B-PLC hierarchy model approach: based on ATM network.

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Abstract. In this paper, we present applications using Broadband-Power Line Communications (B-PLC) networks in low voltage conditions; improving multi-objective paths as a function of base station (BS) and channel allocations (CA). Considering the B-PLC network hierarchy model approach based on ATM Networks, we identified the basis for Generalized Base Station Placement (GBSP), minimizing costs and maximizing coverage as well as the Signal Noise Rate (SNR) and Channel Frequency Response (CFR).

Key words: MV-LV, networks, B-PLC, GBSP, SNR.

I. INTRODUCTION

A B-PLC network access consists of CPEs (number of user terminals) that transmit and receive traffic in a shared medium from an Electrical CS (centralized station).

The REP (repeaters) are normally inserted in the B-PLC network in order to retransmit the signal and thus increase coverage, as the signal is too weak to reach all CPEs from the same CS (centralized station). Repeaters can be either TDR (Time Domain Reflectometry) or FDR (Frequency Domain Reflectometry).

Network topologies are commonly expressed as ring shaped; but in the LM and MV, are reduced to a CS (centralized station) considering the repeater structure. Therefore, the topologies considered by B-PLC access network are based on tree-like descriptions, depicted in figure 1, in which a central node called a CS (centralized station), concentrates all up and down stream traffic.

The B-PLC is a tool used to provide telecommunication services such as: internet, IP-telephones, etc, using LV and MV lines, thus saving in investment, installation costs, and network access. Therefore, most MAC (Media Access Control) techniques are candidates to be used in B-PLC environment communications, that provide: accessibility, proactive containment and arbitrary protocols. Normally, these topologies are described as busses or trees, but the last processing step for MV and LV requires the tree model.

Gateway traffic communication in B-PLC terminal service network is usually located in a MV transformer, allowing it to operate within a WAN (Wide Area Network).

This paper does not focus on the enormous complexity that exists in creating topology communications or telecommunication networks, leaving experts to research this area, considering the aspects such as: control versatility connections and low costs involved in installation.

B-PLC network functions in the last mile concept is integrated by an MV-LV electrical network as a WAN hybrid solution. This methodology uses a physical grid area, supported by VCP (Virtual Connection Path).

The first part of the grid is based on the ARQ technique (an engine for Java framework building Semantic Web applications) oriented by point-to-point connections. The second adapts the Hierarchy Model Approach to ATM [1]. So that, this carries out the base station placements and channel allocation model considering multi-objective concepts [2].

The B-PLC methodology requires stage numbers, based on the Hierarchical Model Approach identifying and scheduling stages by medium and low voltages, with respect to the topology proposals.

A typical B-PLC access network is shown in Figure 2, where the BS (base station) is built into the transformer station by MV (medium voltage), inserting the information signal in the low-voltage line cable, using a modem device to connect the terminal end-user power cables [2].
The network efficiency operations depend on a set of design parameters where one is the optimal routing for medium and low voltages. The efficient routing design policy has enormous complexity, because it is a function of: a) uncertain variables and unknown parameters sets, b) bandwidth and performance that the network must support, and c) SNR parameters. The policy routing has traffic supplies and topology changes.

II. MEDIUM AND LOW VOLTAGES NETWORK STRUCTURE

Electricity distribution networks are formed by three main levels as shown in Figure 3: a) High voltage network, consisting of the highest grid voltages, b) Middle and c) lower voltages that transmit data.

In this paper we are interested only in showing the half grid and low-voltage access broadband networks.

Medium-low voltage networks MLV-Ns have different structures for each location, observing the great differences between urban and rural areas, as well as residential or industrial users, changing the operational conditions. Either way, taking into account environmental conditions, MLV-Ns gives a structure classification. An example of this was proposed in [3], categorizing the grid structures for medium and low-voltage lines in agreement with the following type conditions:

A: Scattered building establishments.
B: Villas and mainly agricultural buildings.
C: Small houses with low density establishments.
D: Family homes with high-density establishments.
F: Buildings rows with low density.
G: Tall buildings rows with high density.
H: Separate building blocks

I: Medieval towns.

The influence of the above conditions in the MLV-Ns considers two grid power structures classified as types B and C, shown in Figure 4 and Figure 5, respectively. These figures show what we call an "island of medium / low voltage." An "island" means that the set (or entity) is formed by a transformer, telephone box or energy user that connects to this system. In this research, we believe that the "islands" are independent in each division, having uncorrelated scheduling.

III. HIERARCHICAL APPROACH MODEL AND ITS TOPOLOGY APPLICATIONS

The hierarchical approach design is a reference model where the strategic design of the communication networks has many layers. For example, the OSI model allows intercommunication between two computers through layers. This modular concept has many elements to be used reducing the design complexity and providing fault diagnosis locations [4].

The hierarchy model approach is shown in Figure 6.
a. Heart Level
This level is defined as part of the ridge of the available high-speed network. In this part we assign the topological arrangement of the medium voltage network. It is described as the backbone of the switches and its operation is based on the established virtual path connections between switches. This determines the necessary connections provided by each B-PLC subnet.

b. Distribution Level
This level refers to the demarcation boundary between the access layers and the network core. This includes management aspects such as traffic routed to specific interfaces, security, broadcasting definition domains, and communicating between different protocols. It can also specify limit and dynamic routing protocols.

Therefore we believe that BS (base stations) with a link to the end users, mark the distribution level, and determine the B-PLC technology for medium and low voltage. The first level indicates a routing environment and assignment working groups as well as the allocation of signaling protocols. The number of BS and their locations should be optimally chosen in order to be available to serve all users with minimal costs. Within the BS we find the right position and determine the users sub-set to be served. In some cases, one user needs a repeater to enhance the quality if the distance is longer than the coverage. All these tasks are related to its placement.

c. Access Level
At this level, the users have access to local segments on the network. Assuming that the B-PLC system uses the OFDM system, each BS must have a certain number of B-PLC channels, which can be used to communicate to the subscribers. The number of channels should be allocated to cover traffic generated by users on the BS. Furthermore, the channel allocations must not cause harmful interference to the nearby BS. This problem is not taken into account by the B-PLC and B-channel allocation (CAP - PCAP). The B-PLC M-LVN network structure determines the outcome of the approach model network hierarchy. Finally, this classification determines the scheduling operability for multi-objective problems.

IV. SCHEDULING ACCESS AND BASE STATION PLACEMENT
The main task for B-PLC scheduling transforms the M-LVN applying the Approach Hierarchical Model into B-PLC, as shown in figure 7.

An example of a LVN typical structure considered in [4] is shown in Figure 8, where a B-PLC site is a set of nodes or cells. Figure 9, shows a node or cell as an entity composed by BS users, repeaters and a B-channel subset.

Figure 7: Hierarchy B-PLC network standard approach.

Figure 8. Type C structure established for low-voltage network topology.

Figure 9. B-PLC site described as battery cells.

B-PLC integrated cells are connected to a Base Station (BS) as a backbone telecommunications network also called Wide-Area Network (WAN) giving provision services. Integration cells and connectivity depend on the following tasks. The first defines the optimal Base Station (BS) placement with respect to PLC cells. The second identifies the repeater placement (RP), and the third schedule serves as a base for signal limits coverage, place locations and repeater stations. All of these tasks assume that the Wide-Area Network access points (WAP) are available and known, operating through optimal lines or wireless, or a combination of both.

The BS access problems are classified as:
- Base station placement (BSPP).
- Repeater placement (RPP).
- WAP.
This solution using electrical lines lowers cost investment with respect to other WAP applications, thus accomplishing the following conditions:

- Minimize costs and hindrance or postponement.
- Maximize coverage, network ability, effective use capacity and scope.

Therefore the solution of BS identification is primarily focused on the hierarchy model approach according to type C topology in order to have acceptable quality service levels and network performance. Figure 10 shows the BS problems, considering the electrical panel and its details, and specifying the correct location.

V. Experimental Development

According to previous sections, the first three stages HE explain an arbitrary location in the grid, and the second locates the correct position of HE according to the hierarchy model approach. The noise ratio with respect to the first stage is less in B-PLC cells, considering 20 meters as an average distance. The third stage was monitored obtaining 30 dB on average for SNR transmissions. Model 1 considered the Communication Center for Television and Radio located in Mexico City, shown in Figure 11, followed by its line diagram, identifying the CPE and HE locations. The SNR and CFR (Channel Frequency Response) are shown in figures 12 and 13, showing local and remote measurements, respectively.

In the second scene the line diagram is shown in figure 14 and CFR and SNR are shown in figure 15. Applying the hierarchy model approach the distance from the electric board and HE is greater than in the first scene.
The third scene shown in figure 16, uses the most accurate hierarchy model approach with other electrical networks, using the CNM electrical school net (located in Mexico city), where the larger structure in wiring has about 400 meters, shown in figure 17, which obtained an average reading of around 30 dB and SNR around -5 dB, CFR as shown in figure 18.

V. CONCLUSIONS

In this paper, we analyzed the B-PLC network scheduling implementation for medium and low voltages, using a Hierarchy Model Approach such as ATM network. The requirements and problems were analyzed improving multi-objective paths which are determined by two design aspects of a B-PLC network, minimizing costs, hindrance or postponement, and maximizing coverage, functionality network, capacity in a PLC network approach. This is the focus of a connection-oriented network and its specifications in terms of a medium-voltage connection. The strategy was the basis for the B-PLC network. This obtained a better performance in QoS (Quality of Service), and traffic, linking the physical level to the intervention of B-PLC channels by different nodes.

Hence under this scheme we designed a MV / LV type C security topology using a hierarchy model approach.

V. REFERENCES

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