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TONIC – A Decision-Making Tool for Long-Term Telecom Strategies

Part 2: Strategies for Fix and Mobile Networks

TONIC is an international IST project on techno-economic analysis running since early 2001 and ending December 2002. It focuses on service-related network evolution model constructions, market figures and economic tools for processing this information.
Two business cases studied by TONIC are presented here: Evaluation of the impact of a public WLAN service offered together with UMTS, and the comparison of Ethernet and ATM PON technologies for providing future broadband access.

The programme "Future Network Services" deals with network issues focusing on current key questions such as which type of technology to use in the core and in the access networks, as well as on issues related to mobile network.
With its Innovation Programmes, Swisscom Innovations follows the objective of recognising early on the impact of technological developments, finding new business opportunities, promoting technical synergies, and developing concrete innovation proposals. Further, the expertise built up enables active engineering support of business innovation projects.

Using the tool developed within TONIC and described in a previous comtec paper (comtec 10/2002), TONIC studied some evolution strategies in the mobile and fix network areas.
WLAN technology and related PWLAN (Public WLAN) services are developing rapidly around the world. Nowadays, many devices offer more than one access technology. Many concepts in the mobility area are considering the combination of WLAN and UMTS, with WLAN being chosen whenever available, and UMTS

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everywhere else. TONIC has evaluated the advantages for an incumbent Mobile Network Operator to combine offers of PWLAN services with UMTS services to allow mobile customers to move from one access technology to another without service breakdown.
On the fix network side, many operators are looking at providing higher bandwidths than possible with ADSL using VDSL transmission technology or a full fibre solution. Two concepts are currently competing, a solution based on Ethernet and one based on FSAN. Traditionally, telecom-oriented technologies are considered more expensive than computer-oriented ones, however, computer oriented technologies are considered weaker for services with time constraints, like telephony. TONIC has compared both technologies for providing IP-based services in 2 network types, i.e. in a dense urban area, and a less dense urban area. The same topological architectures have been considered (same number of nodes and same number and length of cables). In addtion, the FTTH and the FTTC architectures have been compared for both technologies

With less than 3% investment from a combined PWLAN-UMTS strategy, PWLAN will bring about 10% of the total revenues.
Ethernet technology does not provide significant cost advantages compared to a FSAN standard (ATM based PON, possibly combined with DSL).

The Future is Called WLAN

Confirming the success of the WLAN, PWLAN projects are multiplying around the world. In the future, people will travel with data-capable devices, including communication facilities like personal digital assistants, notebooks and smart phones. Whereas WLAN technology provides high bandwidth at low cost, UMTS provides a large coverage. Combining both will improve the mobility service offer. TONIC has evaluated the economic feasibility of a new cellular network enabling IP-based seamless handover between UMTS and WLAN (Hiperlan/2) networks.

Here, the market development is the one foreseen in 2000-2001 with UMTS roll-out in 2002 and services available in 2003, and seamless handover between both technologies is considered as standard. The impact of the different situations in large and smaller (e.g. Nordic) countries has been considered as well. In this paper, only results for incumbent mobile network operators are given within a considered time period starting in 2002 and ending in 2011.

The Convergence of Computer and Telecommunication Worlds in the Access Network

With the arising demand for new fix broadband services and increasing competition, fix network operators face increasing bandwidth requirements. New infrastructure is required to deliver multimedia services in the Mbit/s range to end customers. Various access network technologies can be used. Nevertheless, incumbent network operators focus on cable-based solutions. These solutions require to use more or less optical fibres and possibly some DSL transmission systems when the bandwidth increases.
TONIC has evaluated 2 different network solutions for providing such services: the Ethernet-based solution and the FSAN solution using SDH and ATM transmission. Due to their bandwidth capability, optical fibres are future proof. Therefore, a full optical solution would make sense. TONIC has compared the full optical architecture with the mixed fibre-copper solution for both solutions.
In order to optimise an access network evolution strategy, several questions must be answered:

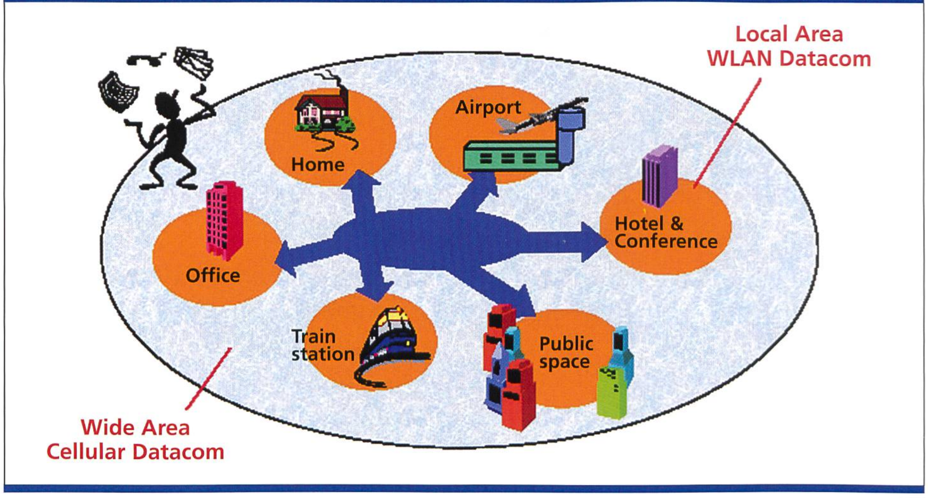

Fig. 1. Concept for Seamless IP Provision (source: TONIC).

- What is the best way to connect different kinds of customers and which technology suits best?
- One single technology for all customers or customised access solutions?
- What kind of network evolution strategy following the existing infrastructure is best?

Combining PWLAN and UMTS: the Model

TONIC Business Case 1 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 aiming at the provision of seamless IP services is illustrated in figure 1.

The network architecture modelled for TONIC techno-economics purposes is made up of two wireless access systems, UMTS and WLAN. The inter-working of these networks and the ability to seamlessly move among them is being developed by the IST projects RAIN and MIND. Figure 2 shows the TONIC forecast model for mobile penetration users in the timeframe 1998-2010 in an average Western European country. The early adopters of WLAN are expected to be business customers. In 2001, over 85% of the users were either corporate or SMEs. From 2003 onwards, an increase in the residential share is expected, rising to almost 50% in 2006, whereas SME and corporate clients decrease to 40% and 12% respectively.

The breakdown of total investments shows that the bulk of expenses lies in the UMTS deployment. Thus, site acquisition, installation and build-out account for 18% of the CAPEX, while the WLAN component makes up only 3% of total non-discounted investment. The revenues generated by broadband services offered via WLAN, however, make up more than 10% of the total by the 4th year of operation (i.e. 2008). Generally speaking, 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 studies help to identify the most critical parameters underlying the economic performance of UMTS+WLAN deployment. Thus, the tariff level has the greatest impact, followed by market share (at the end of the study period).

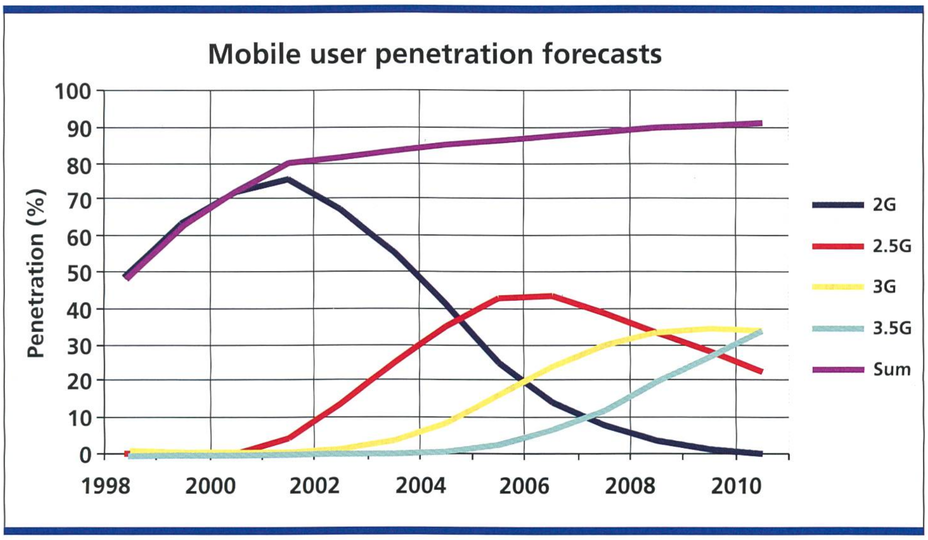

Fig. 2. Mobile penetration forecast (note: 3.5G stands for UMTS+PWLAN).

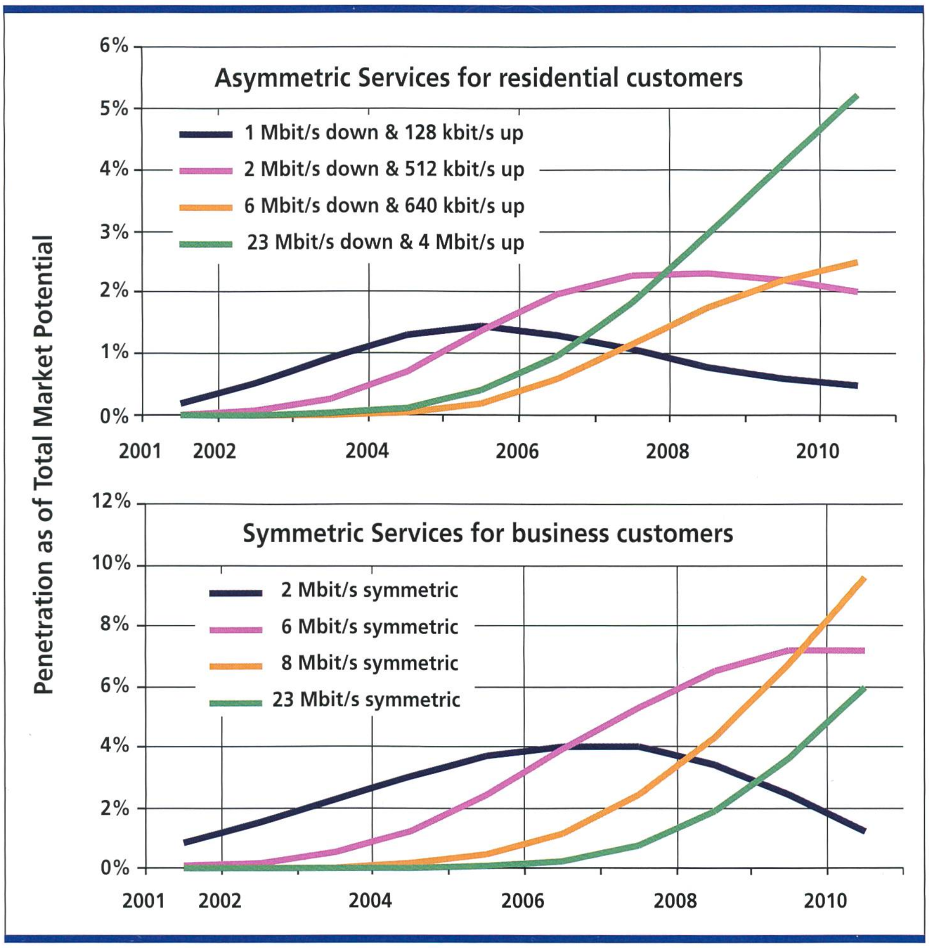

Fig. 3. Broadband service demand forecast for the dense urban area.

Comparing Ethernet and FSAN for Broadband Access: the Model

Within the business case, customers are classified as *residential customers* and as *business customers*. The latter include Small and Medium Enterprises (SME), Small Office/Home Office (SOHO) customers and teleworkers. Key network requirements for business customers are scalability, security, flexibility and differentiated QoS. The range of services required by business customers is also wider than for residential customers: file transfer within an Intranet, which means burst traffics and highly variable bit rates, high bit rate access to the Internet and

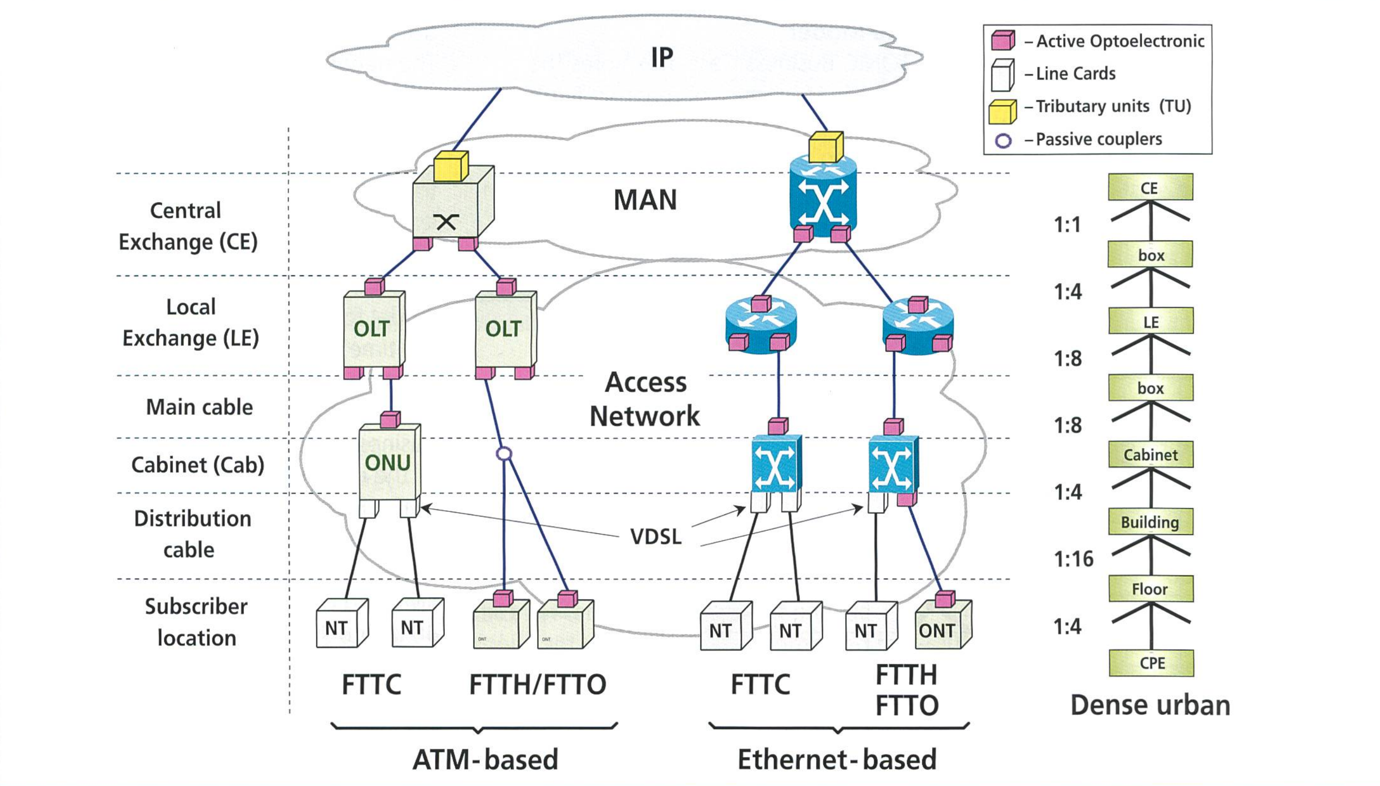

Fig. 4. The business case technology choice and architectural options. OLT: Optical Line Termination; ONU: Optical Network Unit; NT: Network Termination; ONT: Optical Network Termination; CPE: Customer Premises Equipment; MAN: Metropolitan Area Network.

videoconferencing with strong real-time constraints. In most cases, these services require higher bit rates than typical residential services.
The broadband access forecasts for both the business and the residential markets are described in figure 3. In addition, the market share of the incumbent operator has been assumed to be 60%.
The broadband tariff structure is rather complex and might include connection, access, service provider, traffic, transaction tariffs and charge for content (i.e. pay per view). In this business case study, no traffic and content charges are included since the focus is on the broadband access. The monthly charge for an asymmetric 1 Mbit/s access, for instance, is set at 60 €, and to 110 € for 1 Mbit/s symmetric access.
The basic tariff for 1 Mbit/s symmetric and asymmetric capacities is derived from a survey including a number of large operators in Europe. The model assumes a tariff increase for each capacity doubling. The model also assumes an annual tariff erosion of 10%.
The Fibre To The Cabinet (FTTC) scenario has been calculated with both Gigabit Ethernet and ATM-based technologies by using the point-to-point topology.
The complete service set is offered by using the VDSL modem technology between the cabinet location and the subscriber. That gives an incumbent telecom operator the advantage to connect the customers via the old copper cable infrastructure within the first mile.
A new fibre infrastructure takes place between the cabinet and the Local Ex-

		with PWLAN	without PWLAN
Large countries	NPV	5597 m€	4413 m€
	IRR	24%	22%
	Payback Period	7,1 y	7,3 y
	Average ARPU	566 €	562 €
Small countries	NPV	948 m€	859 m€
	IRR	38%	37%
	Payback Period	5,6 y	5,5 y
	Average ARPU	679 €	675 €

Fig. 5. Main economic results of UMTS/PWLAN service provisioning. NPV: Net Present Value; IRR: Internal Rate of Return; ARPU: Average Revenue Per User, per year (source: TONIC).

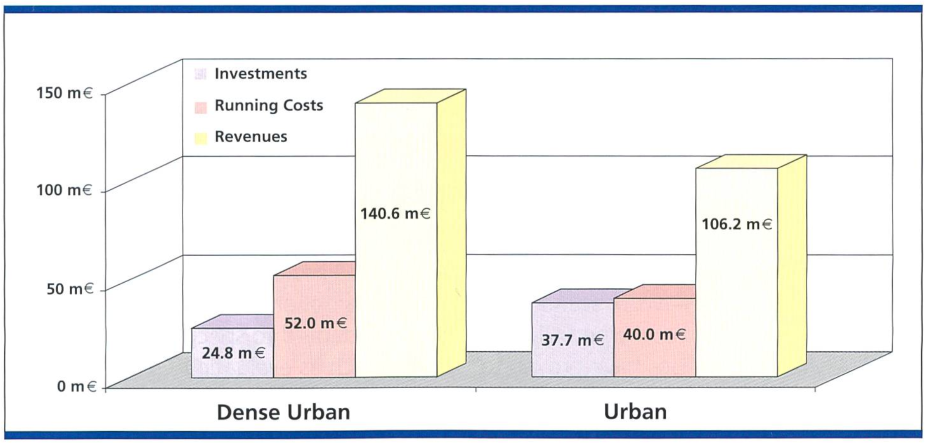

Fig. 6. Cumulated costs and revenues – Ethernet FTTC (in millions of EURO).

change (LE). This also includes the replacement of the old passive cabinets with new climatic conditioned cabinets including power access. The duct infrastructure between the LE and the Central Exchange (CE) already exists. Within this area the cost of fibre cable, branching boxes including installation cost, and the pulling costs into the ducts have been estimated.
The network area includes subscriber density, loop lengths, geographical and market characteristics. The business case includes one Central Exchange and four service access areas with more than 16 000 customer units each, which are connected to the same Local Exchange. The study covers two different service area types, which are the dense urban and urban areas. As an example, the dense urban area has been modelled as an area of 3 km^2.
The duct availability is set to 90% for the network part between the LE and the cabinets and to 50% between the cabinets and the customer buildings. This factor is important, because it strongly influences the economics of the various scenarios due to the high investment costs of ducting systems related to civil works.
The network options and assumptions are presented in figure 4. Two basic architectures have been considered: The Full Service Access Network (FSAN) Broadband Passive Optical Networks (BPON), based on ATM, and the Gigabit Ethernet based architecture. Two basic network configurations are examined: Fibre To The Cabinet (FTTC) and Fibre To The Home/Office (FTTH/O).

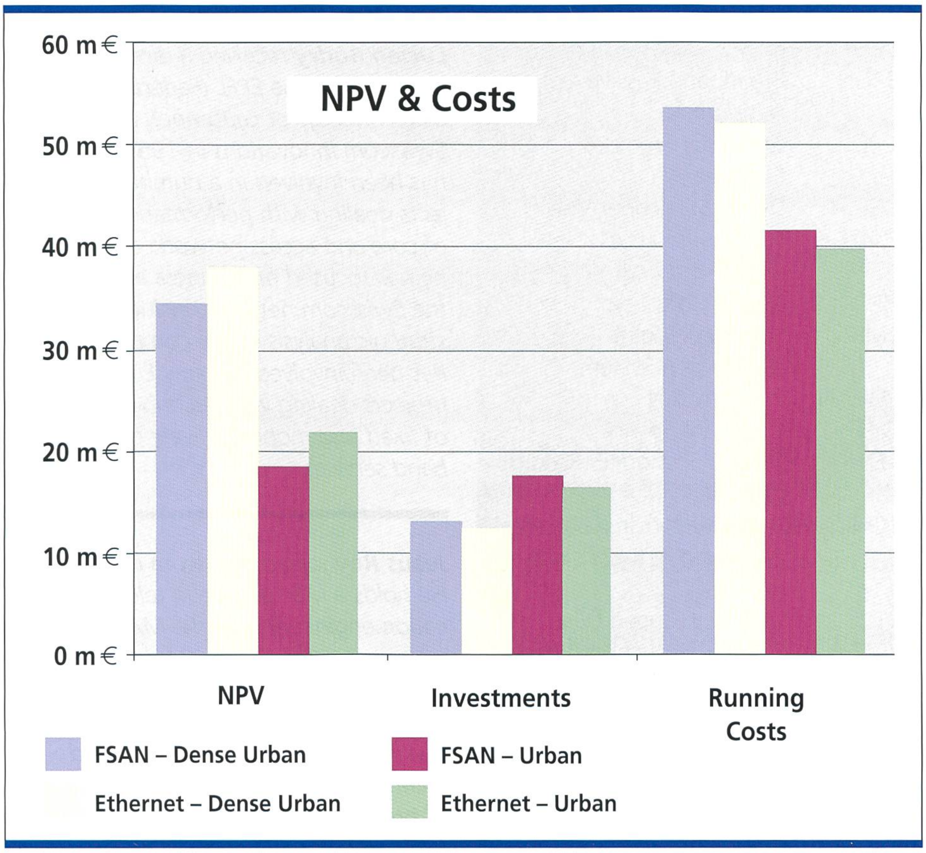

Fig. 7. Comparison between the ATM/FSAN and Ethernet architectures.

Combining PWLAN and UMTS: the Results

Four different scenarios have been considered to extract key economic conclusions about the UMTS-WLAN coupling to offer seamless IP wireless coverage in large and small countries (the former with population of around 70 million and high licensing fees, the latter with population patterns of around 5 million and lower licensing fees). The main results are illustrated in figure 5.
These results show that UMTS operators investing in WLAN roll-out benefit from a considerable increase in Net Present Value levels over the 10-year study period: 27% for a large country and still 10% in the case of a small country. Internal Rate of Return increases to a lesser degree. The Payback Period figures are practically unaffected.
The comparison of the cash-balance levels leading to the economic outcome above shows that, regardless of the country type, the revenues gained from offering broadband services via WLAN deployment for complementary coverage and greater bandwidth are distinctly higher than the incurred costs. This is obviously in line with the improvement of the net present value and the internal rate of return.
The work conducted will be continued in order to target topics such as capacity-driven WLAN roll-out, WLAN-only competitor scenarios, and risk analysis associated with different investment options. Other network scenarios may also be explored in cooperation with the MIND project.

Comparing Ethernet and FSAN for Broadband Access: the Results

Figure 6 presents the cumulated investments, running costs and revenues of dense urban versus urban area for the FTTC scenario. Note that infrastructure

expenditures account for one-third of the total investments, in the dense urban, and three-fifths, in the urban area. For the densities and duct availability assumed, the projects' payback period is between 4 and 8 years for the different network scenarios. Also, the NPV of the scenarios do not differ much for the various network scenarios.
For the dense urban area there will be a strong argument for using fibre-rich solutions (i.e. fibre going all the way to the building) as they are more future-proof. In addition, outside plant maintenance is costly and reinvestments unnecessary. Figure 7 presents a comparison of the ATM/FSAN and Ethernet in a FTTC configuration. The running costs over the study period clearly exceed the investment costs. The infrastructure investments are more important in urban than in dense urban areas due to the duct availability and the duct length.

Conclusions

Using the TONIC tool, a number of simulations have been carried out. The comparison of the results allows to give some general guidelines for the wireless business area, as well as for the fix network evolution.

The incumbent mobile operator analysis shows that with much lower investment and good revenue potential, PWLAN appears as a nice complementary solution to UMTS. The seamless handover functionality is a key function for this business model and no specific costs and revenue have been included in the presented scenario. In the analysis of different case studies and network scenarios, revenues coming from combined UMTS-PWLAN wireless solutions have proved to offset investments in WLAN infrastructure deployment. A number of sensitivity studies show that costs are mostly driven by coverage constraints rather than by capacity demand, and that tariff levels have the greatest impact on the overall financial performance.
The fix network operator analysis shows that investments for an Ethernet-based network architecture are in the same range as the ones for the FSAN-based network architecture, but with a small identified cost advantage for Ethernet. The NPV clearly shows that all these technologies are more attractive for dense urban areas than for less dense areas, but the payback period remains long. For a solution combining fibre with VDSL, the payback period reaches 6 years for a partial coverage or 8 years for a full service coverage and about half a year more for an all-fibre solution. Nevertheless, this new infrastructure opens new business opportunities for network operators.

Outlook

TONIC will continue in 2003 with a follow-up IST project. The current TONIC tool, assumptions, and business models can be adapted to specific operator needs such as evaluating GPRS and WLAN 802.11, or comparing other technological alternatives for providing higher bandwidths. 10

Eric Demierre *received his Master of Science degree in physics from the EPFL (Ecole Polytechnique de Lausanne). He joined Swisscom Innovations in 1989 where he focused on access network issues. In 1997 he led an Innovation Programme on access network and residential services. In 2000, after getting an executive MBA from the IIMT (International Institute of Management in Telecommunication) of the University of Fribourg, Eric Demierre was involved in innovation and business activities. He is currently responsible for the Swisscom participation in TONIC.*

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Pointers

TONIC web site:
http://www-nrc.nokia.com/tonic/
Website of the 4th Workshop on Telecommunications Techno-economics:
http://www.nrc.nokia.com/tonic/workshop/index.html
IST website:
http://www.cordis.lu/ist/home.html

Related Literature

TONIC Deliverable 1:
Description of selected business cases

TONIC Deliverable 2:
Demand models and preliminary forecasts for IP services

TONIC Deliverable 3:
First results on seamless mobile service provision economics

TONIC Deliverable 4:
First results on broadband network solutions for new IP services offered in the fixed network

Abbreviations

BPON	Broadband Passive Optical Networks
CPE	Customer Premises Equipment
DSL	Digital Subscriber Line
FSAN	Full Service Access Network
HFC	Hybrid Fibre Coax
LMDS	Local Multipoint Distribution System
PWLAN	Public WLAN
QoS	Quality of Service
TERA	Techno-Economics Results from ACTS
TONIC	TechnO-ecoNomICs of IP optimized networks and services
VDSL	Very High Speed DSL
xDSL	x Digital Subscriber Line (of any type)