Design Considerations for Broadband Community Area Networks

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Abstract

During the last few years, a number of community area networks (CAN) have been launched in North America and Europe. Contrary to other telecommunication infrastructures, these networks are sponsored and financed by local governments and operate according to business considerations and are based on business models that are different from a classical telecom operator, requiring therefore a tailored business and technological solution. Main CAN customer groups include (i) telcos and ISPs, (ii) business customers, (iii) public sector institutions and (iv) residential users. The two main product groups are fiber and wavelength products offered to wholesale customers and data, voice and video services offered to public sector institutions. Although the individual technologies to be deployed within these networks are no different from those used in the advanced telecommunications systems operated by public carriers, community networks can be more creative in using leading edge broadband core and access technologies and in providing advanced services. The main objective of the paper is to demonstrate that CANs, if properly designed, implemented and managed, represent a viable business model as well as the right technology basis for providing e-government services, in particular, and for contributing to the development of an e-society, in general. A preliminary design of a Province network in Northern Italy has been carried out by the authors and serves as a case study for this article.

1. Introduction

1.1. The community area network (CAN) concept and its role in developing in e-society

A community area network is a telecom infrastructure created and owned by a local or regional government. Community networks have evolved in the last few years in North America and, more recently, in Europe, and represent a dramatic shift from the current telecommunications business model, where the service providers own the network infrastructure and provide managed services for individual, institutional, business and government users for a fee. The products offered and services provided in a CAN are managed, marketed and sold to customers (companies and institutions) by an entity which is preferably a joint venture with the local government. Through owning a community network, local governments can create the climate for attracting new businesses, generate revenues from alternative service providers, and can leverage the synergy with local universities and research centers.

Areas of great importance for the citizen, that can be served by a CAN, include:

- Tourism: information base and access to it containing events, conferences etc.
- Cultural heritage: access to archives, libraries, museums.

- Hospitals, health care: solutions for telemedicine, interactive care, medical administration, tele-learning in health care.
- Schools, education: infostructure to facilitate continuing education through distance education and e-learning.
- Labor market: helping unemployed and other seekers of jobs as well as employers by creating and managing databases of job opportunities.
- Environmental management: creating databases and search functions.
- E-government functions: many services today provided only person-to-person can be reachable without traveling.

A large number of community networks have been deployed and are being planned worldwide, mainly in North America and Europe. In the following subsection, we are going to demonstrate some characteristic examples.

A remark on terminology: the term "community network" was originally introduced as a synonym of "free net" or "civic net" meaning the volunteer-based cooperative effort within a given community to provide free or low-cost services to citizens of that community. Today's community networks are a diverse world, some still limit themselves to services, some take care of the appropriate telecom network as well. In our context a community network is (i) an infrastructure, (ii) a business model and (iii) the set of services it offers and provides. The term Community Area Network (CAN), similarly to the widely used acronyms in computer networking and telecommunications such as LAN (a local area network) emphasizes the infrastructure aspects, as well.

1.2. Community networks worldwide

An example of a large community network implementation in North America is *Chicago's CivicNet* [1] where one of the main objectives of the project is to level the playing field for incumbent and competitive service providers in order to foster competition. A second objective is to provide affordable broadband connectivity for the SMB community and institutional users. Thirdly, the increased demand for advanced on-demand communication services as well as the generated additional business activity and employment are increasing the sales, property and income tax revenues of the city.

There are many CANs in operation in *Canada.* Let us mention *Alberta's SuperNet* [2] which is made possible by the province's investment which holds IRU on all fiber. It connects schools, hospitals and similar institutions in over 400 municipalities. New competitive telecom companies are also customers of the network and the province expects fast return of investment due to them.

In Europe a high visibility project is the *Stockholm* example. The government of the city created an optical metropolitan infrastructure and is selling dark fiber, through a publicly owned company, *Stokab* [3], which is 100% owned by the city of Stockholm and Stockholm County Council. In addition, Stokab also operates a transport network for data and telecommunication on behalf of the City of Stockholm and its public enterprises and is in charge of operating the network both for its customers and for the government. The Stokab network covers most of central Stockholm and the Stockholm County with an area of about 6500 sq. km.

Interesting examples in Italy and Germany are *Fastweb, Metroweb* in Milan, Italy and *Hansenet* in Hamburg, Germany. The driving force behind them is an Italian company, *e.Biscom*, specialized in planning, implementing and operating CANs jointly with utility companies owned by local governments. In *Fastweb,* Milan, the partner is AEM, Milan's main power utility. Fastweb uses an IP platform to deliver integrated services to businesses and residents, including telephone, high speed Internet, TV distribution and TV on demand services. On the contrary, *Metroweb*, also operating in Milan, is a provider of dark fiber products only. *Hansenet,* a joint venture with the municipal power utility in Hamburg, is similar to Fastweb in terms of the service portfolio.

1.3. CANs as the right infrastructure and business model for providing e-government services

The delivery aspect of e-government services is a very important one which is frequently overlooked, in spite of the experience that the existing telecom service providers (both the incumbent and the new competitive providers) and the ISPs (Internet Service Providers) can very rarely represent a low-cost, reliable, predictable and future-proof basis for providing e-government services.

As for the citizens, critical objectives are that the telecommunication service must be (i) ubiquitous, including rural and sparsely populated areas, (ii) inexpensive for the basic e-government services the citizens are mostly using and (iii) expandable to broadband as soon as and to the extent residents want to access new advanced services that require much higher bandwidth. Typically, telcos and ISPs can satisfy none of these conditions. Their service is not ubiquitous: areas where building up their networks is too expensive as compared with the expected revenues remain underserved (rural areas, mountains etc.). Prices even for the Internet service is too high for citizens with lower income. And because most telcos are stuck with a single technology used for access in a particular area (copper subscriber

lines, cable, wireless), they typically cannot upgrade their access network for enabling customers to use new broadband services.

For the interconnection of public institutions, broadband, reliable and cost-effective telecommunication networks are needed. Implementing government networks solely relying on facilities and services leased from telecommunication service providers is a not feasible solution, at least not in long term, and definitely not in areas where the telecom market has been liberalized only recently and the incumbent telco continues to preserve its de-facto monopoly. Telcos are not only an expensive solution today but their networks cannot support emerging broadband services or if yes, at prohibitively high costs.

Therefore, a number of local, regional and national governments have already decided to invest in a private network that is largely independent of telco's facilities, managed and maintained "in-house" and can be upgraded or extended according to future needs based only on the government decision and of course on financing possibilities.

It is easy to proceed one more step and arrive at our definition of a Community Area Network: private government networks are well positioned to serve also as basic infrastructures for services to citizens and businesses. These days a new optical cable contains up to 300 individual fibers, which in turn can be further split into tens of independent so called "wavelength" channels. This is a huge capacity and the greater part of it can be sold, as a basic infrastructure, to businesses, including telecom companies, which then will use it for their own interconnection needs (and will pay for it) as well as for providing services to end-users thus solving most of the access challenges residents face when desiring to use e-government services.

We are going to demonstrate, through a case study, that CANs, if properly designed, implemented and managed, represent a viable business model as well as the right technology basis for providing e-government services. Our methodology includes using the experience gathered from existing community networks worldwide, defining carefully the product mix and customer classes the CAN will offer, working out guidelines for technology selection, defining business models for implementation, operation and maintenance and carrying out economic/financial calculations.

The organization of the rest of the paper is as follows. We'll address the business models used in community networks in Section 2, starting with the definition of products and services, then summarizing business considerations on the implementation and operation of CANs and concluding with the analysis of the regulatory and policy environment. In Section 3, we provide guidelines for technology selection. Section 4 presents our methods applied to and results obtained for our case study, a CAN for a Northern Italian Province. We conclude with a summary and conclusions in Section 5.

2. Business models for community networks

In this section, we will deal with issues related to business planning, first summarizing the specific products and services, followed by a discussion of business constructions for the planning, implementation and operation and maintenance of CANs.

2.1. Products and services

The products and services portfolio consists of two parts. The first one contains products and services to be sold mainly to *service providers ("wholesale" products).* This includes *fiber and wavelength products, collocation services and services for ISPs*. The second part contains products and *services to be sold to end-users*. This group contains the rest of the list.

Wholesale Products

Dark fiber: In this case there is no equipment installed at the end of the fiber. Service providers buying dark fiber collocate their switching equipment in the network's switching facilities and manage their network independently.

Dim fiber: In this case switching equipment is installed at the end of the fiber. Customers who buy dim fiber remain responsible for setting up their links and for routing their information and managing their networks.

Wavelength product: In this case customers get separate wavelengths (in pairs) rather than fibers. Transmission capacity is essentially the same as via a whole fiber.

High speed transparent connections: This is a transparent bit pipe type service between service access points. Potential users of this service are those with high bandwidth demand, wishing to transmit concentrated traffic or high bandwidth real-time multimedia traffic.

Collocation and exchange point services: Collocation is a service offered by the infrastructure provider and aims at locating customer's telecom equipment within the provider's facility, together with the provider's own management and other node equipment.

Services for ISPs: The most important service is a *"virtual POP" service* where the users of an ISP can dial up to the ISP's physical POP from the PSTN/ISDN networks through the IP backbone. This way users benefit from paying only for local calls. It is an alternative to ISPs having to build their region-wide network and install physical POPs next to every local exchange.

Services for end-users

Voice services: In the context of a community network, by voice services we only mean voice over IP (Internet Protocol) when voice is transmitted in packetized form on an IP network. For the customers, however, similar quality criteria as the usual ones in PSTN have to be met, the packet network infrastructure has to be "hidden" from the users.

VPN service: VPN is essentially a managed secure private network implemented on top of a shared backbone and/or the public Internet using the Internet Protocol (hence the name IP VPN).

LAN interconnection: LAN interconnection service is a flexible, reliable, on-demand communication service and is also cost-effective for the customer compared with the high speed leased line service.

Video conferencing services: It is a family of valued-added services based on the technology that allows for voice, video and data communication between two or more sites.

Server hosting and housing: It is an attractive service for small to medium size companies (can be feasible even for large ones). By using a *server hosting* service, companies do not need to invest in own hardware and software. *Server housing* allows a company for placing its own hardware and software in the service provider's facility.

2.2. Business models

2.2.1. General

One of the characteristic features of business models for CANs, as it was already pointed out, is that for a local government - while proper management of public money is essential in the interest of the taxpayers – getting their money back in short term is not of primary importance. Thus longer ROI is acceptable, and maximizing the profit is not the primary objective for at least two main reasons. One, there are important indirect benefits resulting from helping new service providers, telcos, ISPs, value added service providers, CATV companies to enter the market and grow, thus obtaining additional revenues from their company taxes if not immediately but in medium-to long term. Two, significant savings can be obtained in the public sector by providing telecom services to institutional users using the local government's own infrastructure, as opposed to leasing telecom services from the market at market prices.

Models of operations of community networks are complicated because of two reasons. One, a local government has to carefully consider and decide on the services it wants to sell to its business partners directly, while letting them to provide other types of services themselves.

There are differences also in operational structure. A local government has to carefully design the structure of entities that implement, operate, manage the infrastructure and sells the products and services. The ideal structure is a mix of public and profit-oriented companies, also with outsourcing some activities to third parties, as we are going to explain in the following sections.

2.2.2. Network implementation, operation and management

After the planning phase managed by the community's organization (such as the telecom department of the municipality) implementation is done by contracting third parties, selected by an appropriate tendering procedure according to the specific rules of public purchases in a given region or municipality. It is critical that the implementation is closely supervised and managed either by a local government - if it has appropriate resources - or by a consulting company. Some activities can be done by public sector companies, in particular when transport and utility infrastructure is used (electricity poles, railway tracks, tunnels, ducts etc.). Proper contract management is essential.

In the USA, there are companies specialized in planning, design and implementation of optical infrastructure for community networks. To hire a neutral company, not involved in providing telecom services, can be a good solution for a local government because of its experience gathered in the implementation of other community networks.

From business and strategy perspective, the right operation and management system is of critical importance for any telecom service provider, and in this sense, a community owning an infrastructure is a telecom service provider, regardless of the particular product mix it wants to offer.

There are several options to implement Operation Support System (OSS) functions, in particular for the management of the physical network. Two models are common.

a) Outsourcing entirely to a third party. A telco operating a network in the area is a good candidate as it has equipment, points of presence, manpower and skills to operate the network with required service level agreements. Proper contract management is important to ensure the seamless operation of the network.

b) Creating and operating a special company owned by the community (Stokab in Stockholm is a good example.)

2.3. Regulatory and policy aspects

In creating the right business model for a CAN, the prevailing regulatory and policy environment has to be taken into account.

Recent political and strategic decisions both in Europe and in North America have set forth objectives for "broadband services for all" (an EU R&D programme strategic objective) and for "promoting the availability of

broadband to all Americans" (an FCC strategic goal). Regulatory institutions are instructed to create a regulatory environment that allows all potential players in the telecom market, including local governments, for taking part in broadband services development.

Participation of local governments in providing broadband services, directly or indirectly, is a highly desired movement as they can and want to invest in areas which are underserved by traditional telcos for business reasons.

Whether, in what form and with what kind of products and services a public entity is allowed to enter the telecom market is a matter of local regulations. In general, telecommunication laws allow for the public participation, or, at least, contain permissive statement such as "No State or local statute or regulation ...may prohibit ...the ability of any entity to provide any interstate or intrastate telecommunications service" (US Federal Telecommunication Act of 1996, 47 USC par. 253(a)). Similarly, European Union directives and the national telecom laws of individual member countries do no exclude public ownership of telecom facilities and the right to provide services.

National and regional regulations, however, may decide on specific conditions affecting the ability of local governments and public institutions in offering services to the market. These regulations are based on competition considerations. The conditions therefore also depend on what type of facilities the public owns and which products are being offered to the market. For example, it is generally permitted for a local government to create an optical cable infrastructure and sells only "dark fibre", mainly to service providers. In this case, the public is not competing with the telecom players by providing services to end users.

3. On technology selection

In terms widely used in telecommunications, a community network architecture and topology consists of a backbone network with nodes possibly collocated with the POPs (points of presence) of a telco or ISP, and of access networks. Sometimes distribution networks as an intermediate layer are installed between backbone nodes and the access networks. Fig. 1 illustrates the generic CAN architecture.

The key functionalities can be grouped according to the technology layers of the CAN which are as follows:

a) The physical infrastructure, which provides dedicated permanent physical connections such as individual fibers or individual wavelengths.

b) The transmission layer, which is responsible for providing digital links between nodes of the network, with proper management capability and reliability.

c) A 3rd layer, denoted by „Switching and QoS" (Quality of Service) which is responsible for providing

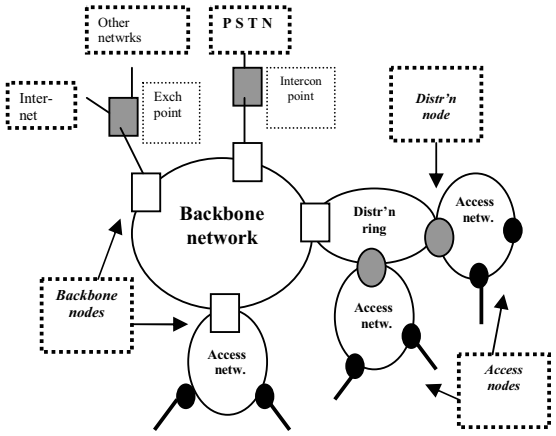

Fig. 1. The generic CAN architecture

virtual connections between end users with the requested quantitative parameters and quality of service. Discussion of particular existing and emerging technologies to fulfill functionalities of different layers is outside of our scope.

Depending on the type of service offered, one or more layers should be implemented. As it is illustrated in Fig. 2, for dark fiber products the bottom layer is enough (Fig. 2/a), for transparent leased line connections – the two bottom layers (Fig. 2b), and for services to end-users the whole architecture needs to be implemented (Fig. 3/c).

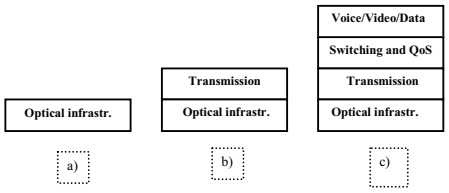

Fig. 2. Architectures of Community Area Networks for different services

The access part of CANs should be based on several existing and emerging technologies. A multi-platform capability is a very important objective, in particular from the point of view of providing e-government services, which must be accessible by all citizens regardless of the specific access solution they are using for connection to the network. ADSL (asymmetric digital subscriber line) is the most commonly used broadband access technology today. This technology utilizes the existing copper subscriber wires and provides the users with data rates up to 512/128 kbps in downlink/uplink direction, respectively, thus being very suitable for a typical Internet usage. ADSL, however, is not a real broadband technology, many present and future applications need

higher data rates which can be provided only by some sort of fiber-based access. FTTH (fiber to the home) is a solution when optical cable connects the user directly, FTTC (fiber to the curb) is when it is terminated at a single distribution point for a multi-flat building or for a group of small houses and the users are connected to the distribution point via the same copper lines as used by ADSL, however, the much shorter distance allows for significantly higher data rates.

An emerging and already important access technology is WLAN (wireless local area network). It is well known for the general public from „hot spots" where users with their notebooks or handheld computers can access the public Internet. In a CAN, WLAN is used as a last mile solution and is adequate for several reasons: it bridges distances of several kms, provides 10 Mbps bandwidth using current products and will provide 54 Mbps based on new standard versions, it operates in a frequency band which is unlicensed in many countries and lastly, the equipment needed both at central site and in the customers' equipment is inexpensive. It is not surprising that many CANs have already implemented this technology in the United States, Australia and Europe.

The objective of the technology selection phase is to select an optimal network technology solution that meets several criteria. Some of criteria are addressed below. There are also difficulties that have to be taken into account, including:

a) Technology trends are diverse and some new and promising solutions have not reached their maturity. One of the clear trends is that IP is emerging as a unified platform for all services and the challenge is how to implement it in the most efficient way.

b) The optimal choice depends on the target customer markets, services to be provided and the existence of any legacy infrastructure. However, usually no dominant application can be identified in CANs, which would make the architecture selection easier.

c) It is not easy to evaluate different vendors' offerings from the point of view of future-proofness, scalability, compatibility etc. In particular, during the current economic slowdown, the telecom sector is in a difficult situation, vendors are not motivated to provide the most advanced and future-proof solutions. Some suffer from large stock of recent generation equipment. Most of them were forced to cut R&D efforts, thus they are not capable to finish the development of equipment that corresponds to the latest standards.

An additional important task is to identify a clear migration strategy from a traditional technology to a more advanced one. A solution should not be selected if there is no clear migration possibility at reasonable costs.

Lastly, it is an important requirement that the community network architecture supports interconnection with "external" networks such as telecom service providers' infrastructure, and regional and national government and research networks.

4. Preliminary design of a CAN in North Italy: a case study

4.1. Economic and telecom environment in North Italy

In the presentation of the case study, we are using the experience collected during a preliminary design of a Community Network for a North Italian Province. However, as the conditions are typical for an EU region and most of the methods described can be generally applicable, in the rest of this section we will use the general terms "incumbent"and "competitive telcos", for the incumbent telecom operator and, "region" for the administrative area which can be a region in the EU sense, a province or county and "local government", or "LG" for the corresponding administrative authority.

The existing telecom situation in the region is characterized by the following facts:

- Extensive use of telecom service providers' services, in particular voice, but also data communication and Internet services, both by the public and private sectors.
- Data communication needs of the public sector are covered, to a large extent, by a private network which has serious limitations in terms of bandwidth and services.
- The telecom market is dominated by the incumbent.
- New entrants to the telecom market cannot compete successfully since the incumbent has a de facto monopoly.
- Geographic coverage of the existing province network is limited, as is general broadband access.
- Telcos are economically not motivated and not expected to cover the sparsely populated areas.
- There is a growing "digital divide" between the large cities and rural areas.

4.2. The objectives of the local government and the scope of the case study

The objectives to be achieved by creating a CAN are as follows:

- ensure the development of telecommunication and IT services for the region, taking into account the specific conditions outlined above,
- make telecommunication the driving force for the development of the region,
- avoid the "digital divide" between the large cities, on one hand and, the rest of the population, on the other,
- create a high-speed infrastructure for the public administration, including the public services.

The scope of our study was:

- define the strategic alternatives for the local government,
- define the business structure,
- analyze the market and the potential customers,
- define the potential products & services,
- carry out a technology analysis,
- demonstrate the feasibility of the planned development by building a business model and executing calculations for realistic sets of assumptions.

4.3. The proposed business structure

The following strategic alternatives have been identified: (i) Building the CAN by the LG. A special case of this option is to build the CAN together with an alternative carrier, provided favourable conditions can be achieved. (ii) Teaming up with the incumbent, while carefully considering strategic advantages and disadvantages. Within the current phase of the project, the main objective was to perform a detailed analysis of the first option.

The proposed set-up was based on business, legal and operational considerations. The final structure will depend on the negotiations with external parties, political considerations and the legal situation. *The proposed structure is as follows:*

- An *"Infrastructure" company,* set up by the LG, makes the investment in dark fiber and owns the fiber network itself. This entity offers dark fiber/dim fiber products and, potentially, wavelength products, to the *internal customers* and to the *external market*. Internal needs and requirements for fiber and wavelength products are channelled through the second entity that takes care of the internal telecom services.

- A second company/entity called *"Services" company* is to be set up to take care of the "internal" services, including voice, data and others, for the public administration and the public institutions. It should operate on business terms but should not sell its services in the open market.

The proposed ownership structure was that the "Services" company is majority-owned by the "Infrastructure" company, but it can also have minority interests from partners, see Fig. 3.

In this model, there is a clear separation from the point of view of products and services offered and the target markets for products and services. The "Infrastructure" company sells fiber and/or wavelengths (that is, rough infrastructure) to anybody, including service providers.

The "Services" company provides services to "internal" users, including e-government services, to the residents, too, but does not compete with general services in the market with other providers. This separation makes it possible to select the most appropriate external partners for each of the companies.

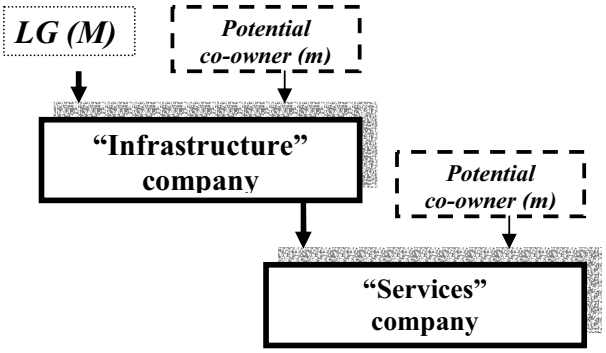

Fig 3. The proposed business structure. Arrows indicate ownership, *M* – majority, *m* - minority

Notes to the structure:

a) Due to legal constraints, a majority ownership of the LG might be necessary to channel through an already existing utility company.

b) In the business model calculations, the two entities were not handled separately at the present stage.

4.4. Identification of customers and products&services to be provided

Information on present and planned applications has been collected using questionnaires and personal interviews with high level representatives of selected institutions, administrative organizations and companies. We have also utilized previous results obtained by experts in the region [4].

Our methodology was based on identification of applications that are of primary importance for the users presently and in the future, and on grouping them into "generic" application classes. Generic classes constitute non-overlapping groups and possess different sets of traffic characteristics and quality of service requirements. These classes thus can be used to derive quantities relevant to network design, as well. The proposed classification summarized below is based on the approach taken in some recent EU projects [5], with some modifications to take account the specific environment.

Based on the above, the following principal customer segments have been identified:

- Wholesale customers (telecom operators)
- Public administration and public institutions
- Business users

Residential customers were not separately considered at this stage, as it was assumed they will be served by telecom operators who are in turn customers of the CAN (buying fiber products). Additional possibility not included in our model is that they are also served by the "Services" company.

4.4.1. Wholesale companies (telecom sector)

These are the customers for fiber type products and related services which the LG can sell directly to the market.

The market of telecom operations/wholesale companies consists of a small number of players; however, they are prospective buyers of dark fiber as an attractive alternative to leasing it from the incumbent. The coming 3G mobile (UMTS) operators represent a potentially large future market for dark fiber as UMTS will very likely boost the need for broadband connections all around Europe, including the region investigated. The operators that have already obtained the concession are the main potential wholesale customers for the CAN.

4.4.2. Public administration and public institutions

Here the LG will provide services "directly", meaning through its own company. This sector consists of the local government administration, all of its institutions, the municipalities of the larger and smaller cities and all community administrations.

The situation in our case study is typical for many administrative regions: the data communication needs of the public sector are served by a network owned and controlled by the LG and the voice traffic is carried totally by the dominant telco. For the public sector, the planned CAN is considered as an enhanced version of the existing network, that would offer, among others, the following direct benefits: (I) provide a future-proof infrastructure for data communication services virtually without limits, (ii) provide a platform for internal voice communications which then can be moved from the incumbent operator to the internal network, resulting in significant cost savings, and (iii) provide a platform for modern multimedia communication services such as video conferencing.

Publicly controlled institutions include: public transportation companies, utilities, education and research institutions, culture institutions, health care organizations and providers. In the health care sector, even the near-term needs, related to the introduction of remote medical image processing and storage, cannot be fulfilled by the existing network due to bandwidth limitations.

4.4.3. Business users

This is the segment LG will sell services indirectly, through third parties i.e. through fiber customers. In short term, the business users will not be using the community area network to a very large extent. In long term, the following business sectors should be seen as primary potential customers to the network: banking & insurance, cable-TV companies, utility companies, tourism. Among them, the banking&insurance sector is generally a very IT and communication intensive sector. The tourist industry, with its importance for the given region, can also be a key sector and a showcase for the CAN.

Based on the analysis of potential users and the services they would need, a product-customer matrix was built to match the products&services set to the different customer groups outlined above.

4.5. Considerations on the technology selection

The basic architecture of the network is a hierarchical, 3-level one consisting of a backbone network, distribution networks and access networks. Backbone and distribution networks are ring-based with two backbone rings coinciding at several backbone nodes to increase reliability and several distribution rings.

During the preliminary planning, a carefully compiled Request for Information (RFI) has been used to achieve the following objectives:

a) identify a few feasible technology alternatives for the CAN which is then to be used in the RFP phase to solicit detailed and exact proposals,
b) shortlist companies for the RFP phase,
c) provide a reasonable estimate for the business model calculations.

The invitees were granted a great degree of freedom as far as the proposed architecture and topology is concerned, they only had to take into account the aforementioned hierarchical topology and the physical parameters resulting from the cable plant design (lengths of cables, planned geographical location of the main nodes).

We have set the following evaluation criteria.

- Technical merit (compliance with requirements and pluses)
- Integration level of the proposed solution
- Technical solution maturity, stability and scalability
- Compliance with standards
- Migration capability
- Carrier-level quality and capabilities, support of multi-vendor environment
- Technical support
- Reference projects
- Price
- Financial stability

The RFI procedure achieved the aforementioned objectives.

4.6. Creating the business model

The most important part of building a business model is to work out the set of assumptions for the calculations. We have carefully defined the assumptions based on interviews and general statistical information from public sources. The assumptions for the calculations can be summarized as follows.

- Fixed voice traffic, internal needs

This part of the assumptions was built based on the general voice traffic data, available from the annual reports of the telecom companies and other sources, plus on the fact that the business part within fixed voice is traditionally around 40% of the total market, slightly increasing. Based on the expected population development, the increased economical activity due to the creation of a CAN in the region, a realistic annual growth in the business voice traffic can be estimated. We also assumed that 40% of the traffic is internal (and can be totally carried by the CAN) thus saving the corresponding costs and that a 20% cost cut can be achieved on the external traffic by using the community network before reaching the external world.

- Data traffic, internal needs

On the data and information related traffic, a combination of two scenarios have been used:

a) A conservative scenario, where the bandwidth growth and the price reductions will compensate each other.
b) A growth scenario, due to all present and expected future applications made possible by the practically unlimited bandwidth capacity, (e.g. a planned medical imaging system for the regions health care network).

- Dark fiber market, external

International experience shows that dark fiber companies grow with a rate of 30-40% per year, compound growth, even in cases when they are already large in the market. In the business model, we have drawn up a scenario for two different types of customers: (i) telecom operators and (ii) business customers. It is realistic to believe, that 2-3 out of the telecom operators identified will be customers of the CAN to a large extent. We do not expect any new, major players in the market segment the coming 5-10 years. Pure business customers, including media companies, cable TV and ISPs, will have a slower start, but a continuous development like that we have seen in other parts of the world.

- Investments

The plan of investment in infrastructure depends on various factors in a given region. A typical assumption, which has been used in our calculations, is a 3-year period with equal division over the period. The investments in dark fiber deployment can be calculated based on the preliminary network design. For a network size we took as a case study, the total investment is approx. 100 M €. Our model includes depreciation calculation for different periods.

- Financial assumptions

The total needed equity is calculated to be 100 M €. We have assumed 50 M € own equity and 50 M € external financing, either through a project financing or a long-term loan. The external financing will be repaid until 2012, according to the model. Note that while this may be a typical scenario, it was just an assumption in our calculations. Using our business model and the tool we developed, one can carry out calculations with different equity-external financing ratios.

- Operational costs

The operational costs can be split into three main groups:

- Operation & Maintenance for the network. It includes external service contracts and costs for technical personnel.
- Personnel costs. Its estimate (excluding technical staff) was based on management experience.
- Other costs, including administration, marketing, etc. All these costs were calculated as a percentage of the revenue which gives a fairly precise figure.

Based on the above assumptions, balance sheet, profit&loss statement, and cash-flow statement were calculated. Figures 4 through 7 illustrate the results for a particular set of assumptions.

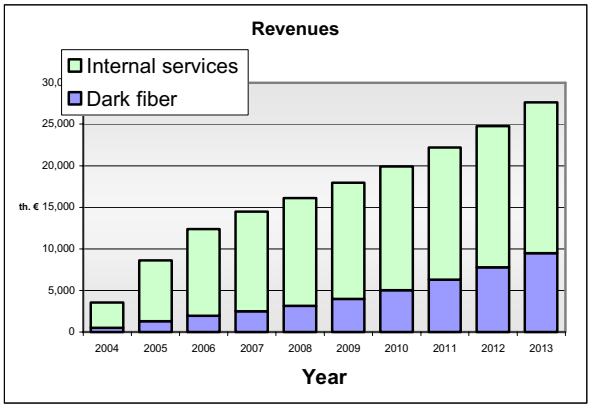

Fig. 4. Revenues

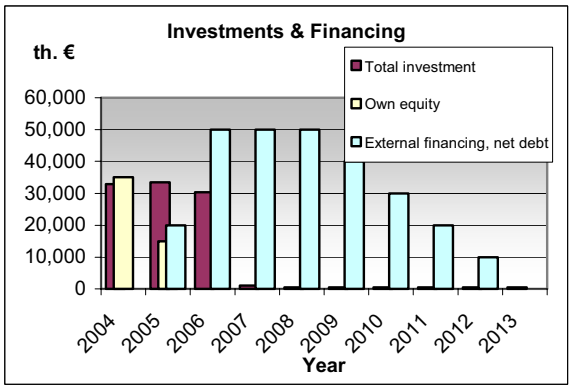

Fig. 5. Investment and financing

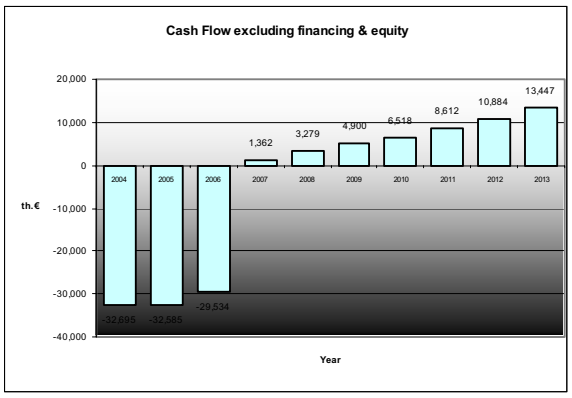

Fig. 6. Cash flow

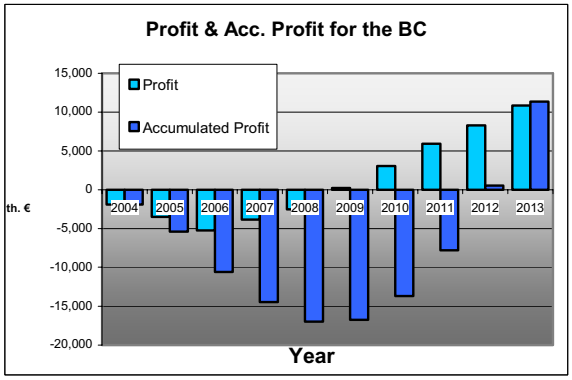

Fig. 7. Profit and accumulated profit

5. Summary and conclusions

Based on the detailed analysis of our business model, we can conclude that *it is possible and financially sound to create a Community Area Network in a given region, provided that:*

- V*oice traffic of the public administration and institutions is routed predominantly through the CAN.*
- The CAN *is used as a higher level replacement of the existing data network for public administration and publicly controlled institutions.*
- An agreement is reached with *more than one telecom operator* regarding usage of the CAN.
- The implementation and the operation of the CAN *are managed with the assistance of a professional organization* of professionals with telecom experience.

A carefully planned, implemented and operated Community Area Network will offer a number of advantages, including:

- Direct benefits, in the public sector, from saving the fees currently paid to telecom service providers, for instance for voice services within the region.
- Direct benefits resulting from implementation of new services the existing public administration network cannot support. These benefits include: (i) direct benefits due to saving costs that would otherwise have to be paid to telcos and (ii) cost savings due to more efficient working processes, savings in travel time, working hours etc. of employees and citizens involved.
- Direct revenue generation through selling the capacities to commercial customers, first of all to emerging competitive telcos and ISPs.
- Indirect benefits, including:
  - Improving the quality of life of citizens, reaching EU objectives in education, health care and business, overcoming the "digital divide".
  - Benefits resulting from economic growth due to the new infrastructure and services.
  - Fostering competition in the telecom sector, thus reducing costs to end users and business customers.
  - Generating revenues from taxes collected on new businesses that will benefit from CAN.

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