Polymer Optical Fibers (POF) Applications for Indoor Cell Coverage Transmission Infrastructure

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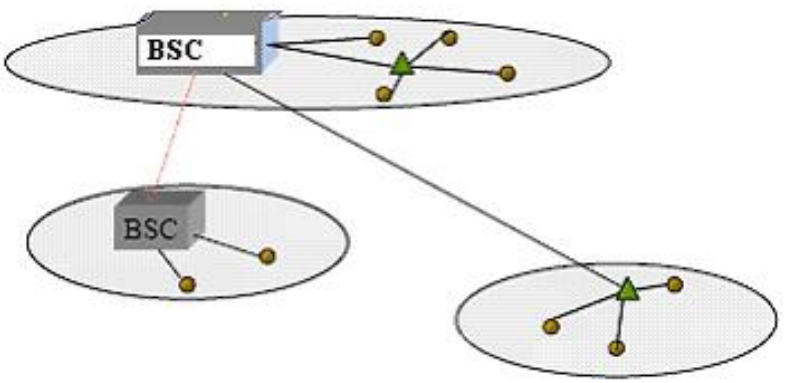
INTRODUCTION

The role of transmission network design is diverse. Basically, it includes the preparation of transmission solutions for access and core (backbone) transmission networks. In the design of a transmission network, the engineer must have knowledge about existing transmission products and also operator budget analysis. For this reason, the transmission engineer might also act in early discussions with an operator and, in that case, support the marketing unit with technical competence within the area of transmission. In GSM/GPRS networks the user traffic is circuit switched through the GSM network and the signaling messages (including SMS) are transported on dedicated circuits, while the packet traffic is packet switched through the GPRS infrastructure. One of the most important parameters to consider is the design of GSM/PRS networks is the access radio topology. The network topology selection is an evaluation process, which incorporates business strategy, investment costs, technology roadmap, network redundancy and robustness, network evolution path, and the migration strategy from the current network to the planned target network. The topology selection produces a preferred network topology plan for the target network. The topology provides information about the network such as node/site location, geographical information, existing network infrastructure, and capacity, new node/site to be added, and new network configuration, such as new hub sites. The information contained in the topology plan allows the radio transmission network planner to formulate an expansion strategy to meet future cellular network growth (Figure 1).

Cell plan is a graphical representation of the network which simply looks like a cell pattern on a map. However, there is a lot of work behind it, regarding the correct geographical position of the site, the antenna parameters and types, the dimensioning analysis regarding the offered and designed capacity and interference predictions. Such planning needs computer-aided analysis tools for radio propagation studies, for example, planning tools like TEMS CellPlanner Universal or NetHawk analyzer.

Figure 1. Radio access network for cell planning



Topology evaluation means the choice of the best structure of the network to satisfy the transmission robustness of the network. Robustness guarantees that the network will have a minimum risk of failure and hence a minimum loss of revenue. Robustness needs to be established at an optimal price-performance level. There are various topologies that are generally adopted for the development of a transmission network. The following topologies are commonly considered (Figure 2):

- Chain
- Ring
- Star
- Tree

The preferred and selected topology may be uniform across the network; however, it also may vary in different parts of the network. Different topologies could be selected to satisfy different criteria but which are the most appropriate for the regions served by the network. A special case is the indoor coverage and urban areas like city centers where the mobile handset densities and usage is high. The topology chosen may need to exhibit a high reliability or availability and be highly robust.

Since most of the operators do not own an access network during the cell planning and expansion phase, the best choice normally is to build the access network based on leased line or microwave links. A common approach is to order leased lines (LL) in the access network.

Microwave links suitable for a mobile network have transmission capacities in the range from 2 Mbit/s up to 34 Mbit/s when concentrators/multiplexers are used to save resources in long distance transmission (Louvros, 2000). The working frequency of the digital radio will set an upper limit to the maximum hop distance and will therefore determine the number of repeaters needed for a certain distance. Special long haul radios are available at working frequencies from 2 GHz and above. Typically, distances between repeaters are 40 km in the suburban or rural areas, best suited for use in the backbone network. In the access network, working with shorter distances, the working frequencies are available from 15 GHz and above. The performance and the reliability of the systems will depend on local parameters such as rain, terrain, and so forth. Microwave systems are installed quickly provided that the civil works, such as buildings and towers, are finished in advance and the advantages are high performance, high reliability, flexible haul distances, and fast installation lead times. However, for indoor applications and special cases (like tunnel coverage or underground coverage), the advantages of microwave links are not important. In these cases, only coaxial wires or optical fibers are the proposed solution. The investment in fiber infrastructure can be viewed as future-proof since it allows for easy capacity upgrading. Installation lead times are very much dependent on the existing infrastructure as well as the indoor architecture. The performance and reliability will depend on the chosen equipment, but they generally meet the specific requirements well. Furthermore, the attenuation in the fiber, which is hardware dependent, in coordination with the indoor buildings size will determine the number of repeaters needed for a certain distance. Polymer optical fiber (POF) is a promising candidate for optical cabling

Figure 2. The different transmission topologies