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Economic Viability of Advanced Telecommunications Services

This paper presents a methodology for the assessment of the access network for the residential and small business user. This enables a global system assessment and the identification of minimum-risk introduction strategies. The various network alternatives are further assessed using risk methodology. The impact of critical variables such as key component costs, civil works, operation, administration and maintenance (OAM) costs, competition and demand forecasts is modelled through probability distributions.

Introduction

The world economy has experienced a significant proportional shift of the major sectors over the past 30 years—agriculture, industry, services—in the gross domestic product. The main thrust of this movement has been a steady decline in the shares of manufactured and agricultural products on the one hand and an expansion of both market and non-market services on the other: finance, transport, tourism, distribution consultancy, education, etc.

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While employment in industry has declined over the past decade, services have been the major job creator, compensating for losses from industry, though unable in Europe to create enough jobs to prevent an overall decrease in employment. Advanced communications is a key factor in the service sector's role as a job creator. The share of information-based jobs is rising fast. Two basic elements are needed for such services: unambiguous standards and critical mass. The attraction of a telecommunications service depends directly on the number of compatible users. Thus a new service cannot really take off until a certain number of users is reached. Once this critical mass has been achieved, growth rates can increase dramatically, as in the case of Internet.

A virtuous circle of supply and demand can be created only if a significant number of market testing applications, based on information networks and services, is launched Europe-wide, to create a critical mass. The issue of critical mass is even more crucial for peripheral regions, where economic, social, cultural and technical barriers are a hindrance to the diffusion of such services. Also, the business opportunities for small and medium enterprises (SMEs) are limited by a variety of factors such as human resources and finance and the difficulties they encounter accessing appropriate information and being integrated in the global industrial fabric. The rapid growth of the Internet illustrates the enormous potential of new global networking possibilities. However, specific services adapted to SMEs' needs are poorly defined or missing.

Innovative use develops best when driven by user communities together with manufacturers and network providers. Such uses assume the availability of service-oriented networks and open access for service providers. Moreover, in a competitive environment, new network infrastructures have to be viable in the usual economic sense; that is, by minimising the present worth of the annual charges. Furthermore, the investment must generate positive returns, consistent with investors' typically short-term expectations. The decision to invest in new technology is subject to the risks and uncertainties inherent in the competitive marketplace. Technology-driven innovation is the most costly route to a new product. Diminishing the profitability of a product limits a key source to new investment. In the former monopoly environment, network deployment was implemented by a single regulated firm. Product life times as well as user numbers over time were then predictable and the risks associated with the investment were readily known and manageable.

A number of studies have been carried out in order to provide a sound support to the strategic decisions of the main actors in the field of access network techno-economics. As a main result, guidelines are provided to the network operators for both the selection of the candidate set of services and the deployment of the appropriate network architecture in different operating conditions. Additionally, considerable information has been made available to the manufacturers to make them aware of the risks and opportunities of developing broadband equipment. Finally, cost/benefit analyses highlight the user's point of view regarding the opportunities of the various telecommunications services.

Overview of the Techno-Economic Methodology

The methodology is being used for the evaluation of advanced multimedia services and networks in a competitive, deregulated environment. Fast improving technology gives birth to new alternatives, yet society's ability to fully exploit them still lags by years. The scenarios studied include gradual provisioning of services like plain old telephony service (POTS), narrowband integrated services digital network (N-ISDN), asymmetric switched broadband, symmetric switched broadband and broadcast broadband. The quality of the existing infrastructure, the average subscriber capacity demand and demography are among the key elements likely to affect the economic viability of access network upgrade strategies.

The importance of key engineering parameters such as subscriber density and civil works are highlighted through various sensitivity analyses. The various network alternatives are further assessed using risk methodology. The impact of critical variables like key component costs, civil works, operations, administration and maintenance (OAM) costs, competition and demand forecasts are modelled through probability distributions. The effect of a set of values of the critical variables is calculated by one program run. The risk is then assessed by generating many values from the probability distributions and subsequently performing a large number of program runs. The parameters relevant to the engineering of the network, such as subscriber density and type of civil works are then defined. These are the inputs to a geometric model which calculates the overall cable length of the various sections of the network. The costs of the network components are calculated using an integrated cost database, containing data gathered from many European sources. The resulting discounted system cost can then be derived. Finally the overall financial budget is calculated for the various architectures by integrating demand and tariff data with the life-cycle cost. The database includes costs at a given reference year for components, installation, civil works, operations and maintenance. Learning curve data together with demand estimates classified in relevant groups, are included in the database. The demand for the services, which can be provided over different network architectures, is estimated through a Delphi survey carried out in the countries participating in the project. The potential market and demands are derived for each service. The revenues, determined from tariff and demand estimates, together with the life-cycle cost, lead to the overall financial budget of the system considered. The impact of key engineering parameters is highlighted through various sensitivity analyses.

Different architectures which can provide a selected group of services are considered. Some key model outputs are time series over the study period, others are constant values:

Investments are usually spread over the study period. To get a single figure of merit for the total investment, the future investments are discounted to the start of the study period using the conventional discounting formula. The total discounted investment cost is usually called *First Installed Cost*.

Most often, the calculation includes the *revenue* from the services. This is derived from a service connection tariff and by estimating an annual tariff for each service per connected customer.

Profits are calculated from the revenues, investments, depreciations and taxes.

Cash Flows are derived from the other relevant economic parameters in a standard manner.

Life Cycle Cost is defined as the sum of global discounted investments and global discounted running (OAM inclusive) costs. This value represents the total cost for constructing and running the network over the study period.

Cash-flow is the difference between the cash to be paid (negative cash-flow) and the one to be received (positive cash-flow) during a certain period.

Component Price Versus Time

The cost trends are described using the learning curve relation according to Wright's law:

$$P_{2n} = K \times P_n$$

where P_{2n} and P_n are the prices for the completion of the $2n^{th}$ and n^{th} units respectively. Network components have been clustered according to the K factor, subsequently used in the tool.

By combining a standard demand logistic curve for the growth over time of the accumulated component volume with a learning curve, every component can be classified by four parameters. These are the component price today *P(0)*, the learning curve coefficient *K*, the time it takes for the accumulated volume curve to go from 10% to 90% of the saturation value ΔT and the value of the accumulated volume today *n(0)*, normalised to the saturation value. The last parameter is the inverse of the assumed market potential. The ΔT and *n(0)* are the only two parameters that need to be estimated by forecast methods. The forecast function for the evolution of the relative accumulated volume *n(t)* is given by

$$n(t) = [1 + \exp\{\ln(n(0)^{-1}-1)-(2\ln 9/\Delta T)\times t\}]^{-1}$$

where the only inputs are $n(0)$ and ΔT. The previous relation is now inserted into a learning curve:

$$P(t) = P(0)\times[\, n(t)/n(0)]^{\log 2^K}$$

This yields the final expression of the price of the component versus time:

$$P(t) = P(0)\times[n(0)^{-1}\times\{1 + \exp[\ln\,(n(0)^{-1}-1)-(2\ln 9/\Delta T)\times t]\}^{-1}]^{\log_2 K}$$

which contains all the four parameters involved in the component price versus time evolution. The asymptotic price level for long times only depends on $n(0)$ and is given by:

$$P(\infty)= P(0)\times\,[n(0)^{-1}]^{\log_2 K}$$

and the slope of the price curve for small t is proportional to ΔT^{-1}.

Cash Balance is the cumulative cash flow. A typical cash balance curve for a network scenario goes first deeply down to the negative side because of the high initial investments. If the scenario is profitable, the cash flow turns positive fairly soon and the curve starts to rise. The point in time when cash balance turns positive gives the *Payback Period* for the project.

Net Present Value (NPV) gives a single figure of merit for a project. Its definition is the sum of *Discounted Cash Flows* plus *Discounted Rest Value* of the project. NPV is a good indicator for the profitability of the scenario especially in these cases where the Payback Period cannot be used because major investments are spread out in time. The weakest point in this figure of merit is the definition or calculation of the rest value of the network.

Internal Rate of Return (IRR) is the discount rate at which the NPV is zero. If the IRR is higher than the opportunity cost of money (that is, interest of an average long-term investment), the project is viable.

Cost/Benefit Analysis

Cost/benefit analysis is a prerequisite to the 'before' phase of an investment project. This is a process of making shared assessments of investment projects which identifies, measures and compares actual and potential costs and benefits of an application over the entire application life cycle. It incorporates all costs and benefits incurred during the entire life cycle and includes operating costs as well. Cost/benefit analysis in TERA† focuses on the end-user point-of-view. The goal of cost/benefit analysis is to assess the costs and benefits of new telecommunications services to a specific group of users compared to the costs and benefits of traditional solutions for this user group. This is a critical step for decision makers, since it helps to identify and manage costs, run the project in a more business-like manner, optimise return on investment and compare the financial and non-financial impact of a project.

In TERA a number of appropriate business cases have been chosen in which the cost/benefit analysis is applied.

† Techno-Economic Results for Acts, project No. 364 of ACTS programme of the European Commission.

The framework for the cost benefit analysis consists of six steps:

- identification of key user groups, life span of the application and discount rate;
- identification of benefits (by business owner) and costs (by cost/benefit project manager), both direct and indirect over the life span of the application;
- calculation of net present value;
- definition of key parameters and performance indicators;
- sensitivity and impact analyses; and
- assessment of the worthiness of the project, evaluation of options and go/no go decision.

The above framework has first been applied to two selected cases, for which reliable cost inputs were available: tele-medicine and tele-learning. The first results quantify the relative savings due to new multimedia services.

A cost/benefit analysis must be completed before the final decision. As the project goes along, the business owner and project manager track the costs and benefits to see if the promises of the cost/benefit analysis are fulfilled. If the scope of the project is changed, the cost/benefit analysis needs to be revisited and readjusted to the new scope.

Cost/benefit studies are closely linked to externalities. In models for market demand in the case of network externalities it is important to estimate the willingness of customers and potential users to pay for the services. Cost/benefit analyses can help in quantifying the willingness to pay for different services and also in different markets. Therefore the two analyses should be combined when applying them in business cases. Cost/benefit studies require considerable resources, especially for gathering the necessary data. Therefore, a simplified cost/benefit model will be derived and inputs from other projects will be possibly used to determine the costs and benefits for the user. The objectives of the cost/benefit studies are the:

- identification of the costs and benefits of a telecommunications project;
- use of the discounted cash flow technique;
- calculation of the net present value for after-tax cash flows and comparison with the conventional alternative;
- calculation of the user's willingness to pay; and
- cost/benefit analysis as a comparison of alternatives over a study period.

Cost/benefit studies are likely to estimate the impact of costs and benefits of an advanced multimedia service upon the user's activity as compared to the old conventional alternative. In today's competitive environment, the end user increasingly needs tools for measuring the relative impact of various alternatives in order to determine his/her strategy. The final choice is not always straightforward and a combination of alternatives might be an acceptable approach; for example, a short-term option chosen as a stop-gap measure and a long-term option also chosen to maximise benefits over time.

Commonly, the time period considered for economic evaluation ranges from 5–10 years. For tele-medicine and tele-learning, a time period of five years was considered appropriate, since new emerging technologies may thoroughly alter a scenario over a longer period.

Conclusions

Demand and tariffs have a major impact on the viability of a particular service, whereas the cost of technology turns out to be of secondary importance. The number of technological options is significant smaller, if an adequate infrastructure exists and the main geographic characteristics are known. The uncertainties associated with revenues are much higher than the uncertainty on the cost of technology.

The broadband upgrade of the access network is of paramount importance for the incumbent operator. The costs associated with such an upgrade are equivalent to the overall costs of building a new access network. Hence the existing infrastructure has to be utilised in an effective way.

The results achieved reveal strong indications for high-tech teleservices such as telelearning, for which the most important costs are for labour. Therefore, telelearning allows substantial savings by sparing labour cost during transportation time. However, the labour costs of the remote learning centre (help desk essentially) may be key for the economic success of the operation. Thus, depending on the quality of service required, the degree of interactivity wanted by trainees can strongly increase the cost of telelearning operations, if the time of individual support greatly increases. The transportation and accommodation expenses appear to be the second important item, especially for long distances. In comparison, the telecommunications costs turn out to be fairly low, even in the case of a high-price connection time policy. The same observation can be made for the telelearning software tools.

Teleworking, information services, and teleentertainment stand out as the most promising services for broadband applications in the future. There will be a substantial demand for broadband services in the residential and the small office/home office (SOHO) market during the next 10 years. However, households are not willing to pay too much more for additional broadband applications and additional capacity.

There is a wide range of telemedicine applications already available but before any real market implementation, deontological and regulatory problems must be addressed. There are two main attributes of telemedicine: bringing the patient closer to the health centre and retrieving the appropriate pieces of medical expertise. Their objective is to favour the right diagnosis and therefore to help take the correct decision. Telemedicine implies an improvement of communication within the health world and a wider dissemination of medical expertise. Both telemedicine and telelearning are of great social importance. However, technologically advanced network infrastructure is a prerequisite for an efficient take-up.

In conclusion, from a strict and limited financial point of view, telelearning is always profitable when there are several hours of transportation between the trainee and the learning centre. However, on-line telelearning also brings additional benefits, in particular a better reactivity for high-tech companies needing to be on top of available technology. Combined with information available from the Internet and specialised media, it provides a tool of efficiency enabling companies to be more competitive.

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Alcibiade Zaganiaris graduated in mathematical physics from the University of Athens. He received a postgraduate certificate in telecommunications electronics and a doctor's degree from the University of Rennes, France, then a Ph.D. on telecommunications economics from the University of Lyon. He joined the research centre of France Telecom-CNET, where he carried out research on optical materials and fibre properties, local networks and techno-economic studies. He is author of 75 publications, conferences and patents. He is currently in charge of international cooperation projects involving high-tech SMEs.

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