Plan

In a similar fashion to IPKO, Kujtesa is offering the FTTH solution, P2P topology for its business clients, offering greater capacities and high-quality services. The FTTH solution, shown in figure 9, is only available to a limited number of clients.

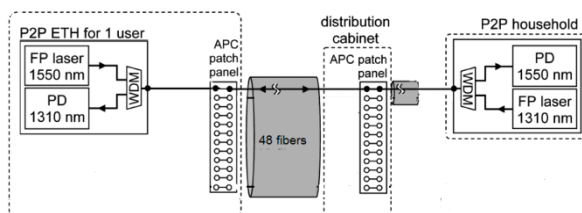


Figure 9. Kujtesa's FTTH (P2P) network topology

4. Conclusion

During the past two decades, Kosovo went through some painful processes, starting with the war in 1999. After the war, Kosovo was in a time of rebuilding, but this was a complicated process, because Kosovo had a complicated status at the international level. After 2007, when Kosovo declared its independence, things started to move in the right directions. However, even today, Kosovo finds it difficult, at some international levels, to find financial support, because of political issues.

Even though the real expansion of the access network did not start before 2005, because of very aggressive competition, within a few years, besides TK, which inherited the POTS, there were two other operators, i.e., IPKO and Kujtesa, that achieved national coverage. Today, besides the three main operators at the national level, there are many local operators, with local licenses, which operate in different regions of Kosovo.

The period of crisis in Europe had its impact in Kosovo, though not as much as in the EU states. The main impact was that during the period of crisis some capital projects that were dependent on EU investments were delayed.

Most of the operators have, as their main access technology, a copper-based access network, with TK opting for an ADSS network, which was a logical choice, having inherited its network from PTT Kosovo. As for IPKO and Kujtesa, they started building their networks from zero, choosing a HFC network as the main access technology, bearing in mind that a potential

migration to a FTTH solution would be smoother and with fewer consequences.

Operators offering broadband services to residential clients use the copper-based network. For business clients, all the operators are using a FTTH network, choosing a P2P solution. The data traffic in the P2P solution for all the operators is designed in such a way that for upstream and downstream data there is a dedicated fiber, using the same wavelength of 1310 nm in each direction.

In the previous two years, IPKO and TK have started deploying a FTTH network, opting for a P2MP solution, for residential clients. Although the P2P solution can provide a larger bandwidth per customer than P2MP, it has already been realized that a mixture of P2P and P2MP solutions will be the right, future-proof solution. While P2P will serve for more-demanding users, P2MP will be employed for residential users, with lower requirements, but will still be in line with the European Digital Agenda [6]. Both presented solutions, P2P and P2MP, are passive without expensive electronics in the outside plant and are far less costly to operate and maintain. A video signal can be delivered either as IP traffic using the IPTV solution or via RF video broadcasting over a PON. For RF video broadcasting, the use of APC connectors is mandatory, as well as the wavelength of 1,550 nm, since amplification is made by an EDFA. The RF video signal carried by a dedicated wavelength is first split into multiple, identical streams by an optical splitter and then fed into the distribution network, which can be P2P or P2MP [6].

The ultimate goal of Kosovo's main operators is installing a fiber infrastructure all the way between the CO and the business or residential customer locations. This full optical solution has numerous advantages and is also the final solution in broadband access technologies.

References

- [1] Kosovo Agency of Statistics. Population and households, 2011. Accessed June 2016, from <https://ask.rks-gov.net/sq/rekos2011#>
- [2] Regulatory Authority of Electronic and Postal Communication, Accessed June 2016 from <http://www.arkep-rks.org/repository/docs/Raporti%Vjetor%20i%20Punes%20-%20Viti%202014%2001072015.pdf>
- [3] IPKO Telecommunication, <http://www.ipko.com>
- [4] Telekom i Kosoves, <http://www.ptkonline.com>
- [5] Kujtesa, <http://www.kujtesa.com>
- [6] B. Batagelj: Deployment of Fiber-to-the-Home in the Slovenian Telecommunication Market. Fiber and Integrated Optics, vol. 32, no.1, pp. 1-11.
- [7] Ministry of Economic Development: 'Electronic communication sector policy – Digital Agenda for Kosova 2013 - 2020.
- [8] GPON Fundamentals – Huawei