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

Part 1: Forecast, Methodology & Tool

TONIC is an international IST project on techno-economic analysis running since early 2001 and ending December 2002. It focuses on network evolution model constructions, market figures and economic tools for processing this information. TONIC produced first recommendations in 2001 concerning the technologies to be used in the access network and the impact of WLAN for mobile network operators and mobile virtual network operators. The objectives of TONIC are firstly to provide tools and data that can be adapted to particular situations of the participants for evaluating strategies in the fixed and mobile access domains, and secondly to provide recommendations for related long-term strategies.

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 network, as well as on issues related to mobile networks.
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.

Today's fast evolving society must address basic universal needs of citizens and businesses: citizens need jobs, education and entertainment, whereas businesses must optimise productivity, increase their customer base and ensure cost-effective training for their workforce. Internet, including mobile IP services, contributes to a growing extent to the satisfaction of these needs and provides a unique opportunity for sustainable development in both central and rural areas.
Advanced user-friendly IP applications will lead to new ways of consuming and working. Broadband communications and flexible home office solutions should be strong drivers for new employment opportunities. In sparsely populated areas, people will benefit from distributed services and functions for work and health care, for example. These advanced services save time and resources, improve the quality of life, and favour the development of less urbanised areas. New services require reliable network infrastructures providing ubiquitous access. IP is currently gaining an important position as a unifying protocol, migrating from transport to access networks. This migration, combined with the emergence of multiple access technologies and convergence between fixed and wireless media, will have a strong impact on how the customer is reached, and which services can be offered.

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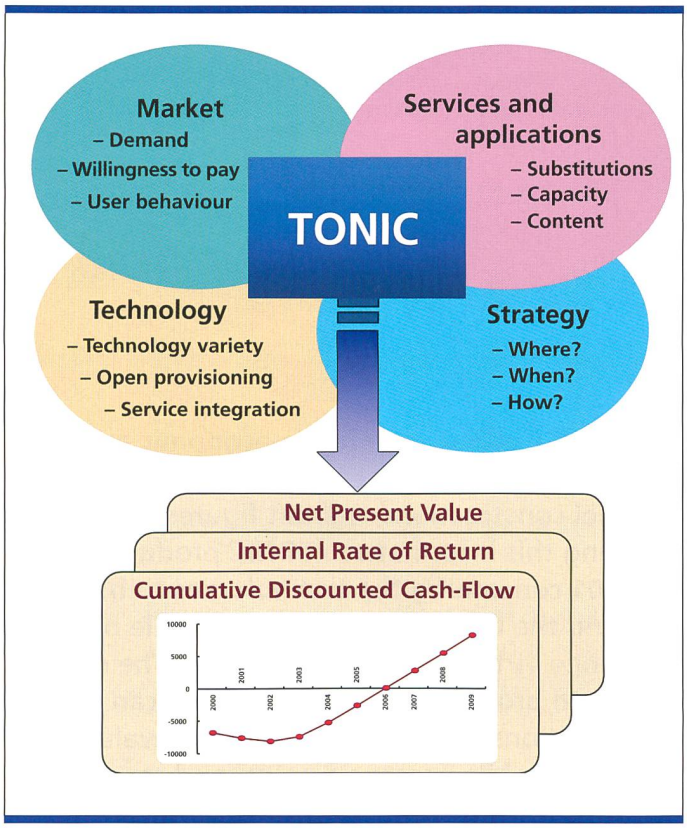

Fig. 1. TONIC gathers input information from market, services and technologies to assess the business strategy of a business case.

New actors are positioning themselves in the access network through new technologies including HFC (Hybrid Fibre-Coax networks), LMDS (Local Multipoint Distribution radio Systems), dark fibres, local loop unbundling, GSM, WLAN and later UMTS (Universal Mobile Telecommunications Services). In addition, virtual operators are appearing in the marketplace. These trends will shape the communications world in the years to come.
TONIC (TechnO-ecoNomICs of IP optimised networks and services) is a project within the European IST programme (Information Society Technologies). The partners are Nokia Corporation, Telenor AS R&D, France Telecom R&D, University of Athens, Atlantide Consulting, University of Aveiro, T-Systems Nova Gmbh and Swisscom Innovations.

TONIC offers a powerful methodology for evaluating fix and mobile service strategies and allows participating telecom operators to improve their long-term strategy definition by consolidating assumptions, models and results.

This article introduces the TONIC capabilities and describes the applied methodology. A later article, to be published as Part 2, will present actual results from two case studies obtained with the TONIC tool.
TONIC concentrates on techno-economic evaluation of new communication networks and services, with the objective of identifying the economically viable solutions. TONIC uses a case study approach to assess new broadband and IP service scenarios, yielding quantitative economic results, and identifying and quantifying the associated risk factors. The project team builds upon long experience in developing and exploiting techno-economic models for broadband access network evolution analyses.
The results are key economic indicators (figure 1) such as Net Present Value (NPV), Internal Rate of Return (IRR) and Payback Period. Based on these results and on the risk analysis, TONIC will formulate recommendations for optimal service rollout strategies.
TONIC's main objectives are:
– to assess the new business models associated with offering IP-based mobile services in a competitive context;

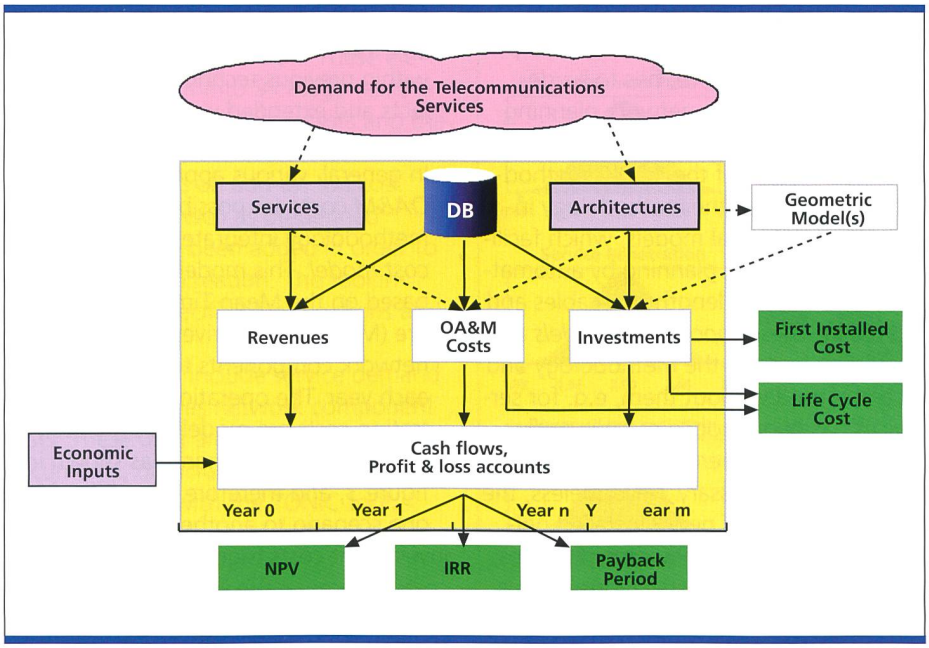

Fig. 2. The TONIC information flows (NPV: Net Present Value; IRR: Internal Rate of Return).

– to evaluate the cost and benefits of providing broadband access to both competitive and non-competitive areas, and to determine the most appropriate network infrastructure from an economic viewpoint;
– to analyse the results of the above studies in order to formulate pertinent recommendations to policymakers, network operators and service providers regarding communications investment strategies.

TONIC defines, in association with cooperating projects, representative sets of services – e.g. teleworker package, entertainment, games and interactive video – in order to determine the traffic load incurred on the network and to provide a target set of services for demand forecasting studies.

Following the collection of broadband demand data and tariff information, TONIC develops demand-forecasting models for mobile and fixed broadband services. These models consider factors such as fix-mobile convergence, broadcast communications, and mobile Internet, as well as seamless service provision across different types of networks. Substitution and stimulation effects are considered. The impact of competition and tariff levels on demand is also taken into account. Tariff structures including connection fees and traffic charges are derived from mobile and broadband tariff structures observed today. Criteria for tariffs include data transmission rate, degree of bit rate symmetry and quality of service. The completion of this phase is materialised by the description of the demand and tariff models, as well as their basis.

TONIC investigates a number of business cases on 3rd generation mobile networks in combination with WLAN technologies in close cooperation with other IST projects like BRAIN. It studies the economic viability of Mobile Virtual Network Operators in the 3G environment, and investigates different business cases on broadband access solutions in both competitive and rural or non-competitive areas. The focus is on how to provide broadband access to rural and sparsely populated areas and on determining the cost for making broadband access a nationwide commodity affordable to all citizens.

In order to carry out the number of simulations needed to analyse the business cases, TONIC has developed a data base containing the relevant costs, and will implement the business models using adapted software. This software is particularly important for the risk analysis phase.

Methodology

The financial assessment of a new network service can be achieved with a methodology generically called "techno-economic" study which combines models of the resources required to support the new service, and financial figures. These are resulting from resource related costs and expected service revenues.

The framework of the TONIC techno-economic evaluations is shown in figure

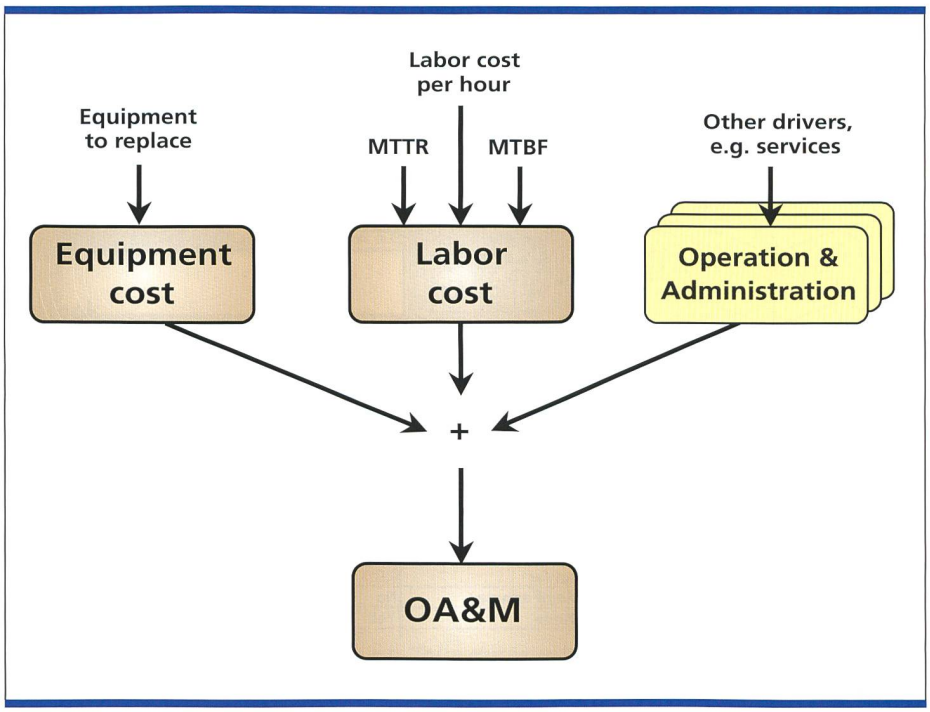

Fig. 3. The OA&M (Operation, Administration & Maintenance) cost modelling considers replacement costs of failed equipments (equipment & labour) and other operation and administration costs.

2. Typically, two types of results can be achieved:
- The costs of the service-related infrastructure.
- The typical financial outputs of a business case taking into account revenues generated from the service.

TONIC uses the discounted cash flow method to provide these results. Therefore, a timeframe, typically 5 to 15 years, must be considered and cash flows, including all the inputs, are calculated for each year of the study period. Financial ratios like Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period are defined and calculated based on the discounted cash flows.

The different inputs and models required by the methodology are mentioned below:
- The service description includes *tariffs*, *demand* or *penetration* and *quality of service*, including the performance of the service offering. The revenue model combines the tariff and the volume of customers derived from parameters like customer base, market penetration and market share, which in addition takes into account the technological or business competition.
- The *network architecture*, which supports the new service, has to be defined. This requires network planning expertise, which is mostly outside of the framework of the TONIC methodology. However, the methodology includes topological models, which facilitate the network planning by automatically calculating lengths for cables and ducting. These *topological models* are optional parts of the methodology and can be used without them, e.g. for services based on mobile or radio access technologies, where no topological models are necessary. Nevertheless, the yearly amount of newly installed network components (equipment, cables, cabinets, ducting, installations, etc.) is defined based on the service demand, and never includes over-capacity.
- The effective cost of the network components is calculated using an *integrated cost database* including *reference costs* of components and *learning curves*. Architecture scenarios together with the cost data base yield investments for each year. An extensive cost data base containing data gathered from many European sources (telcos and manufacturers) was developed within previous techno-economic projects and extended within the TONIC project.
- In general, various approaches towards *OA&M costs* are possible. The TONIC methodology integrates a *maintenance cost model*. This model is essentially based on the Mean Time Between Failure (MTBF) which drives the number of network components to be replaced each year. The operation and administration costs are modelled separately for each service scenario, as shown in figure 3, and therefore may differ from one scenario to another.

Investment costs together with OA&M costs determine the life cycle cost for the selected network architecture.

Finally, by combining service revenues, investments, operating costs and general economic inputs (e.g. discount rate, tax rate), TONIC yields cash flows, cash balance, and other economic results and ratios (NPV, IRR, Payback period, etc.).

TONIC Tool

The TONIC project has developed a generic, Excel and Access based tool (figure 4) to support the technical calculation and modelling of the methodology described above. This techno-economic tool initially aimed at performing studies on access networks, but includes features that allow as well to analyse mobile and transport networks. The openness of the interface allows the inclusion of new methodological aspects with Excel equations or Visual Basic code. The tool is flexible enough to discard all internal models to be replaced by simple time series data or new complex models.

Sensitivity and risk analysis could as well be included in the financial study. The risk analysis calculation is handled by an "add-in" software, Cristall Ball®, which performs Monte Carlo simulations. This risk method assigns probability distributions to uncertain variables (market or technology specific variables) and produces distributions to output variables, like NPV, which are calculated by the TONIC tool. Risk simulations (see figure 5) produce statistical information of the financial output variables and are interpreted using decision criteria of the project.

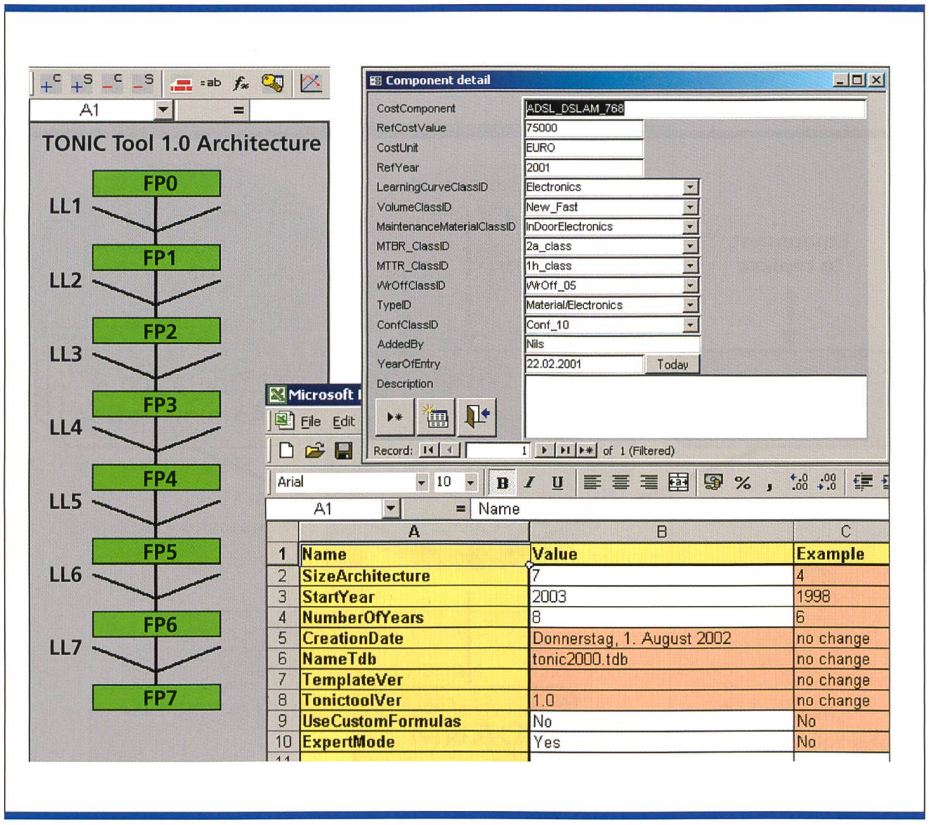

Fig. 4. The TONIC tool is an upgrade of the TERA tool. It is based on Office 2000 (MS-Excel and MS-Access) as well as Crystal Ball® for risk analysis. The output consists of graphs as well as tables of values.

Results

The results achieved consist of an efficient set of information and tools that

can be used for long-term service and network strategy evaluation. These elements can be split into 3 categories: the TONIC tool, the market forecasts and the basis models.
The TONIC tool is an add-on to Excel. Many macros as well as predefined worksheets have been added in order to speed up model creation. The tool includes TONIC specific help functions and a user manual.
Market forecasts include service demand forecasts as well as network component costs. These data are either described in documents, or included in Microsoft Access files linked with the TONIC tool.
The following basis models have been developed:
- Stand-alone UMTS services.
- Combination of public WLAN with UMTS services.
- Stand-alone Mobile Virtual Network Operator (MVNO) for UMTS.
- Broadband access using Ethernet technology with location dependent geographical network architecture models.
- Broadband access using ATM PON (FSAN) technology with location dependent geographical network architecture models.

These models, with the TONIC tool and market forecast, have been used to study the following business cases:
- Evaluation of the impact of a public WLAN service offered together with UMTS by a Mobile Network Operator (MNO). Seamless handover facilities between the 2 networks have been considered.
- Comparison of Ethernet and ATM PON technologies for providing future broadband accesses.
- Evaluation of the impact of a public WLAN service on the business of a Mobile Virtual Network Operator.
- Evaluation of the subsidisation required for providing fixed broadband access at market prices in rural areas.

The first 2 business cases above will be presented in detail in a forthcoming Comtec article.

Conclusions

The TONIC project allows participants to improve a telecommunication strategy evaluation by consolidating assumptions, models and results within the collaborative work.
TONIC proposes a powerful methodology for studying fixed and mobile service strategies requiring network infrastructures. This methodology can be applied to many types of telecommunications issues. TONIC provides strategic information resulting from a business case like Net Present Value, Internal Return Rate and requirements on resources. Thanks to predefined network architecture models it is easy to model any kind of access networks for business evaluation purposes. The TONIC information and tools are available to the TONIC participants for internal company projects.
TONIC is focusing very much on the fix and mobile services and their related networks. It provides a very flexible and powerful solution for business strategy analysis. Nevertheless, the work done shows that experience is required to achieve valuable results.

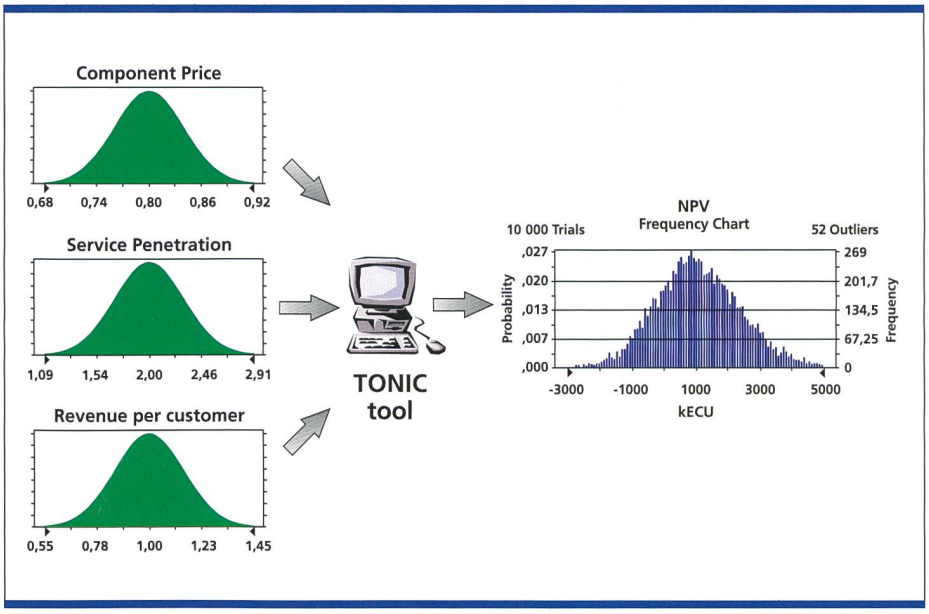

Fig. 5. Risk analysis qualifies the consequences of an uncertainty of one or more inputs.

Outlook

TONIC can be adapted to company specific environments for internal service strategy studies. It allows to efficiently adapt the existing TONIC business models for other strategy evaluations. For instance, it can be used to identify the best long-term mobile network service strategies, or to select the best fixed network technology for providing broadband services.
The TONIC project will end in December 2002, but a successor is planned for next year.

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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

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

BRAIN website: http://www.ist-brain.org/

IST Program website: http://www.cordis.lu/ist/home.html

Abbreviations

ADSL	Asymmetric Digital Subscriber Line. Technology that enables rapid transfer of digital information through regular telephone cables.
ATM	Asynchronous Transfer Mode. This is a digital broadband network technology allowing quality of service.
BRAIN	Broadband Radio Access for IP based Networks (IST 1999–10050).
FSAN	Full Service Access Network. This is a world-wide standardisation initiative led by network operators and focusing on next generation access network technologies and architectures.
FTTC	Fibre To The Curb. This is a mixed optic and copper based network architecture.
FTTO	Fibre To The Office. This is a full optical access network.
GSM	Global System for Mobile Communication
GPRS	General Packet Radio Service. An enhancement to the GSM mobile communication system that allows continuous flows of Internet data at rates from 56 up to 114 kbit/s.
HFC	Hybrid Fibre-COAX
IFC	Investment First Costs.
IRR	Internal Rate of Return
IST	Information Society Technologies. A European research programme.
LMDS	Local Multipoint Distribution Service
MNO	Mobile Network Operator
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
MVNO	Mobile Virtual Network Operator
NPV	Net Present Value. This is the result of the balance between discounted revenues and costs over the duration of the project.
OA&M	Operation, Administration & Maintenance
PON	Passive Optical Network
TONIC	TechnO-EcoNomICs of IP optimised networks and services. TONIC participants are: Nokia Corporation (co-ordinator), Telenor AS, France Telecom S.A., National and Kapodistrian University of Athens, Atlantide Grenat Logiciel, Swisscom AG, Universidade de Aveiro, T-Systems Nova GmbH.
UMTS	Universal Mobile Telecommunications System. A so-called "third generation" (3G), broadband, packet-based transmission, offering a consistent set of services to mobile computers and phone users no matter where they are located in the world.
VDSL	Very High bit rate Digital Subscriber Line
WLAN	Wireless Local Area Network. A computer network that allows the transfer of data and the ability to share resources, such as printers, without the need to physically connect each machine with wires.

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.*

Lucien Budry *received a diploma in physics from the EPFL (Federal Institute of Technology of Lausanne). He joined Swisscom Innovations in 1993, where he has been involved in a number of projects dealing with performance aspects of core and access network. Since 1996, he has focused on business aspects of the Swisscom network, including the strategic analysis of the competition. He has been involved in many European projects dealing with techno-economics of fixed and mobile delivery of broadband services.*

Jesús Roy *joined Swisscom Ltd in 1997. He holds a MSc degree in telecommunication engineering, and a MA degree in economics and new technologies of the European University in Madrid. He has been involved in a number of projects dealing with business planning and techno-economic assessment in the field of broadband service provision on both fixed and mobile networks.*

Résumé

TONIC est un projet européen auquel Swisscom Innovations participe. Il a pour but le développement d'outils pour l'évaluation de stratégies à long terme dans le domaine des télécommunications.
Ce premier article décrit les 3 piliers de TONIC qui sont: l'outil (basé sur Excel), les modèles (associés aux business cases) et les prévisions de services, de coût et de technologie.
L'outil est très flexible et performant. Il peut être adapté à des études de stratégies particulières. Les modèles et les prévisions permettent de faciliter l'expression des stratégies en éléments calculables par l'outil. Le processus de modélisation est guidé par une méthodologie éprouvée.
Un prochain article décrira des résultats concrets obtenus dans le cadre de ce projet à l'aide de cet outil.