Power Utility Companies as Telecommunication Service Operators

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Abstract – **After structural reform of Electricity sector in Bosnia and Herzegovina, electricity distribution companies consider possibilities to enter liberalized telecommunication market as alternative telecom operators using some of available models for provisioning telecom services. The paper presents use of Broadband Power Line (BPL) technology as a model for delivering broadband services to the End-users**.

Keywords – **electricity companies, alternative telecom operators, BPL models, Access network, In-Home network**

I. INTRODUCTION

Deregulation and liberalization of Electricity sector will causes entrance new players in the electricity supply segment of market. The onset of growing competition in the supply segment will drive electricity distribution companies to investigate and develop strategies that will differentiate their service and be able to provide competitive advantage in the marketplace. One strategy is entering the telecommunication market.

Electricity sector in Bosnia and Herzegovina is faced with ongoing structural reform. Separation of Transmission Company from other parts of system is main step. Power Generating Companies will form one holding, and Power Distribution Companies will remain as independent market entities. Following the examples from countries, which already finished such reforms, electricity companies in Bosnia and Herzegovina exploring their own capabilities for providing telecom services on liberalized telecom market.

In Bosnia and Herzegovina the electrical power distribution grid is divided into three sections with high (HV) voltage level refers to 400 kV, 220 kV and 110 kV, medium (MV) voltage level refers to 35 kV and 10 kV, and low (LV) voltage level refers to 400 V. Three still existing power utilities (EPBiH, EPHZHB and ERS), within the SCADA/EMS Project for Bosnia and Herzegovina, have already implemented and design telecommunication systems for their own needs. The general approach was to design and build a communications system that would satisfy the current and future communications requirements. The network architecture was developed to support a wide range of utility information exchanges as well as integration with regional utility operations and possible interfaces with external markets, users and third party service providers. It is about modern communications systems based on SDH technology with STM-4 and STM-16 multiplexing equipment and realized mostly using OPGW cables. OPGW cables are installed or will be installed during reconstruction for all HV and MV (down to 10 kV).

Depending on the shape and operations of an electricity company, there are various paths that can be taken in order to enter telecommunications market. These paths cover a wide area of telecom services, ranging from basic property leasing land for mast builds, to complex managed services such as the provision of telecommunication data services using IP VPN. Generally, there are three basic models that can be defined for entering telecommunications market:

- Model 1: Fixed networks – unmanaged services *(Rights-of-way; Duct space; Dark fibre; Lit fibre-Wavelength)*
- Model 2: Fixed networks – managed services *(Co-location; Managed transmission; Non-IP and IP wholesale; End-user services)*
- Model 3: Mobile network services *(Leasing: existing land, rooftops, towers; Build towers: new business or partner; Backhaul provision, MVNO-Mobile Virtual Network Operator; Mobile Network Operator)*

There are several options in each model, which may be used by electricity distribution companies, but this paper is focused on the Model 2 for providing telecom services to the end-users.

After the signals is transmitted over fibre network to the 10 kV power network or in some cases to the 10/0,4 kV/kV transformers there is still problem how that signals forward to the users premises. One solution is employing *Broadband Power Line - BPL* technology on MV and LV segments of power network, for delivering broadband services to their customers.

II. BPL OVERVIEW

Broadband over Power Lines (BPL), also known as Power Line Communications (PLC), is a rapidly evolving technology that utilizes electricity power lines as “Local Loop Access Medium”, for the high-speed transmission of data services. BPL works by transmitting high frequency data signals through the same power cable network used for carrying electricity power to household users. Simultaneous transmission electricity and data over same power lines is possible due to transmission over different frequencies. Electricity is transmitted at low frequencies (50 Hz), whereas data signals are at range 1,7 to 30 MHz).

The new low-power, unlicensed access BPL systems couple RF energy onto the existing electric power lines and carry high-speed data signals outdoors over the medium voltage line from a point where there is a connection to a telecommunications network. This point of connection may be

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at a power substation or at an intermediate point between substations, depending on the network topology. Within a residential neighborhood, most access implementations employ a coupler or bridge circuit module at the low-voltage transformer to enable the transfer of high-frequency digital signals across the distribution transformer (the low voltage transformer is a poor conduit for high-frequency digital signals, as it is intended to conduct 50 Hz signals). The broadband communication signals are then brought into the home over the exterior service power cable from the coupler/bridge, either directly, or via an access BPL adaptor module.

Some access BPL implementations use the medium voltage lines to bring the BPL signals to neighborhoods and employ a wireless link between a transceiver mounted on the power pole and a companion transceiver located inside the end user's premises to complete the connection. Typically, the medium voltage lines are carried overhead on transmission poles or tower mountings; however, in some locations they are enclosed in underground conduits and only the distribution transformers are mounted above ground on a pad, inside a metal housing.

In addition, BPL systems can be used by electric utilities to manage their electric power networks more efficiently. Utility company application may include AMR (automatic meter reading), voltage/VAR control, SCADA (supervisory control and data acquisition), equipment monitoring, energy management, remote connect / disconnect and power outage notification, along with collecting power usage information to be used to bill customers. BPL is simply data transfer via a combination of the power network within the home or office, the metropolitan power distribution grid, and a means of getting the data signal from the Internet Service Provider – ISP to the "last mile" point of injection on the power line or grid. Most important is that there are no needs to install new wires in the "last mile", and BPL takes advantage of one of the largest networks on earth - the power grid.

III. DEFINING BPL MODELS

BPL systems are categorized in two segments. These segments can be considered as two models for application:

- Model 1 – External system (Access BPL)
- Model 2 – Internal system (In-House BPL)

External system (Access BPL)

Access BPL equipment consists of injectors (also known as concentrators), repeaters, and extractors. BPL injectors are connected to the Internet backbone via fiber or T1 lines and interfaced to the MV power lines feeding the BPL service area. MV power lines may be overhead on utility poles or underground in buried conduit. Overhead wiring is attached to utility poles that are typically over 10 meters above the ground. MV distribution circuits running from substation comprises three-phase wiring. One or all three-phase lines (in most cases) branch out from the three-phase lines to serve a number of customers. A grounded neutral conductor is generally located below the phase conductors and runs between distribution transformers that provide Low Voltage (LV) electric power for customer use.

BPL signals may be injected onto MV power lines between two-phase conductors, between a phase conductor and the neutral conductor, or onto a single phase or neutral conductor, depending upon the application being utilized. Extractors provide the interface between the MV power lines carrying BPL signals and the households within the service area. BPL extractors are usually located at each LV distribution transformer feeding a group of homes. Some extractors boost BPL signal strength sufficiently to allow transmission through LV transformers and others relay the BPL signal around the transformers via couplers on the adjoining MV and LV power lines. Other kinds of extractors interface with non-BPL devices (*e.g.*, WiFi) that extend the BPL network to the customers' premises.

For long runs of MV power lines, signal attenuation or distortion through the power line may lead them to employ repeaters to maintain the required BPL signal strength and fidelity (typical distance without a repeater is from 300 to 500 meters). Figure 1 illustrates the basic BPL system, which can be deployed in cell-like fashion over a large area served by existing MV power lines.

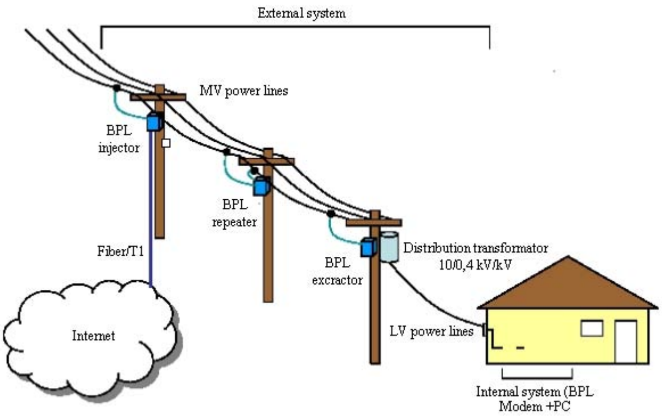

Figure 1. External BPL System

Internal system (In-Home BPL)

In-House BPL utilizes a building's existing electrical wire as a local area network (LAN). By simple plugging a modem into an electrical outlet, a user can communicate with other computers and printers on the same network within the building without any new wiring. Since nearly every room in a house or building has an electrical outlet, this allows for a very extensive and flexible network. Current technologies support speeds up to 14 Mbps, but theoretically should be able to surpass 100Mbps. Cost reductions, particularly in semiconductor chips, has allowed prices for power line modems to become affordable at €50-€70. Figure 2 illustrates internal BPL system (In-Home network), which uses home electrical installations as computer network.

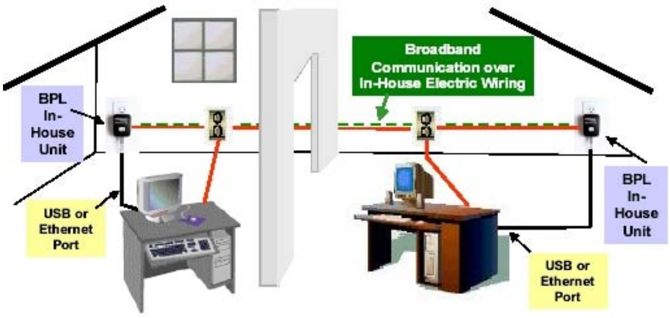

Figure 2. Internal BPL System

IV. ADVANTAGES

One of the major advantages of BPL is that the basic infrastructure is already in place. This allows the power companies to roll out the service faster and reduces the amount of capital expenditures required. Significant is the fact that other broadband technologies currently available on the market, such as fiber optic, Wireless Local Loop, UMTS, xDSL, CaTV, etc., can yield comparable or higher throughput than BPL but generally do not have a fully deployed infrastructure with which they can reach a mass market in such a short timeframe. Penetration of power lines to homes and businesses of potential users is very near 100%. BPL service is a potentially attractive and cost-effective way to reach rural customers that do not have access to cable or DSL. Estimates are €130-€250 (depending on technology) per house/building passed to upgrade power lines and provide BPL access. This allows the service to be offered to the consumer at lower prices than DSL or cables. Preliminary estimates are in the €25-€50 range. This attractive price point could influence customers that already have cable or DSL to switch to BPL and should make the service an easy decision for rural customers. BPL technology has the capability to deliver speeds up to 54Mbps, but current testing delivers reliable signals in the 2 to 5Mbps range. From the government's point of view, BPL increases national security. Wide scale BPL would provide another layer of redundancy for communications systems and allow more careful monitoring of the power grid. Overall the implementation of BPL could offer both consumers and ISPs a third broadband access solution

V. DISADVANTAGES

One of the biggest issues is potential interference with other electronic equipment. Power lines were designed to carry electricity and not data. Therefore, signals transmitted across power lines could leak out and cause interference. Conducted energy can cause harmful interference to radio communications by two methods. The first is radio frequency (RF) energy may be carried through electrical wiring to other devices also connected to the electrical wiring. This poses a problem with In-House BLP. Other devices plugged into the electrical wiring could pick-up interference from the network. Second, at frequencies below 30 MHz, where wavelengths exceed 10 meters, long stretches of electrical wiring can act as an antenna, permitting the RF energy to be radiated over the airwaves.

As a result of low propagation loss at these higher frequencies, the radiated energy can cause interference to other services even at large distances. Solution is in using orthogonal frequency-division multiplexing (OFDM), a technology similar to that used in DSL. This creates a low power signal by spreading the signal over a very wide bandwidth. Using OFDM substantially reduces the chance of producing interference. In addition, most new BPL equipment has the ability to blocking frequencies that may conflict with nearby devices.

VI. BPL POTENTIAL IN BOSNIA AND HERZEGOVINA

Considering BH telecommunications market liberalization level as well as power company's assets for providing services as alternative telecom operators, it could be understand that BH power companies may use options from Model 1 and Model 2 for entering BH telecom market.

BPL technology has unique potential for BH power distribution companies either they leasing bandwidth (end-to-end connections) or they providing broadband services to the end users (Internet services for example). Figure 3 illustrates network architecture for providing such services using combination of optical and BPL technologies. Target consumers are various financial, government, cultural and educational institutions and organizations, which has geographically dispersed subsidiaries all over the country. Figure 3 represents example of linking couple subsidiaries with NOVA BANKA A.D head office.

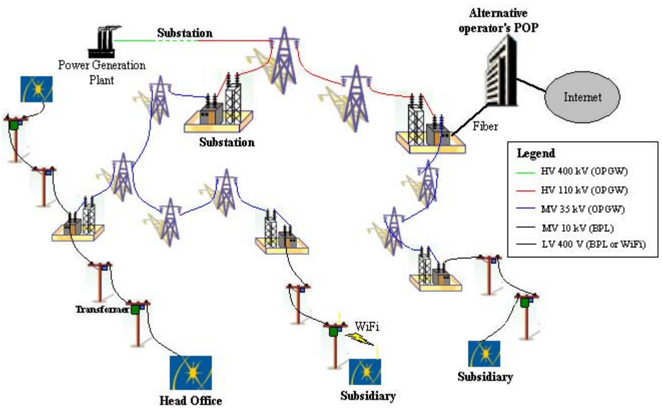

Figure 3. BPL example for NOVA BANKA AD networking

Although, the broadband access is the future for communication services, in the Bosnia and Herzegovina, across all technologies, the penetration is very low. In this case, the total and especially rural market for BPL might not be as large as expected. Power companies, alone or with partners, would potentially have to go after current broadband users to create a profitable business model. One solution might be bundling strategy (one-bill for electricity and telecommunication services), with competitive prices for broadband access.

VII. Conclusion

After structural reform of Electricity sector in Bosnia and Herzegovina, electricity distribution companies will get possibilities for entering liberated telecommunication market as alternative telecom operators using some of available models for provisioning telecom services.

Beside the fact that power utilities in BH has already designed and implemented modern telecommunication system based on optical SDH technology, there are still problem of “last mile access” for provisioning services to the end users. To overcome this problem application of the BPL technology over MV and LV segment of power network is recommended.

In order to perform a set of measurements of BPL channel under practical power line noise and impedance loading, and to investigate commercial viability of such appliance a pilot projects are planed and will start in near future, in Bosnia and Herzegovina, within regional electricity company operating in Sarajevo.

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