

# Business opportunities through UMTS-WLAN networks

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## Abstract

*This article outlines the economic feasibility of mobile operators that combine nationwide mobility with 3G networks and hot spot coverage with WLANs. WLANs are based on HIPERLAN/2 architecture and the UMTS network exploits WCDMA/FDD technology. The evaluated business scenarios are focused on two different deployment areas, in terms of demographic characteristics and mobile penetration: a large and a small European country. The business case spans 2002 to 2011 with UMTS' roll-out year in 2002 and WLAN's in 2004, covering indoor hot-spot areas (stations, airports, stadiums, etc.) where demand is high. The demand for this UMTS-WLAN roaming case is evaluated based on observations from Europe's current mobile market and its evolution. Usage scenarios of different service packages corresponding to both residential and business markets have been taken into account. Direct investments and operational costs as well as revenue streams from traffic have been calculated. The methodology and the tool developed in ACTS-TERA [1] and IST-TONIC [2] projects have been utilized for this case study. Economic conclusions have been derived, presented and discussed using key profitability factors. Profitability for all scenarios and business profiles has been calculated, presented and discussed. It includes a sensitivity analysis in order to identify the major opportunities and threats, for specific service sets as well as critical parameters and uncertainties. A wide audience from mobile operators and service providers to retail companies interested in entering the 3G market, can exploit this information.*

**Key words:** Wireless LAN, Mobile radiocommunication, UMTS, Network interworking, Economic aspect, Telecommunication operator, Telecommunication regulation, Demand forecasting, Economic forecasting.

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## L'INTÉRÊT ÉCONOMIQUE DES RÉSEAUX RLAN UTILISÉS EN COOPÉRATION AVEC LES RÉSEAUX UMTS

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### Résumé

*Cet article souligne l'attrait pour les opérateurs mobiles que constitue la couverture des lieux publics à forte fréquentation par les réseaux RLAN en combinaison avec les réseaux 3G. Les réseaux RLAN sont basés sur l'architecture HIPERLAN/2 et les réseaux UMTS sur la technologie WCDMA/FDD. Les scénarios économiques étudiés ont ciblé deux différents types de*

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*pays en terme de caractéristiques démographiques et de pénétration de la téléphonie mobile : un grand pays européen et un petit. Le plan d'affaire court sur 2002-2011 avec déploiement UMTS en 2002 et déploiement WLAN en 2004 pour la couverture des lieux publics à forte fréquentation tels que les gares, aéroports, stades, etc. où la demande est élevée. La demande dans ce modèle économique est estimée à partir de l'analyse du marché actuel de la téléphonie mobile en Europe et de son évolution. Les scénarios d'usage des différents services correspondant aux segments de marché entreprises et particuliers ont été pris en compte. Les investissements, le coût opérationnel ainsi que les revenus générés par le trafic ont été calculés. La méthodologie et l'outil développés dans les projets européens ACTS-TERA et IST-TONIC ont été utilisés pour cette étude de cas. Les conclusions sont présentées avec une analyse de facteurs clés ainsi qu'une analyse de sensibilité incluant permettant d'identifier les principaux risques et opportunités.*

**Mots clés :** Réseau local entreprise sans fil, Radiocommunication service mobile, UMTS, Interfonctionnement réseau, Aspect économique, Opérateur Télécommunication, Prévion demande, Prévion économique.

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## I. INTRODUCTION

Despite the current climate of pessimism regarding the economic viability of UMTS deployment in Europe, mobile operators are moving ahead with their plans. At the same time, a new access concept has begun to emerge, that of wireless local area networks or WLANs which are owned and run by a public operator to supply high-throughput coverage of hot spot zones such as airport lounges, shopping centres, hotels etc. Indeed, up to the present, such networks were owned and operated privately within company premises. While UMTS is geared toward providing mobile customers with wideband capabilities, operator WLANs are aimed at nomadic customers, who require broadband communications capabilities while in a stationary position, away from their office or home. It is generally recognized that the two systems are complementary, WLANs being Ethernet-oriented, for data only, and UMTS encompassing both voice and data. Mobile operators such as Sonera and Telia have already begun to deploy WLANs themselves to exploit these complementary characteristics [3]. By the same token, they are able to gain a lead on potential WLAN pure players, which could conceivably take business away from UMTS networks. For the time being, however, the two systems are technically separate and there is no possibility for users to roam freely from one environment to the other.

This case study explores the techno-economics of a network infrastructure based on an IP core network enabling users to receive a common set of services through different access technologies. Such a concept for the provision of seamless IP services is illustrated in *Figure 1*.

The network architecture modeled for this purpose is comprised of two wireless access systems, UMTS and WLAN. Since the UMTS-WLAN standardization is an ongoing process [4] and only recently ETSI published the requirements and architectures for interworking between WLANs and 3G networks [5, 6], the main sources for the work were the IST projects BRAIN [7] and MIND [8], which enables IP-based seamless handover between 3G mobile and Wireless LAN (HIPERLAN/2) networks as well as the 3GPP and ETSI working groups. The reference architecture is illustrated in *Figure 2*. (source: IST-BRAIN project [7]):

Following the definition of appropriate service sets and taking into account demand scenarios for mobile services, a model for the dimensioning of the network and service resources, encompassing both the 3G mobile and WLAN components has been developed. The tariff structures are applied to compute key economic indicators such as Net Present Value, Internal Rate of Return, and payback period. The economic indicators are calculated from pre-tax cash flows.

The techno-economic modeling described hereafter provides a business case analysis in the sense that it answers the question: *“Is the WLAN-UMTS business scenario profitable or not, under the defined circumstances and what are the critical parameters for a successful business?”* taking into account direct investments (CAPEX), OA&M (Operation Administration & Maintenance) costs (OPEX), and revenues.

### A. Regulatory environment and implications for the economic assessment

Two sub-bands have been identified worldwide for future 5 GHz WLAN systems : 5150-5350 MHz and 5470-5725 MHz, i.e., 455 MHz in total. Future 5GHz WLAN systems vary slightly

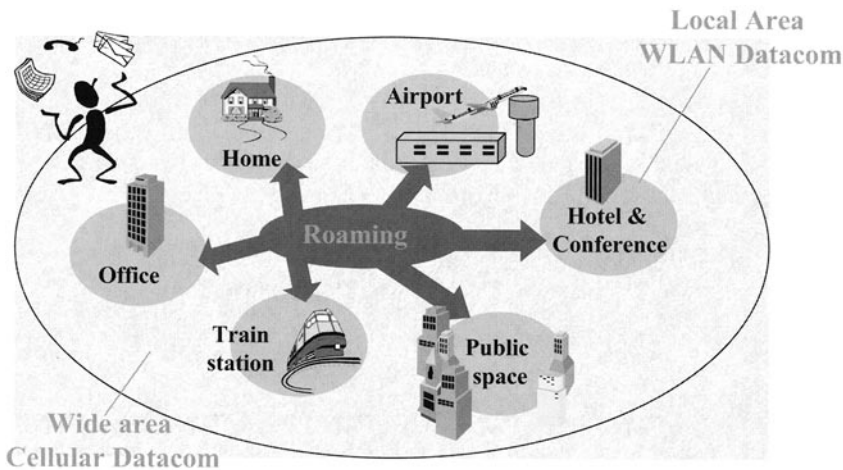


FIG. 1. – Concept for seamless IP provision.

*Concept des fournitures de service IP sans couture.*

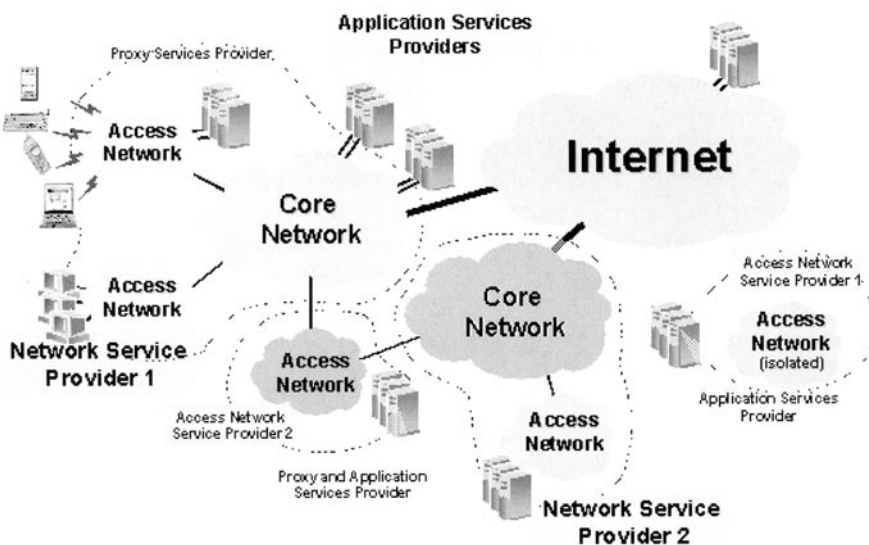


FIG. 2. – Network Model for WLAN-UMTS roaming [9].

*Modèle d'itinérance WLAN-UMTS.*

in different areas of the world (HIPERLAN2 in Europe, IEEE802.11a in the US and MMAC in Japan), but very similar physical layers are expected to allow economies of scales on chipsets, as well as easy coexistence between standards. The actual allocation of these bands (or part of these bands) depends on local authorities. In Europe, CEPT decisions are the following:

- Allocation of the full band to HIPERLAN systems for indoor use, part of it being shared with radars and satellite systems. Dynamic frequency selection (DFS) is thus required (and described in the HIPERLAN standard).
- Outdoor use permitted for HIPERLANs (1W max. EIRP) in the upper band.

Compared to the 2.45 GHz band, the 5 GHz band offers the following advantages :

- more bandwidth available, allowing both wider channels (typically 20 MHz) and coexistence of several WLANs without interference.
- the band is shared among a limited number of systems and is mainly dedicated to 5 GHz WLANs (HIPERLAN or equivalent), which considerably limits interference problems.

This makes the 5 GHz band more suitable for applications requiring high bit rates and guaranteed QoS.

On the other hand, competition between standards and the specifically European DFS requirement may delay the stabilisation of a worldwide 5 GHz WLAN market comparable to that of 2.45 GHz WLANs.

The rationale for creating a unified system based on a common IP core network is that such an approach will allow the delivery of current and future services and applications to users equipped with a single terminal for all of them.

The economic success of such a system, however, will depend on many factors such as user demand for new and advanced services, the emergence of recognised standards, the implication of service and content providers, the cost and functionalities of terminals and network equipment, as well as the regulatory environment.

As mobile devices and the Internet become increasingly popular throughout the world, it is reasonable to expect a demand for systems combining the advantages of both. Reliable, easy-to-use services will be available, in a smooth transition from 2<sup>nd</sup> generation mobile systems like GSM and GPRS to 3<sup>rd</sup> generation systems (i.e., UMTS). With the pervasiveness of mobile systems a growing need for faster and more attractive services requiring greater bandwidths arises. WLANs are expected to have a positive impact on demand, as they already allow nomadic workers to take advantage of broadband access to Internet and Intranet resources.

The major WLAN manufacturers recognize the advantages of a single standard, and are putting significant efforts into at least ensuring that customers of both 802.11a and HIPERLAN2 can transparently access the desired services via hybrid access points, while looking into more tightly converged solutions. Economically, the higher volumes of production will lead to lower unit costs for network equipment. For the customer, the ability to use WLANs of different types should have a positive impact on demand, as it removes the need to have network-specific cards in the terminal.

Regulatory measures impact the economic performance of such systems in that they dictate the available spectral resources and modes of use. For the time being, unlike 3G mobile systems, WLANs are not subject to licensing procedures and the associated costs, essentially because they are expected to manage their own coexistence within a limited, indoor space. However, with the possibility to function outdoors in the upper band, they may be subject to greater scrutiny by the regulatory bodies, particularly if their earning potential is deemed to be high [10].

## II. FRAMEWORK AND ASSUMPTIONS OF THE STUDY

The business case is evaluated from the incumbent 3G mobile network operator's point of view. It is assumed that the same operator owns and operates both the UMTS and WLAN networks. Consequently, areas served, services offered, tariffs, demand assumptions, as well as network architecture and dimensioning rules have been studied.

The case study spans from the timeframe year 2002 to 2011. UMTS roll-out is assumed to begin in 2002, and the services are available as of 2003. The WLAN network deployment is started in 2004 and services are launched in 2005. This time frame is in keeping with the anticipated large-scale availability of HIPERLAN/2 products, and particularly the possibility of seamless handover between this type of system and UMTS networks.

The modeling focuses on two area scenarios: a large European country (population 70 million) and a small European country (population 5 million) exemplified by Scandinavian countries. The models are not exactly representative of any defined country, but rather share typical demographic characteristics of these countries.

The techno-economic modeling was carried out using the TONIC tool, which has been developed by the IST-TONIC project using the TONIC tool [2] as the basis. This tool is an imple-

mentation of the techno-economic modeling methodology developed by a series of EU co-operation projects in the field. The tool has been extensively used for several techno-economic studies [11, 12] among major European telecom organizations and academic institutes.

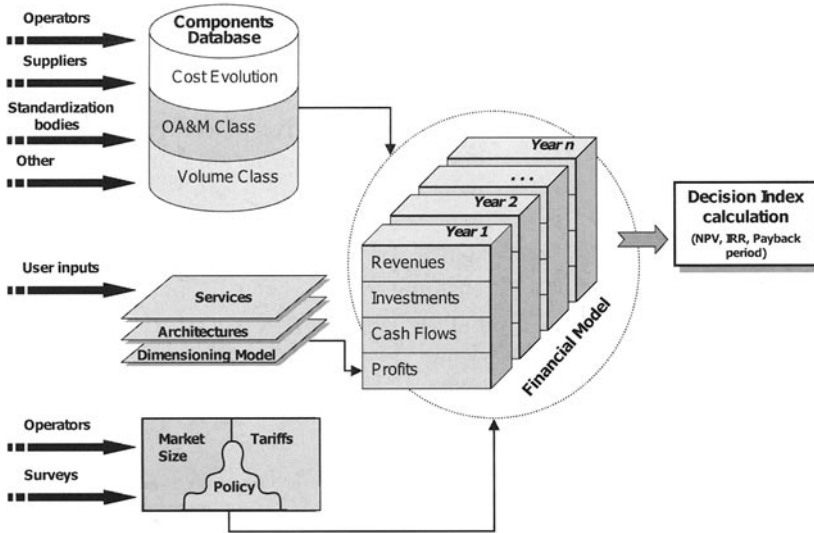


FIG. 3. – Techno-economic Methodology [11].

*Méthodologie d'analyse technico-économique.*

The base of the model's operation is a database, where the cost figures of the various network components are repositated. These figures are constantly updated with data gathered from the biggest European telecommunication companies. The database outputs the cost evolution of the components over time. A dimensioning model is used to calculate the number of network components as well as their cost, for the set of services and the network architectures defined. Finally the future market penetration of these services and the tariffs associated with them, which have been calculated through market forecasts and benchmarking, are inserted into the tool. All these data are forwarded into the financial model of the tool that calculates revenues, investments, cash flows and other financial results for the network architectures for each year of the study period. An analytical description of the methodology and the tool can be found in [11] and [13].

### III. SERVICE CLASSES AND DEMAND FORECASTING

In order to determine the impact of various services on network dimensioning and revenue for the operator, specific service classes in terms of bandwidth quality of service have

been defined. Each bandwidth class – narrowband, wideband and broadband – is assigned an average bit rate, which corresponds to the *average air interface capacity required by a subscriber, when using the given service.*

TABLE I. — Service classes.  
*Classes de service.*

<i>Circuit packet Switched</i>	<i>Bandwidth class</i>	<i>Quality of Service class</i>	<i>Sample services</i>	<i>Nominal data rate (kbps)<sup>1</sup></i>	<i>Supporting network</i>
<i>Circuit</i>	Narrowband	Conversational	voice call	33	UMTS
<i>Circuit</i>	Wideband	Conversational	video call, enhanced m-commerce	390	UMTS
<i>Packet</i>	Narrowband	Conversational	voice over IP	33	UMTS
<i>Packet</i>	Wideband	Conversational	video call, games	230	UMTS
<i>Packet</i>	Broadband	Conversational	video conf.	1227	WLAN
<i>Packet</i>	Narrowband	Streaming	on rich call (e.g. audio clips)	33	UMTS
<i>Packet</i>	Wideband	Streaming	rich call (incl. video clips)	230	UMTS
<i>Packet</i>	Broadband	Streaming	Near video-on-demand	1227	WLAN
<i>Packet</i>	Narrowband	Interactive background	short msg., WAP	3.4	UMTS
<i>Packet</i>	Wideband	Interactive background	E-mail, Internet	16.4	UMTS
<i>Packet</i>	Broadband	Interactive background	Large file transfer, appl.	200	WLAN

Usage, in terms of average minutes per day, differs depending on whether the customer has a professional or residential profile.

Another important tasks for such a business case is the development of forecasts and forecasting models for demand, which drive the dimensioning and hence costs of the network in addition to providing vital information for calculating that demand revenues. Considering for the services based on the combined 3G&WLAN network infrastructure is dependent on overall mobile penetration [14, 15]. Projections on total mobile subscriber penetration (based essentially on 2<sup>nd</sup> generation systems such as GSM today) have been performed. Forecasts for the different penetration rates for the following mobile generations are the basis of this work, [16, 17, 18]:

- 2.5 G – HSCSD, GPRS
- 3 G – UMTS
- 3.5 G – ubiquitous roaming among 3G and WLAN systems

Figure 4 depicts the subscriber penetration curves for 3 G and 3.5G services, which form the basis for the subscriber numbers used in the business case:

1. Overhead included.

### Mobile subscriber penetration: 3G, 3.5G and the sum

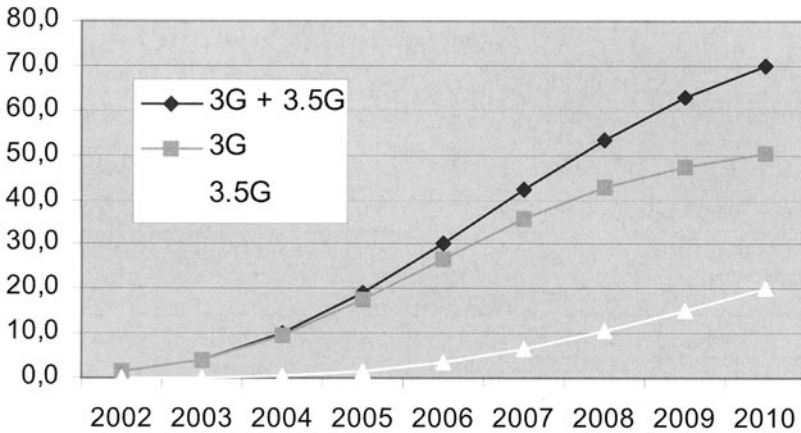


FIG. 4. – Mobile subscriber penetration rates (%) for 3G, 3.5G and their combination.

*Pourcentages de pénétration des abonnés mobiles 3G et 3.5G et leurs combinaisons.*

Information has been collected from different reports from consultancies and international organisations [19]-[31]. The most important reports are from Strategy Analytics [19, 20], Analysys [21] and OVUM [22]. In addition the TONIC project partners have collected up to date information about mobile penetration, demographic data and ARPU (Average Revenue Per User) levels.

The number of hot-spot locations that will be WLAN-enabled is one of the critical uncertainties for the 3.5G subscriber forecasts. Analysys [21] have based their forecasts on the assumption that property owners will react positively to the service propositions currently being in place by operators and that roaming arrangements between public WLAN operators will emerge from 2002 onwards. Analysys have estimated the rollout in hot spots by considering the number of potential locations by type illustrated in Figure 5.

If these assumptions are correct, the number of hot spots with WLAN access will reach over 90,000 locations across Europe by 2006. The figure shows that the overall value of the market is likely to be highly sensitive to the ability of service providers to persuade the owners of cafés, restaurants and hotels to host public WLAN services.

Figure 6 shows the distribution of WLAN users into corporate users, SME users and Consumer users. The figures are based on an average Western European country.

The figure shows that the early adopters of WLAN subscriptions mainly will be the business users. This situation is similar with other telecom products and technologies (i.e. 2G networks) and has been evaluated through observations observation of the current share of



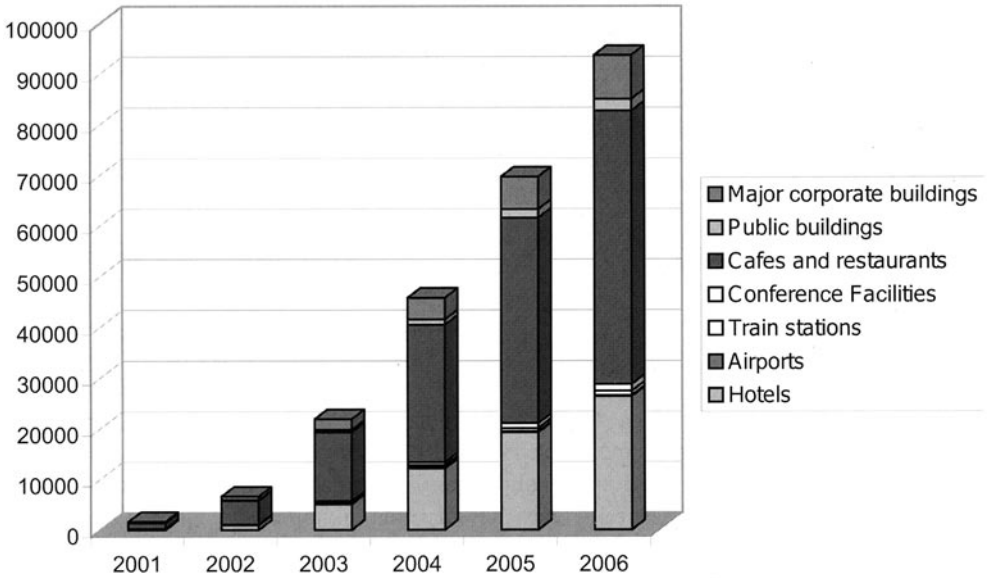


FIG. 5. – Public WLAN access locations, by type of location (source: Analysys [21]).

*Nombre de points d'accès WLAN publics par type de sites.*

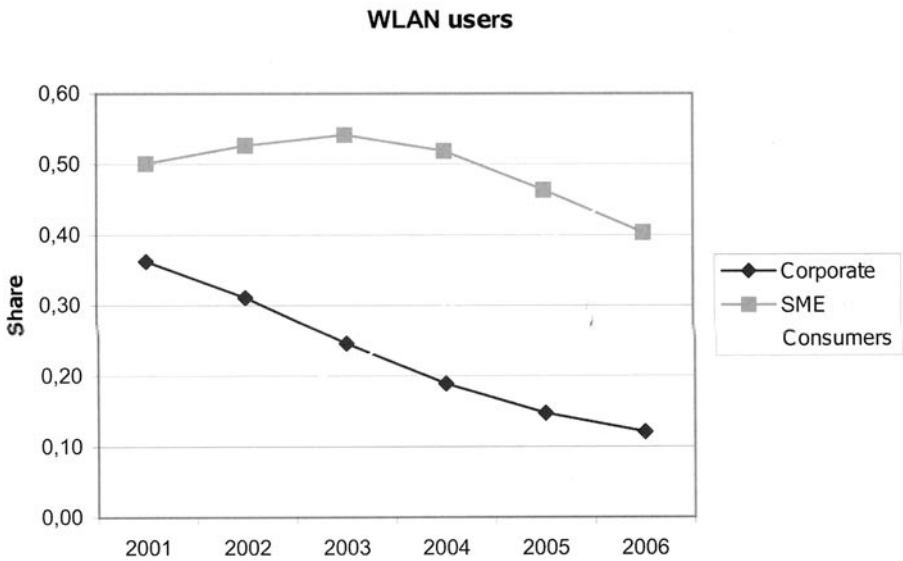


FIG. 6. – Distribution of WLAN users (Source: Analysys [21]).

*Répartition des utilisateurs WLAN entre grandes entreprises, PME et particuliers.*

pre-paid formulas and an estimation of contract-based residential and business subscriptions in the mobile market. In 2001, over 85% of the users were either Corporate or SME users. Therefore an increase in the residential market share from 2003 can be foreseen [21]-[23]. In 2006 this share has increased to almost 50%, compared to 40% and 12% for the SME and Corporate market respectively.

## IV. NETWORK DIMENSIONING

The network capacity dimensioning and busy hour modeling start with total subscriber penetration estimations. Subscriber penetrations in the two market segments, business and residential have been taken into account. Predictions for distribution of the subscriptions between market segments are utilized to get the market sizes for business and residential service classes. These market sizes are assigned to the service classes in the model, so that the penetration percentages refer to the respective market size, either business or residential.

In addition to dimensioning for capacity, the model is designed such that certain coverage requirements are fulfilled. For UMTS, the geographical parameters are set such that the area covered is inhabited by more than 80% of the population. This coverage requirement is in line with most national regulators' obligations for UMTS operators. Roll out is assumed to be progressive, starting in the dense urban and urban areas for service availability in 2003, and then extending to suburban areas.

For the WLAN component, only the country type currently determines the number of sites. The high capacity WLANs are constructed only for indoor hot spot areas where the expected demand is high. These hot spots include airports, railway stations, hotels, congress and exhibition halls, shopping centers, stadiums and arenas.

Because advanced services, which are not yet adopted on a massive scale have been considered, it has been observed that coverage is the main dimensioning criterion, which determines the roll-out cost.

## V. RESULTS

### A. Cost structure

#### Time distribution of investments and running costs

The yearly investments and running costs are illustrated in Figure 7 in the case of the large country<sup>2</sup>, with (LY) and without (LN) a WLAN component where it can be observed that the most significant investment occurs in 2002. This is for the deployment of the UMTS Radio Network, hence it is the same regardless of whether or not there is a WLAN. A second investment is seen in 2004 for the WLAN. The investments over the subsequent years concern increased

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2. The pattern is similar in the small country.

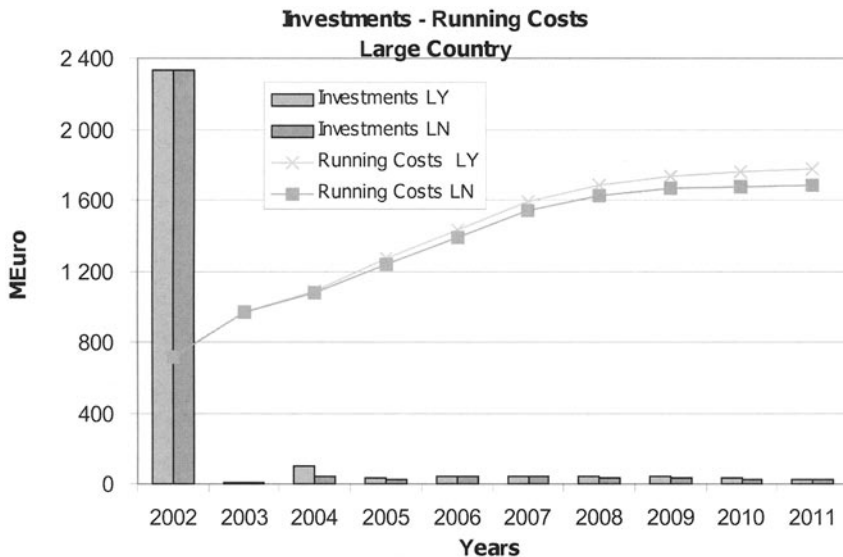


FIG. 7. -- Non-discounted investments and running costs, large country scenario. (LY = Large country with WLAN, LN = Large country without WLAN).

*Investissements et coûts d'exploitation non actualisés  
(LY = Grand pays avec WLAN, LN = Grand pays sans WLAN).*

coverage for the WLAN in terms of number of sites while for the “no WLAN” scenario, these investments relate essentially to the core network, as the number of subscribers increases.

Running costs are seen to increase over the years as the growing number of subscribers requires a larger workforce in customer service, and capacity needs increase as well. The breakdown of running costs is illustrated in Figure 8.

### Investments

The breakdown of total investments in the large country case is given in Figure 8. This chart confirms an earlier observation that the bulk of the CAPEX (> 80%) is accounted for by the UMTS (3G) radio network rollout. Note that site acquisition, installation, and build-out represent 18% of the CAPEX. Note also that the core network investment does not include transmission costs, since these latter are leased lines, and taken into account in the running costs.

Note that, if the discount factor is applied to the annual expenditures (which depreciates future spending), the WLAN component makes up only 1% of total discounted investment.

### Running costs

The annual running costs are shown in detail in Figure 9, for the large country. The main difference between running costs in the large and small country types is the level paid for the

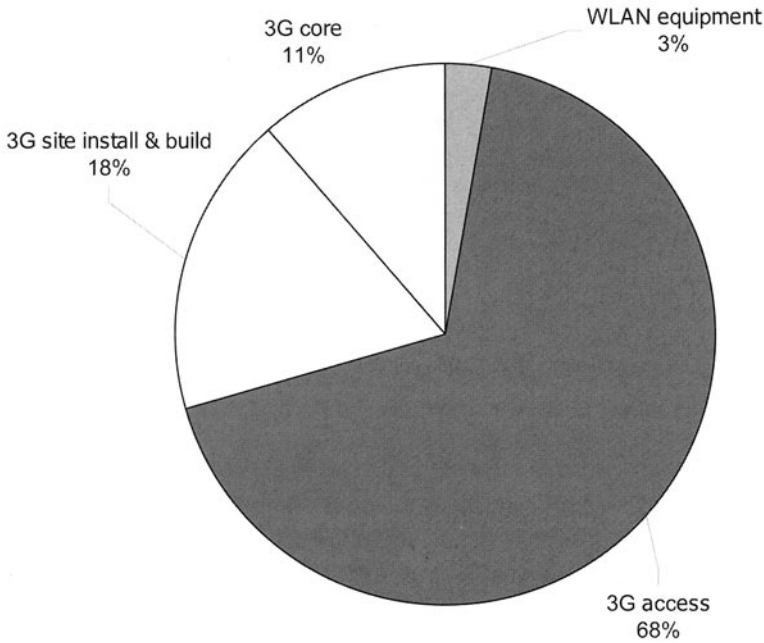


FIG. 8. – Breakdown of non-discounted Capital Expenditures (CAPEX), large country scenario.

*Répartition des investissements non actualisés, cas « Grand Pays ».*

UMTS license fee. It may be argued that this license fee is a “sunk cost” and that it may be eliminated from the analysis entirely. However, it is chosen to be included here in order to evaluate all relevant costs associated with the deployment of UMTS. Terminal subsidies are also lower in the small country (40 € versus 150 €). Personnel costs included both technical training costs, which occur during 2002, and customer service costs, which increase in proportion to customer numbers, then tend to flatten. In order to boost the service especially during the launch, higher marketing costs must be assumed. These costs are starting from the value of about 7 € per inhabitant and will be decreased for the next years into 1 € per inhabitant per year. These values have been based on data from telecom operators across Europe.

## B. Tariff structure

The tariff structure is linked to usage in linear fashion. For each service class, a basic capacity demand has been defined as a percentage of usage time during the busy hour. This parameter is multiplied by a tariff per capacity, which has been deduced from the today’s monthly tariff of an average 2G mobile voice customers. As a result the monthly ARPU for cir-

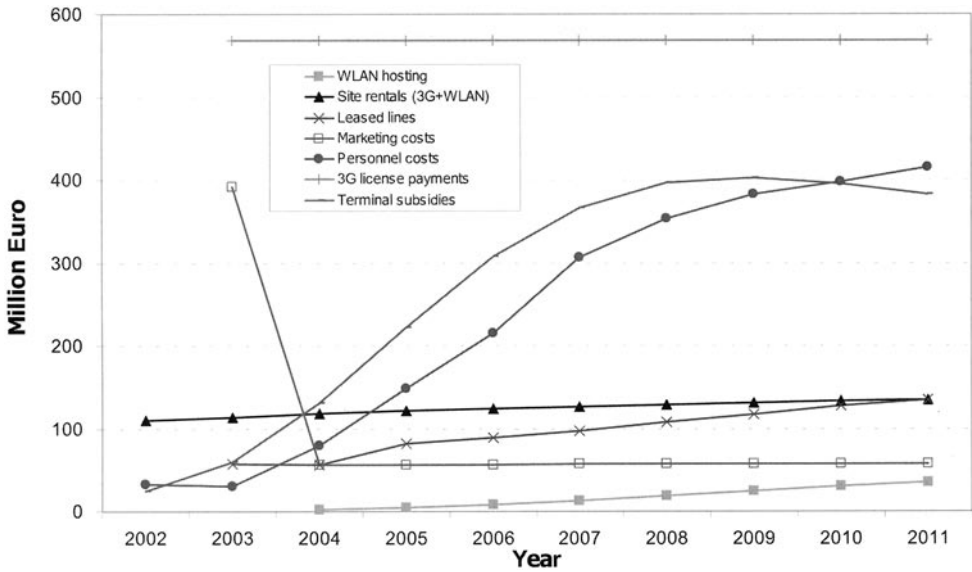


FIG. 9. – Running cost breakdown by year, large country case.

*Répartition des coûts d'exploitation annuels, cas « Grand Pays ».*

cuit switched voice traffic is around 25 Euros in the year 2002, which is in accordance to current situation.

The main interest is the proportion of revenues contributed by the WLAN components. This component makes up only 3% of the non-discounted investment, and 1% of the global discounted investment. On the other hand, as shown in the following graph, Figure 10, the revenues generated by the broadband services offered via WLAN make up more than 10% of the total by the 4<sup>th</sup> year of operation (2008).

Since the tariffs were considered to be uniformly higher in the small country, the same distribution is valid for the large country. If we consider discounted revenues over the study period, the WLAN component contributes 9% (versus 1% of total discounted investments).

### C. Basic scenario economics

The business case is assessed according to four conventional criteria, Net Present Value (NPV), Internal Rate of Return (IRR), cash balance, and payback period.

The *Net Present Value (NPV)* is today's value of the sum of resultant discounted cash flows (annual investments and running costs), or the volume of money, which can be expected over a given period of time. If the NPV is positive, the project earns money for the inves-

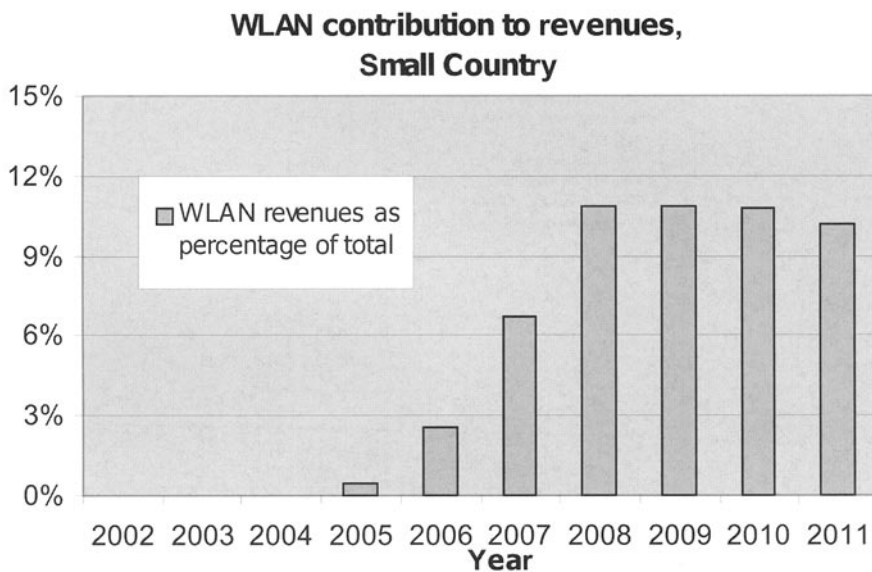


FIG. 10. – Portion of total revenues contributed by the WLAN component.

*Proportion de revenus générés par la composant de WLAN.*

tor. It is a good indicator for the profitability of investment projects, taking into account the time value of money or opportunity cost, which is expressed in the discount rate (10% in the present case).

The **Internal Rate of Return (IRR)** is the “interest rate” resulting from an investment and income (resultant net cash flow) that occur over a period of time. If the IRR is greater than the discount rate used for the project, then the investment is judged to be profitable. The Internal Rate of Return gives a good indication of “the value achieved” with respect to the money invested.

The **Cash Balance** (accumulated discounted Cash Flow) curve generally goes negative in the early part of the investment project because of initial capital expenditures. Once revenues are generated, the cash flow turns positive and the Cash Balance curve starts to rise. The lowest point in the Cash Balance curve gives the maximum amount of funding required for the project. The point in time when the Cash Balance turns positive represents the **Payback Period** for the project.

As mentioned, the modeling focuses on two area scenarios: a large European country characterized by Germany and France, for example, and a small European country exemplified by Scandinavian countries Norway and Finland. The country types differ on several points, in addition to their geographical and demographic features. Firstly, the operator in the large country is assumed to have significant license costs – 100 € per inhabitant. As in the case of France, these fees are staggered. Secondly, the subscriber saturation level is estimated to be higher in the Nordic country type – 95% versus 90% in the large country type.

Thirdly, consumption differs in that the Scandinavian users are assumed to have 20% greater usage than their counterparts in the large country. This consumption leads to a proportionately larger ARPU. Lastly, terminal subsidies are 150 € per new subscriber in the large country type and 40 € in the small country type.

The scenarios have been studied over a ten-years period due to the fact that most of telecom investment projects have a payback period between 5 and 10 years (i.e. UMTS [11], fiber installation) and demand forecasts are reliable for this period. In addition this time plan offers a better understanding of possible risks and a visible financial impact of UMTS-WLAN networks.

The main economic results for the four basic scenarios are illustrated below. It must be denoted that they are indicative and there not show economic conditions for a specific country:

TABLE II. — Summary of the basic results.

*Résumé des résultats de base.*

<i>Country type</i>	<i>Large</i>	<i>Small</i>
	With / Without WLAN	With / Without WLAN
<i>Net Present Value/VAN</i>	5.597 M€ / 4.413 M€	948 M€ / 859 M€
<i>Internal Rate of Return/TRI</i>	24% / 22%	38% / 37%
<i>Payback Period /délai de retour sur investissement</i>	7.1 years / 7.3 years	5.6 years / 5.5 years

These results show that UMTS operators investing in WLAN rollout benefit from an increase in Net Present Value of +27% for the large country and +10% for the small country over the 10-year study period. Internal Rate of Return increases to a lesser degree, and the payback period is practically not affected.

Following figures (Figure 11-Figure 12) illustrate the investments, running costs, revenues and non-discounted cash balance for each of the scenarios studied. Note that the Y-axis scales differ considerably between the two country types.

Lastly, the following plot (Figure 13) enables a comparison of the non-discounted cash flows and cash balances for the large country case with and without a WLAN component:

Looking from Figure 11-Figure 12, it can be observed that investments are roughly proportional to population in the two country types. The population ratio is 14:1 (70 million versus 5 million). For investments, a ratio of 11 has been found. The ratio of Net Present Values, however, is only 5. This reflects the fact that usage and hence ARPU in the Scandinavian type country is assumed to be 20% higher. If the same ARPU level is assumed, the NPV ratio rises to 8.

Furthermore, the comparison of cash balances in Figure 13 shows that the revenues gained from offering broadband services more than offset the additional costs. This obviously accounts for the improvement of both net present value and internal rate of return. It is recalled that the global discounted investment for WLAN represents 1% of the total, while global discounted revenues account for 9% of the total.

Economics Large Country WLAN

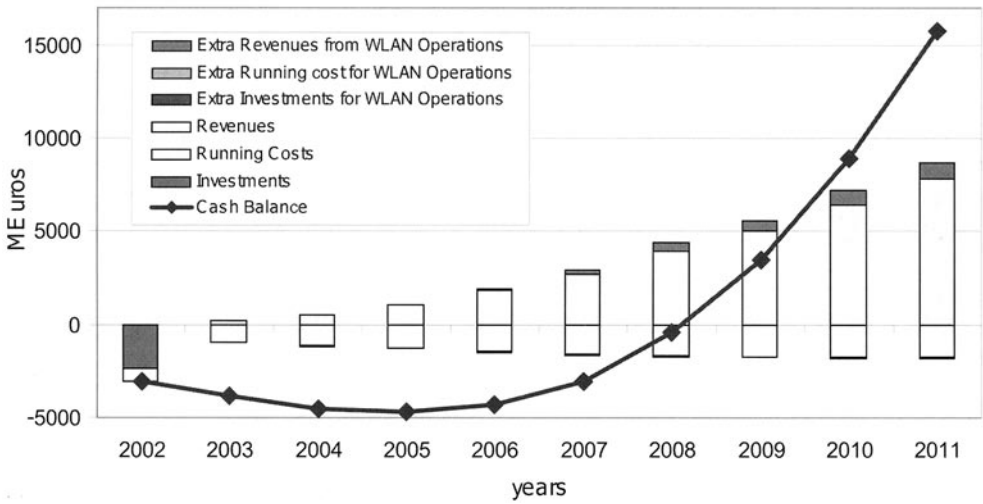


FIG. 11. – Cash flow curves under nominal assumptions in large country case with WLAN.  
*Cash-flows annuels et cumulés avec hypothèses de base, cas « Grand pays » avec WLAN.*

Economics Small Country WLAN

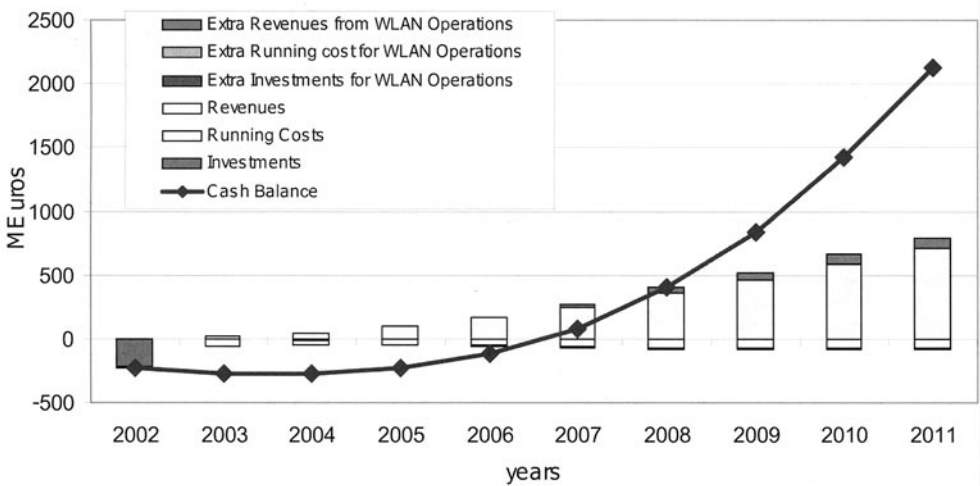


FIG. 12. – Cash flow curves under nominal assumption in small country case with WLAN.  
*Cash-flows annuels et cumulés avec hypothèses de base, cas « Petit Pays » avec WLAN.*



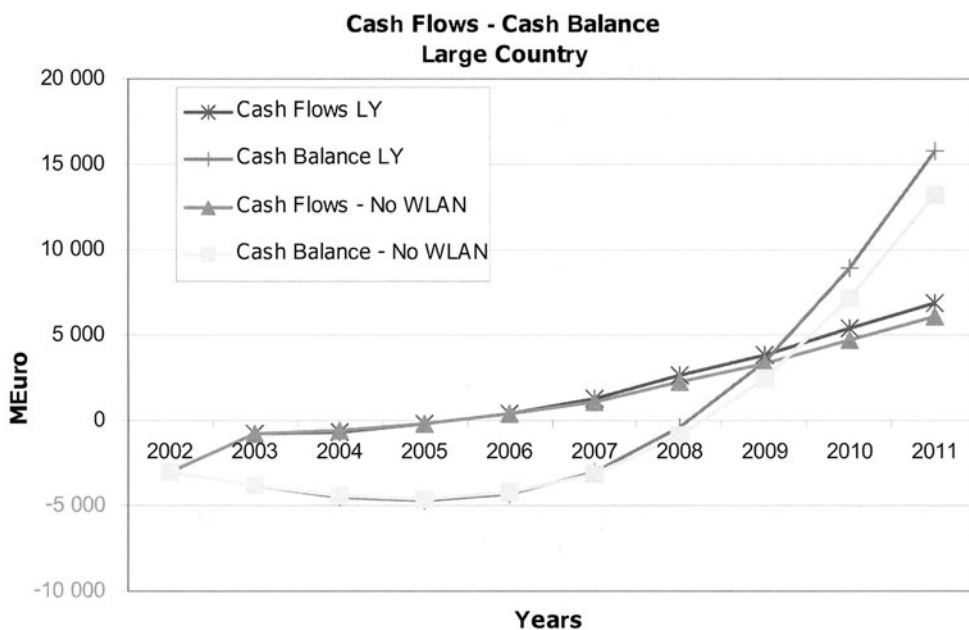


FIG. 13. – Cash flows and cash balance curves in large country case with (LY) and without WLAN.

*Comparaison des cash-flows annuels et cumulés cas « Grand pays » avec ou sans WLAN.*

## VI. CRITICAL FACTORS FOR A SUCCESSFUL WLAN BUSINESS

The above results concern a set of basic scenarios with given parameter settings, which is almost 200. In order to gain a more complete picture of how the investment project performs in regard to the modification of these settings, sensitivity analysis on the UMTS+WLAN scenarios in the large and small country types is needed. Modification of the critical parameters by +/- 50% has been performed in order to evaluate their impact on two criteria, Net Present Value and Internal Rate of Return:

The results for the ten most critical out of a total of 200 parameters are illustrated in Figure 14 to Figure 15. It is recalled that the “low value” represents the value obtained when the nominal parameter value is reduced by 50% and the “high value” represents the result when the nominal parameter value is increased by 50%.

### A. Usage/Tariff level

As seen in each of the graphs, the usage level is the most critical parameter for the financial criteria NPV and IRR, since it is linked with tariff and revenues, as explained in Section V-B.

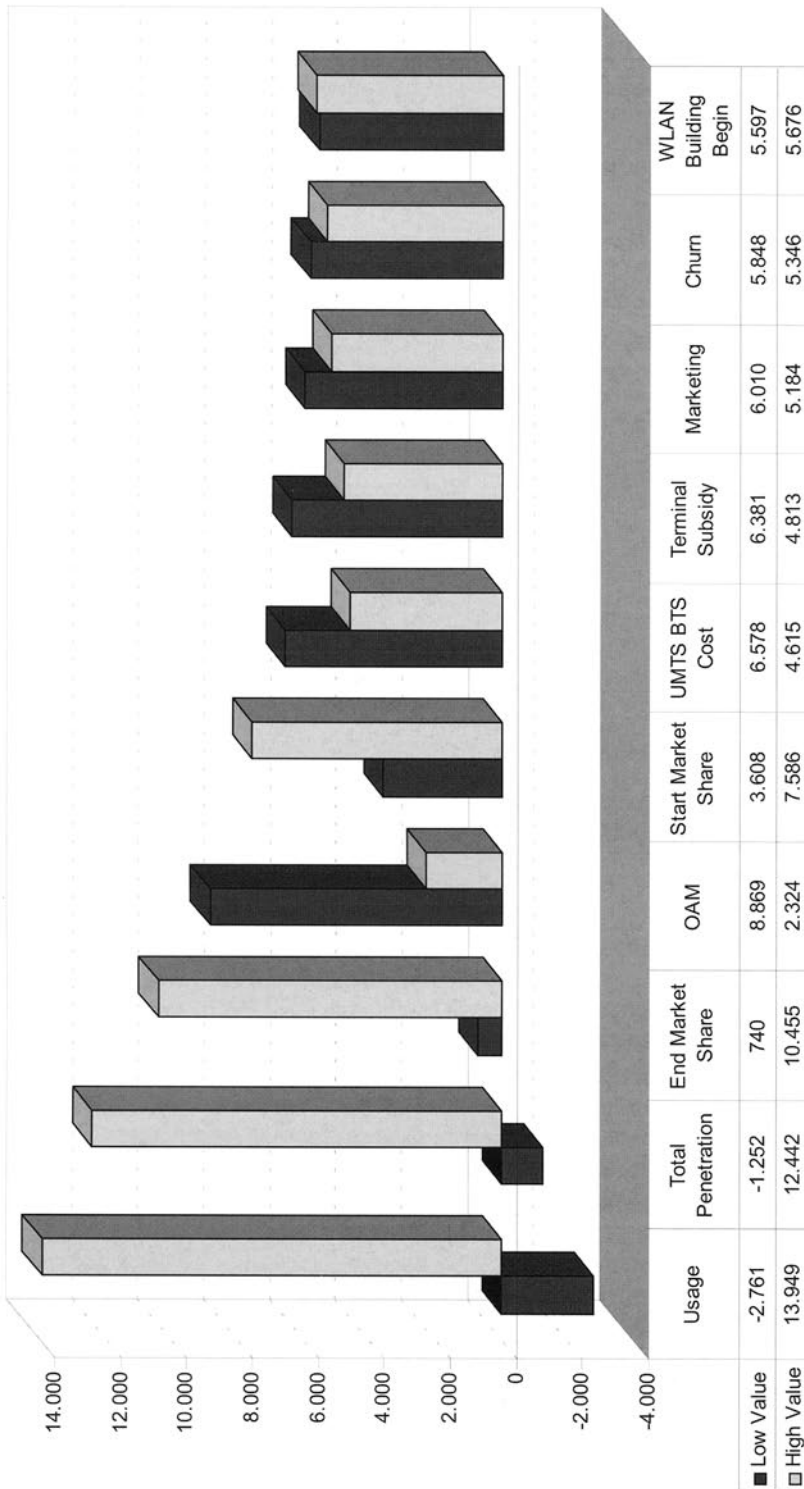


FIG. 14. – Sensitivity Results For a Large Country (NPV in MEuro).

Résultats de l'analyse de sensibilité cas « Grand Pays » (VAN en millions d'euros).

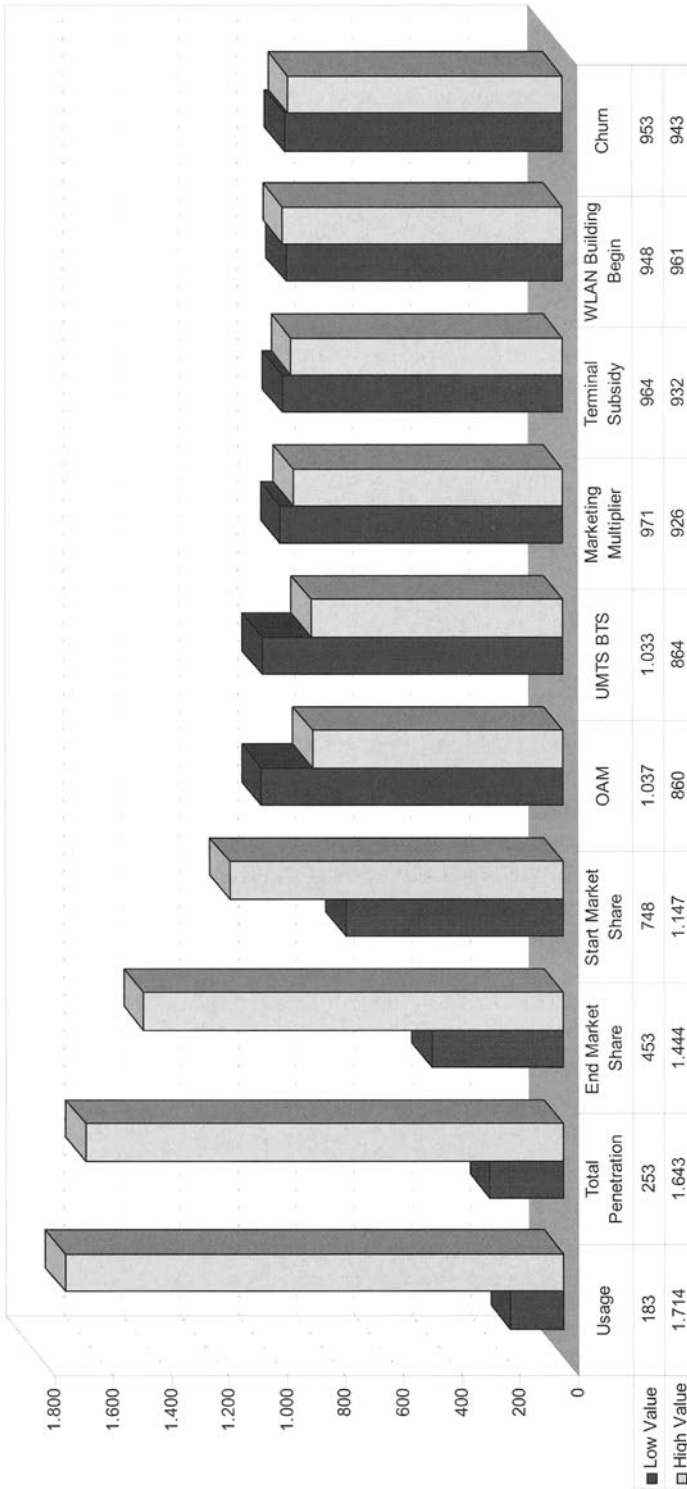


FIG. 15. – Sensitivity Results For a Small Country (NPV in MEuro).

Résultats de l'analyse de sensibilité cas « Petit Pays » (VAN en millions d'euros).

This means that a 50% increase in revenue corresponds to a 50% increased in usage, it would be expected that network costs would increase accordingly. However, network costs are essentially dictated by coverage constraints and not by capacity constraints. Hence, an increase in usage translates only as greater revenues, while the corresponding increase in costs is minimal, and relates to core network elements.

In the large country scenario, a 50% reduction in tariff/usage levels leads to a negative Net Present Value over the study period and a 33% reduction leads to a null NPV, i.e., cumulative costs (CAPEX + OPEX) are only just recovered by 2011. This information provides the operator with an idea of its latitude for changing rates in response, say, to sharp price reductions triggered by a competitor, all other parameters remaining equal.

Furthermore, a 50% increase in tariffs leads to a 150% increase in Net Present Value. Such a variation, however, should not be considered realistic, as many other parameters (overall mobile penetration, market share, marketing costs, etc.) are also affected, and could considerably modify the outcome.

In the small country scenario, NPV is reduced by 80% for a 50% reduction with respect to the nominal tariff level. The fact that it remains positive shows that the operator has significant room to manoeuvre in terms of tariff level. The Internal Rate of Return varies in similar fashion to changes in the Tariff level parameter.

## **B. Total Penetration of mobile services**

The nominal saturation levels for subscriber penetration are respectively 95% in the small country and 90% in the large country. Only the -50% variation is examined, since the subscriber saturation level cannot exceed 100%.

In the large country, if this saturation level is reduced to 45%, the NPV is negative and it is zero for a level of 53%. This information is good news for the operator, since overall mobile penetration already exceeds this critical point. Again, the parameter for overall penetration was modified with all other parameters remaining constant.

In the small country, a null NPV is found for overall mobile penetration of 30%. Here again, this level has been largely exceeded in the Nordic countries, hence there is no cause for concern over this parameter.

It can thus be concluded that, under the assumptions taken in this business case, a 30% shortfall on the estimation of total penetration of mobile services will not adversely affect the economic viability of UMTS+WLAN roll-out, since NPV stays positive for the penetration levels observed today in Europe.

## **C. Start and End Market Share**

In both country scenarios, the 3G operator is assumed to have a 30% market share throughout the study period. However, it would be of interest to study the impact of variations in both start and end market share. The graphs show that the beginning and end market shares indeed affect NPV and IRR, but even if they are reduced by 50%, the resulting economic indicators remain positive (NPV > 0 and IRR > 10%) in both country types.

## D. Running costs

Only Operations and Maintenance are seen to have a significant impact on NPV and IRR. However, most of these costs are quite inelastic since they are related to personnel costs, and the operator does not usually have much leverage to reduce them significantly. A 50% increase in OAM costs results in a 58% reduction in NPV in the large country and a 10% reduction in the small country. All other parameters remaining equal, however, these variations do not lead to a negative NPV at the end of the study period.

## E. WLAN Buildout Year

With equipment costs decreasing over time, it could be expected that the year of deployment of the WLAN component would have some impact on the Net Present Value. The cases where WLAN roll-out (2004) is delayed by one and two years (all other parameters remaining equal) have been studied. The graphs show that this delay has minimal impact on the economic results of the business case in both country types. The change in NPV is null for roll-out in 2005, and there is a very slight increase for roll-out in 2006 (i.e., the operator benefits from a reduction in investment costs): +1.4% in both country types. The fact that the investment schedule has such a small impact is understandable in light of the fact that the WLAN equipment represents only 3% of the total non-discounted investment.

## F. Investment costs

Of all the access components only the UMTS BTS cost variation is seen to have any impact on NPV and IRR. The +/- 50% variations lead to a +/- 17.5 % variation in NPV in the large country scenario and +/- 18% in the small country scenario. The economic criteria are highly inelastic to WLAN cost variations. As in the case of the WLAN roll-out year, this observation can be attributed to the fact that WLAN equipment represents such a small percentage of the total discounted investment cost.

## VII. CONCLUSION

The attention of mobile network operators is increasingly focused on the possible deployment of WLANs for complementary coverage and greater bandwidth. At the same time, R&D and standardization efforts are being led at the European and world levels on interworking between 3<sup>rd</sup>-generation mobile systems and WLANs. The IST-TONIC project is a precursor in the investigation of the economic side of such deployments. This article is a first step in the assessment of the deployment context, the market conditions, the network architectures, and the economic potential of UMTS+WLAN (3.5G) roll-out for seamless IP based services.

In this analysis based on specific assumptions described herein, revenues derived from supplementary higher-bandwidth services offered via WLAN largely offset the additional costs incurred, as demonstrated by a noticeable rise in Net Present Value over the study period, regardless of the country type.

Regarding costs, the bulk of the expense lies in the UMTS deployment, while the WLAN component represents only 3% of total non discounted investments. Moreover, since the study period covers the service introduction phase, costs are driven almost exclusively by coverage constraints rather than by capacity demand. However, once services gain a strong following, especially in the mass market, additional investments will be dictated by capacity needs.

Sensitivity analysis enables the identification of the most critical parameters affecting the economic performance of UMTS+WLAN deployment. The tariff level has the greatest impact, followed by market share at the end of the study period. Variations in the cost parameters have a very limited impact on economic results, and do not threaten the viability of the investment project, since Net Present Value continues to be positive.

Concluding, the business perspectives of WLAN as a complementary to UMTS technology have been shown both for small and large countries.

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