# Deployment of Broadband Infrastructure in the Region of Western Greece

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***Abstract*—This paper presents the work that is taking place in the Region of Western Greece in order to develop state-of-the-art broadband infrastructure. The current status of broadband infrastructure in the region is being analyzed and the main principles on which the deployment of the networks will be based on is being described, by presenting the Metropolitan Area Networks and the Wireless access networks that will be developed. Two case studies of such municipal networks are also presented in this paper.**

***Broadband infrastructure, fiber optics, municipal networks, wireless access netrwork***

## I. INTRODUCTION

This paper presents the deployment of broadband infrastructure in the region of Western Greece, by examining all the necessary parameters and studying all the issues that arise while implementing such a critical developmental project.

The presented work is part of the intervention of the operational program "Information Society" within the Third European Support Framework. This intervention aims to attain the objectives set within the framework of the eEurope initiative, the eEurope 2005 action plan. In the 1st of June 2005 the Commission also adopted the initiative "i2010: European Information Society 2010" to foster growth and jobs in the information society and media industries. i2010 is a comprehensive strategy for modernizing and deploying all EU policy instruments to encourage the development of the digital economy: regulatory instruments, research and partnerships with industry. The Commission will in particular promote high-speed and secure broadband networks offering rich and diverse content in Europe.

According to the Action Line of the Operational Program "Information Society" there have been granted actions for the development of local access network infrastructure and advanced telecommunications services for the citizen. The aim of the proposed infrastructure is to develop local access networks in small towns and non-urban or remote areas, to provide a broad range of basic telecommunication services. The development of local access networks in these regions will liberalise the market, increase competition and improve the quality of life for people living in mountain and island regions, by using information and communication technologies for improved health, education and business services. The development of local access telecommunications infrastructure will be based on a regional strategy and take account of the physical particulars, the foreseeable social, economic and population developments, and existing telecommunications infrastructure. The implementing technology that is going to be used is mainly the optical technology. Over the past few years, optics has established itself as one of the basic communication network technologies as a result of the conjunction of several key technological innovations (optical fiber, semiconductor lasers) and market needs. Thanks to Wavelength Division Multiplexing (WDM), optical transmission now makes it possible to transmit enormous amounts of information over unlimited distances. As far as transmission capacity is concerned, fiber has no competition. Another technology that could be used is the wireless technology such as Wi-Fi, WiMAX and HiperLAN.

This paper is structured as follows. In section 2 we provide an overview of the current status of broadband infrastructure in Greece. In Section 3, we present some critical issues that may govern the design of broadband networks. Following this, Section 4, reviews the overall architecture and design guidelines of the Metropolitan Area Networks that are going to be implemented in municipalities of the region of Western Greece. Section 5 is dedicated to describing the available technologies for Wireless Metropolitan Area Networks. Finally, the Metropolitan Area Network of Patras and the Municipal Wireless Access Network of Ancient Olympia with their supportive business plan are briefly described.

## II. STATUS OF BROADBAND INFRASTRUCTURE

The development of broadband access in Greece and especially in the region of Western Greece has not followed the same pace as in other countries [1]. At the current situation the proper infrastructure in Western Greece is owned only by the former public telecommunications provider (OTE), while the alternative providers seem only to have plans in expanding their network infrastructure within the city of Patras. Conducted studies on the development of broadband infrastructure in the region of Western Greece [2] have shown that the business plans of the alternative telecommunications companies and network carriers do not include the expansion of their network throughout the Region of Western Greece, since they are afraid that non urban areas appear no business utilization. Broadband access, as defined by the "Strategic text on broadband access" [3] of the relevant Task Force, requires the proper broadband infrastructure and the competition between the Internet Service Providers. Since broadband infrastructure has not been developed up to nowadays, the penetration of broadband usage has not been increased. Unfortunately, the broadband penetration level has been very low in Greece and especially in the Region of Western Greece. Greece has been the last country among the EU of 15, and remained last in providing broadband access among the 25 countries of the EU.

The reasons behind this delay are manifold, including some of the following:

- Small market and difficult market conditions
- Geographical composition not favoring network development
- Early stages of competition development in the broadband networks & services market
- Absence of services that will create demand

The limited terrestrial infrastructure (backbone and access) to date in all of Greece able to support widely broadband services is an important problem in competition development. Although some companies have asked OTE to lease infrastructures in order to be able to provide midband access services to their customers, unbundling is proceeding at a particularly slow pace. In general there is not yet sufficient competition in networks and services.

In recent years, research and educational networks in Greece are the first ones to adopt broadband services, training the future users – citizens of the country. Research – Academic Networks have always played a determining part, internationally, in the development of advanced telematics networks. There have been projects in all universities, technical educational institutes and Research Centers for upgrading their local networks into modern broadband networks, Network Management Centers were set up which have been staffed and operate with highly qualified staff.

On the other hand, the telecommunications companies raise a number of issues that discourage them from investing in broadband infrastructure and services. Synoptically these issues are:

- Lack of the regulatory framework that adjusts and defines the market of broadband services, in order to ensure the market and competition's functioning.
- Difficulties in developing the Local Loop Unbundling (LLU).
- Lack of preparation in supporting the demand of broadband services by the former public telecommunications carrier (OTE).

These issues occur as major problems in the Region of Western Greece, since most areas of the region (except from the city of Patras) have no economical prospects in developing broadband infrastructure. This fact is deterring telecommunication companies from having a powerful presence in the region, and thus contributing in the construction of broadband infrastructure.

## III. ISSUES ON DESIGNING BROADBAND INFRASTRUCTURE

This section presents some critical issues on the design of broadband infrastructure in the region of Western Greece. It presents the main principles that should be followed while developing such Metropolitan area and wireless access networks.

The plan in developing broadband infrastructure consist of a technical consultant that will provide a certain number of municipalities of Western Greece with the specialized technical support in developing the above mentioned broadband networks. In this part of the project the studies that will present the network design will be conducted, the supervision of the technical part of the construction of the networks will be done and also the design of a business plan will take place. The business plan will propose the scheme that will be responsible for the function the networks that will be developed, according to the criteria and the guidelines of the EU [4].

The technical support for the municipalities that will construct the networks is essential, since the municipalities do not have the proper know how in order to support such technical projects. Moreover, a common strategic design and implementation in a regional level is desirable. The expected results of these projects are the creation of technically correct implemented broadband infrastructure, and the existence of a business plan that will guarantee their financial viability.

### *A. Main Principles*

The main target of these networks as Metropolitan Area Networks is to interconnect the buildings of the public sector of the cities in which they will be developed. The organizations that have to be connected are the sector of education, health, culture etc. The main principle is the creation of conditions of competition in providing both access and content services in advantage of the end consumer. The provision of the broadband access and

services will be based on the open availability of the fiber optics infrastructure in a cost effective way.

The way of deployment of the infrastructure encourages the provision of a part of it, for public exploitation, through the leasing of pairs of fiber optics. This fact will provide incomes in a cost effective way in order to cover all functioning and maintenance costs.

The projects that will be implemented will mainly consist of manholes, channels, fiber optics, points of interconnection, together with the installation of the passive and the minimum active equipment in order to provide the basic broadband access in the buildings of public interesting.

*1) Open access*

The funded projects must be consistent with the new regulatory framework of electronic telecommunications and the rules of competition (public funding and antitrust). The appliance with the above mentioned rules is a commitment in order to have a clearly defined open access. In particular, the construction of the networks, as already mentioned, should be constrained in the construction of infrastructure and equipment that will be open to any telecommunication carrier and service provider [5].

*2) Neutral Operator*

The network operator should have the obligation to retain the neutral character of the infrastructure. The network should be an open access installation to all the organizations that provide electronic networks and services with absolutely no discriminations against them.

*3) Infrastructure Owners*

*a) City Network Owner*

The City Network owner is the Municipality. Their responsibility is to satisfy the needs of the citizens, provide a bundle of services and take part in the decisions regarding the pricing policy. The Municipality will have specific benefits in the development and the prosperity of the citizens, thus will also be responsible for planning the expansion of the current infrastructure, in a controlled and a rationalistic way. Since the Municipality as a non technical organization does not have the certain skills to decide and propose technical solutions, the only involvement should regard aspects that a Municipality is able to handle efficiently.

*b) Property Owner*

According to the proposed business plan the Property Owner is an enterprise or organization or a private company with installed network facilities in the property (educational institute, Business Park, complex or shopping center). The freedom of choice in the provided services is essential for the customers, while the property owner is responsible for the issues that rise due to limitations by the infrastructure. All possible costs for the expansion of the infrastructure and the distribution of the services within the property burden the property owner.

## IV. METROPOLITAN AREA NETWORKS

This section is dedicated to describing the overall architecture and design guidelines of the Metropolitan Area Networks that are going to be implemented in municipalities of the region of Western Greece.

### *A. Topology Selection*

The overall architecture of the MANs is showing in Figure 1. The topology is based on the three levels model: main network – distribution network - access network. There are three types of nodes in the system. These are:

- Main Nodes
- Distribution Nodes
- Access Nodes

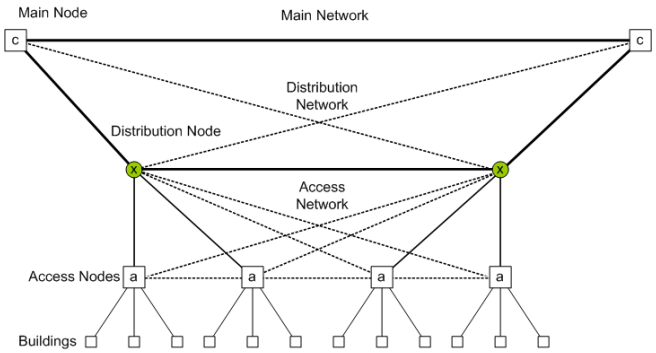


Figure 1. Network Architecture

The main network consists of a number of main nodes that are connected directly between them. In the main network there must be a direct redundancy between main nodes which are close together. This means that it must be possible from one main node to reach the main nodes next to it without passing through the active equipment of another node. The optical cables should be laid without a break between the main nodes, so as to achieve high operational dependability. The optical cables from the main network to different main nodes are to be separately ducted. The number of fibers between the main nodes in the main network in a municipality ought to be not less than 72 per optical cable (optical pipe). If main nodes in different municipalities are long distances apart, the number of fibers may possibly be smaller if this is justified by great differences of fiber cost.

As far as the distribution network is concerned, it consists of the distribution nodes. A distribution node shall connect to a main node and shall be planned to have a redundant connection to another main node. The optical cables should be laid without a break from each main node to any distribution node. Alternatively, an optical cable loop is laid with two or three distribution nodes where the need for each distribution node is hived off. Over long distances this will be a cheaper but more vulnerable option. The number of fibers in the distribution network is affected by the following parameters:

- Number of access nodes connecting with each distribution node.

- Number of operators needing connections in the distribution network.
- Leasing of dark fiber to other actors.

The number of fibers to each distribution node ought not to be less than 72 per optical cable (optical pipe).

The access network consists of the access nodes. A number of buildings are connected to an access node through a fiber cable with at least 4 fibers. The number of fibers in the connections with the buildings can vary and the decision will be influenced by the following:

- The type of the building (Public Building, Business, School etc.).
- The number of operators needing connections in the building.
- Leasing of dark fiber to other actors.

### *B. Fiber Infrastructure*

The amount of optical cable and the number of fibers in each optical cable for the different typical stretches are chosen in accordance with the following criteria:

- The amount of existing ducting
- Type of network (main network, distribution network, access network)
- Number of users
- Possible or anticipated penetration in the area
- Number of Internet operators active in the area
- Leasing of dark fiber to Internet operators, businesses and other organizations constructing active networks
- Number of main nodes in each network
- Positioning of active equipment
- Degree of redundancy in the networks

As a general rule, if existing ducting is to be used, a careful assessment must be made of the best way to use it. If the number of existing optical pipes is small, an optical cable with many fibers will have to be laid so as to make maximum use of the ducting.

### *C. Requirements*

A fiber network shall be built in such a way that the highest possible operational dependability will be achieved. Operational dependability means the network being constructed from the very outset in such a way that any disruptions due to harmful effects or accidents will be noticed as little as possible by the user. If a failure nevertheless occurs in a connection, it shall be rectifiable both quickly and easily. In order to achieve a high level of operational dependability, the network must have:

- A uniform structure: A uniform structure makes the network easy to enlarge, maintain and repair. Repairs can be carried out quickly and easily because all parts having the same function are uniformly constructed.
- Protection from damage, burglary and fire: The level of the protective measures which should be taken to counteract damage, burglary and fire shall in the first instance be defined in partnership with the insurance company which is to cover the IT infrastructure.
- Redundancy and High availability: Measurement and testing are carried out to obtain the right level of quality, so as to verify that the transmission requirements defined for a network are satisfied both by the optical cable itself and by splices and contacts.

## V. WIRELESS ACCESS NETWORKS

Wireless broadband technology can offer the most cost-effective means of providing high-capacity, high-speed, data, voice, video and Internet services. It allows large areas to get covered easily and to be expanded according to customers' demands. Wireless technology provides one of the best ways to establish high speed networks services without the cost or the long deployment time, which is experienced when installing cable or fiber infrastructure [6].

The entrance of WiMAX in Wireless Communications has brought the opportunity to establish secure links in long distances that could not be realized with the wi-fi technology. From the other hand, wi-fi technology provides mobility and scalability which are crucial parameters of a modern wireless communication network. Taking the above issues into consideration, the combination of WiMAX and wi-fi technology makes a reality the development of Wireless Metropolitan Area Networks.

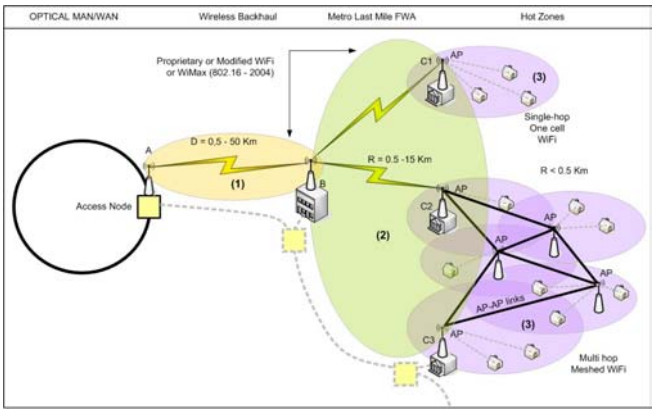


Figure 2. Different wireless deployments

There are three types of wireless deployments applicable within a Metropolitan Area Network as it is shown in Figure 2:

1. Backhaul connections with the main wired broadband network. These connections are mainly

point to point high capacity links, with high power transceivers able to cover long distances with a cost effective way. The selected technology could be either WiMAX or any technology that supports multicarrier OFDM.

2. Large cell deployments with point to multipoint connections (Metro last mile FWA). Typical cell ranges are about 10 Km.
3. Wi-fi cell deployments (Hot Zones). This type of deployment is used in such areas with high client's density with mobility requirements.

The above three deployments are illustrated in Figure 2.

## VI. The Case of Patras

This section presents a description of Patras Metropolitan Area Network which, nowadays, is in the implementation phase. The city of Patras is the biggest municipality in the Region of Western Greece, the third biggest city of Greece and has the second biggest Greek port. Patras MAN connects 300 public buildings in the city, among them 3 university institutes, 6 research centers, 4 hospitals and 120 schools (primary and secondary).

Immediately profited from this network will be all the employees of the institutions of Education, Research, Health and Public Administration in the region of Patras, while in effect profited will be all the citizens of wider region of the city of Patras.

The MAN of Patras (Figure 3) consists of three rings while the total length of the fiber ducts is 40 Km. More specifically the Patras MAN consists of:

- Three (3) Main Nodes
- Ten (10) Distribution Nodes
- Thirty (30) Access Nodes
- Nine (9) Wireless Access Nodes

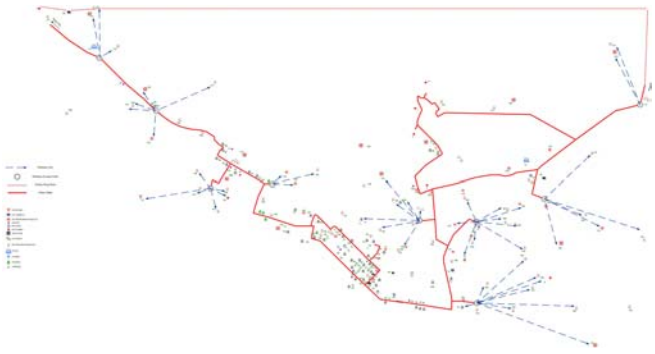

Figure 3. Patras MAN

This project is of critical importance for the city of Patras and Greece, because Patras will be the Cultural Capital of Europe of the year 2006.

Concerning the cost of the total investment, the Patras infrastructure cost approaches the value of 3.5 M€ which is absolutely comparable to the cost of the telecommunication services of the municipality of Patras. This cost is approximately 2.6 M€ according to a recent research of the Research Academic Computer Technology Institute. Consequently, the depreciation of the cost of the whole investment in the municipality of Patras will take no more than two years.

## VII. The Case of Ancient Olympia

This section presents the Municipal Wireless Access Network of Ancient Olympia that is going to be implemented in the municipality of Olympia. Ancient Olympia, the site of the Ancient Olympic Games, is in the western part of Peloponnesus which, according to Greek mythology, is the island of "Pelops", the founder of the Olympic Games.

The proposed Municipal Wireless Access Network covers the wider region of Ancient Olympia and it constitutes a network that could be easily implemented since the covered distances are relatively small. Immediately profited from this network will be all the employees of the institutions of Education, Research, Health and Public Administration in the municipality of Ancient Olympia, while in effect profited will be all the citizens of wider region of the city of Ancient Olympia.

The Municipal Wireless Access Network of Ancient Olympia (Figure 4) consists of the backhaul network and the access network. The backhaul network (depicted in Figure 4 with the black towers) consists of a number of point to point high capacity links, with high power transceivers able to cover long distances with a cost effective way. The selected technology could be either WiMAX or any technology that supports multicarrier OFDM.

As far as the access network is concerned, it could be either large scale cell deployments implemented with point to multipoint WiMAX / multicarrier OFDM technology or wi-fi hotspots if the cell radius is small enough.

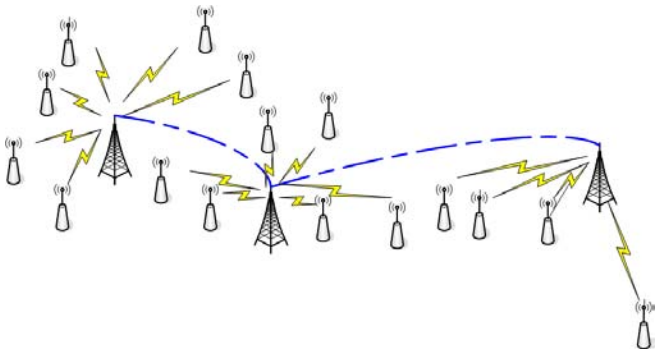

Figure 4. Wireless Network Of Ancient Olympia

## VIII. Business Plan

Concerning the financial viability of the broadband infrastructure that is going to be developed in the region of Western Greece, the broadband infrastructure will be supported by a business plan. The enterprising scheme that will be created in the region, it should guarantee the administration, growth, and exploitation of infrastructures in

the geographic extent of Region, and in parallel, it should ensure the conditions of financial viability of the infrastructures [7].

In addition, the enterprising scheme should take into consideration the possibility of leasing part of infrastructures in private companies, with a cost effective way ex. long-lasting leasing per metre and pair of fibres. This will produce incomes in the scheme that might cover the operation and maintenance of the regional infrastructure [8].

The main targets of the enterprising scheme are the following:

- The infrastructure should be used by a great number of ISPs
- The users may have the choice of selecting the appropriate ISP according to their needs
- Dig one, One wire, Triple Play
- Administration of the infrastructure by a neutral operator
- Low OPEX and CAPEX
- Financial viability in all parts of the infrastructure

The proposed business plan that fits in the above issues could be the one presented in Figure 5.

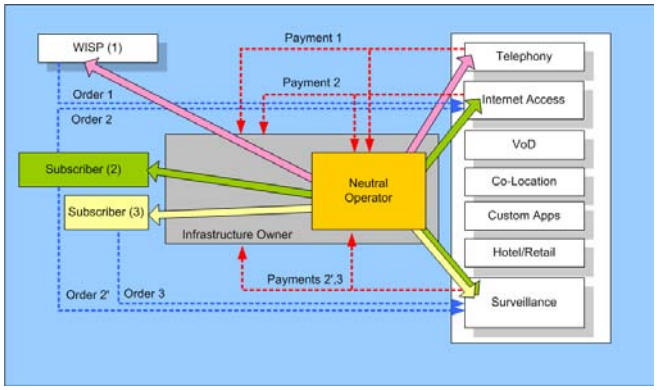


Figure 5. A proposed Business Plan

The neutral operator [9] is of critical importance for the business plan for the following reasons:

- Secures financial viability of the owners of the infrastructure (municipalities of the region of Western Greece).
- Decrease the needs for great initial investments of the service providers and simultaneously it increases considerably the availability of economically accessible services for the citizens.
- The neutral operator should be responsible for the fair revenue sharing to all the municipalities that participate in the enterprising scheme.

Concerning the owners of the infrastructure, they should focus on the following:

- Extension of the infrastructures
- Provide reliable physical connections to the subscribers
- Secure the incomes of the infrastructure through a well planed model of revenue-sharing

In the proposed business plan, the ISPs should focus on providing economical and competitive services without paying any attention to the development of the broadband infrastructure. Finally, concerning the subscribers, the presented business plan secures that:

- There is no relationship between the owners of the infrastructure and the services provided to the subscribers by the ISPs
- The subscriber could choose between a great number of services with economical and quality criteria.

## IX. CONCLUSIONS

In this paper is being presented the deployment of broadband infrastructure in a less technologically developed region of Greece. According to what presented in the previous sections, is obvious that the proposed broadband networks will cover the needs of the major cities within the region of Western Greece. These networks will interconnect the organizations of education, research, health, culture and the sum of the buildings of public administration through high speed data and a bundle of possible provided services. It is shown that the telecommunication expenditures will be reduced significantly, while it is expected that the broadband infrastructure will depreciate their value in less than two years of complete functioning of the networks.

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