The alternative local loop?

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Exploration Programmes:
Corporate Technology Explores Future Telecommunications

PowerLine Technology

The Alternative Local Loop?

A leveraging technology for high-bit-rate data transmission was announced three years ago: PowerLine technology, an alternative local loop. Being deployed on the power lines already installed, this technology has the potential to deliver high bit-rates and boost competition on the last mile. In the meantime however, first players have abandoned the technology and mass deployment has been delayed. Although the service is now available in a few cities for test purposes, the questions about profitability and disturbance have not yet been clarified. The results of our study indicate what kind of disturbances will happen and demonstrate that only a high market penetration rate can lead to profitable figures.

The programme "Electromagnetic Effects" investigates the electromagnetic compatibility (EMC) aspects of emerging telecommunication technologies and the biological effects of electromagnetic radiation. Necessary actions and guidelines are elaborated allowing Swisscom to improve quality of service and minimise installation and troubleshooting cost.
With its Exploration Programmes, Corporate Technology is exploring telecommunication technologies and new service possibilities with a long-term view of 2–5 years. Further, the expertise built up in the course of this activity enables active support of business innovation projects.

CLAUDE MONNEY

Since the invention of the telephone in 1876, almost all houses and flats in developed countries have been connected to this service with a pair of copper wires. The service has evolved from pure voice transmission to a wide range of services including data transmission. With the liberalisation of the telecommunication market, monopolies have disappeared and other players have joined in, mostly by claiming interconnection to the existing access networks or by pulling new cables where the market had high potential.
However, another service has had access to all houses already for a long time: the low voltage power supply. By using these cables for delivering telephone or Internet services, the power distribution utilities may extend their portfolio and invest in a market promising a high growth potential. In addition, it would allow them to strengthen their customer relationship by offering power related services. With this in mind, PowerLine Technology was developed and announced three years ago.

The statement "PowerLine Technology: the alternative local loop" will turn out to be false due to limited bandwidth available, questionable profitability and EMC problems.

For a telecom operator like Swisscom it is important to follow such an emerging technology and its market development with the objective to estimate the related opportunities and threats. For that purpose, we have studied PowerLine Technology in detail in collaboration with Eurescom partners. After a market survey, the available prototypes were evaluated and a large series of trial tests was performed. The study included an evaluation of the compliance with EMC standards and was completed with a business case.
Being the project leader, Corporate Technology was in a position to give important impulses and directions, and to take advantage of the strength of each Eurescom partner. Corporate Technology was particularly involved in EMC measurements, the business case study and the editing of the deliverable. All partners (CSELT in Italy, France Telecom and Deutsche Telekom) produced high quality inputs which demonstrate that collaborative projects can be quite successful.

Alternative Local Loops

The telecommunication domain is growing at an incredible speed and the delivery of services is open to competition since liberalisation in telecommunications in 1998. Different solutions (fig. 1), as alternatives to the telephone network, are possible:
Wireless: A very flexible solution which can be installed quickly. Disadvantages are the necessity of obtaining a licence, the limited bandwidth and the difficulty of building new antennas.
Cable television: A transmission medium that allows very high bit rates. However, today's existing networks need to be upgraded to become bi-directional. Also, penetration varies considerably among countries: e.g., it is very high in Switzerland or Belgium, medium in Germany or France, and quasi non-existent in developing countries.
Low voltage network: Virtually every house is already connected. But it is basically a very poor transmission medium, developed only for the transmission of energy at a frequency of 50 Hz.
Due to the liberalisation trends of the energy market, the power distribution utilities are searching for new markets. As data transmission is exploding and since a low voltage connection exists to every house, the use of this network as a transmission medium appeared to be profitable and development of modems began 3 years ago.

Structure of the Low Voltage Network

A power network is divided into three levels as illustrated in fig. 2: While the *high (purple)* and *medium (yellow) voltage networks* are dedicated to energy

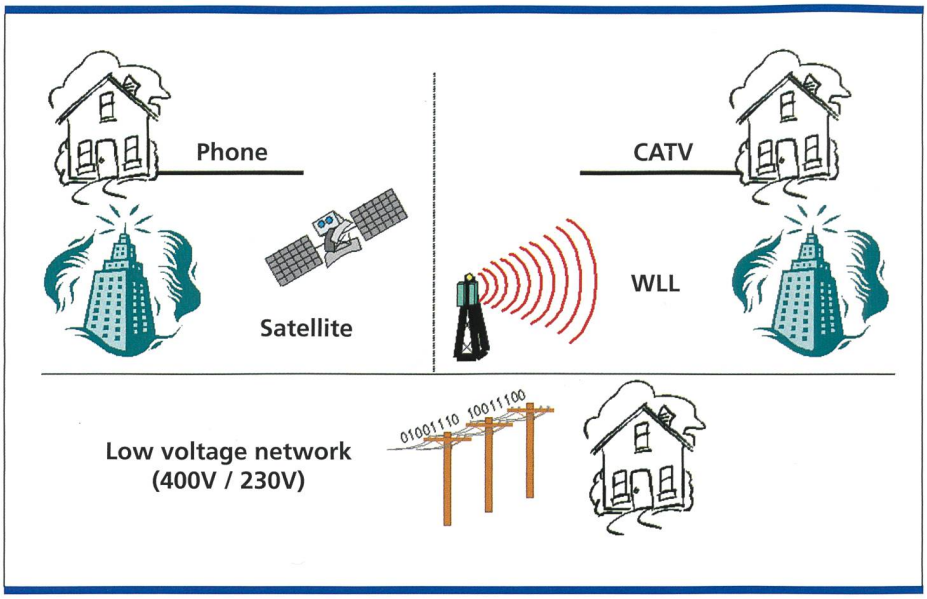

Fig. 1. Alternative access networks.

transport, the *low voltage network (brown)* is the distribution network with connection to the customer premises (fig. 3). In this last level, there are, as a rule, 10 branches per transformer (1 MVA) in a star configuration. Twenty to thirty houses are connected to each branch, so that a transformer serves approximately 200 to 300 houses.
The low voltage network configuration varies between countries: some adopt a TN-system and some others a TT-system. Also the number of available phases at the house entrance varies. Some countries have only one phase while others have the three phases at their disposal (e.g. in Switzerland). This means that the modem signal shall be injected between the three phases and the neutral in order to reach all customers.

Where are the Difficulties?
Although there were many press releases and public announcements about the potential of this technology these last years, no large-scale trial test has yet been performed. Only one final product and few prototypes are available. This is due to the necessary development work to cope with low voltage network characteristics. Parameters such as attenuation (fig. 4), impedance and noise are unknown and vary considerably with time. Moreover, connecting or removing devices from the low voltage network changes these parameters. The transmission problem has to be solved by the modem manufacturer by using adequate code, modulation and error correction.
As an additional challenge, the influence of these new modems on other existing services has to be taken into account. In fact, the frequencies used are already dedicated to other services, such as short wave broadcast, amateur radio, police emergency or maritime radio. They can be disturbed by the signals emitted by a PowerLine modem.
There is currently no applicable standard, and new measurement techniques and limits have to be elaborated. The only basis is that this new service shall not disturb existing ones. The German and English regulators have produced draft requirements concerning measurement and limits. In figure 5, the dotted red line represents the German proposal (NB30), which, however, cannot be fulfilled. Manufacturers have therefore proposed to relax the limit in some specific frequency bands that are either unused or used only by unimportant services. Other discussions by ETSI are ongoing and propose to have a higher limit in the whole frequency band with notches at some special frequencies, where important services exist (3.5–3.8 MHz amateur radio, 5.9–7.4 MHz broadcasting, 9.4–10.15 MHz broadcasting and so on). Although it looks much the same, this would be an important conception difference: instead of saying "I can disturb only in some specific frequencies" the guiding principle would be "I can disturb at all frequencies, except in some limited cases".

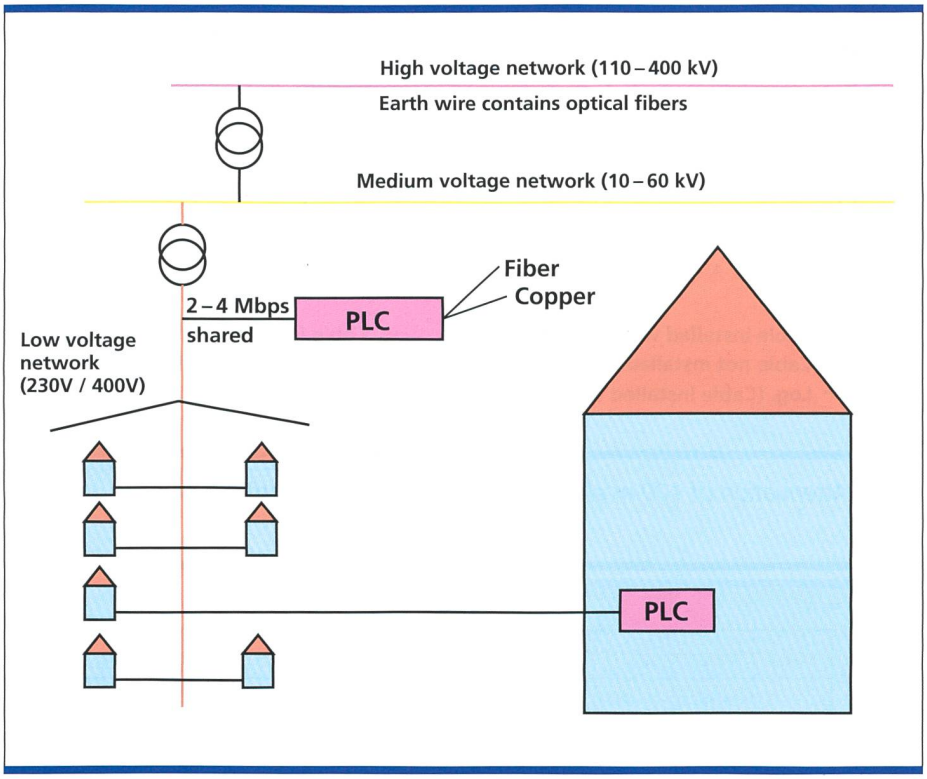

Fig. 2. Topology of a power network.

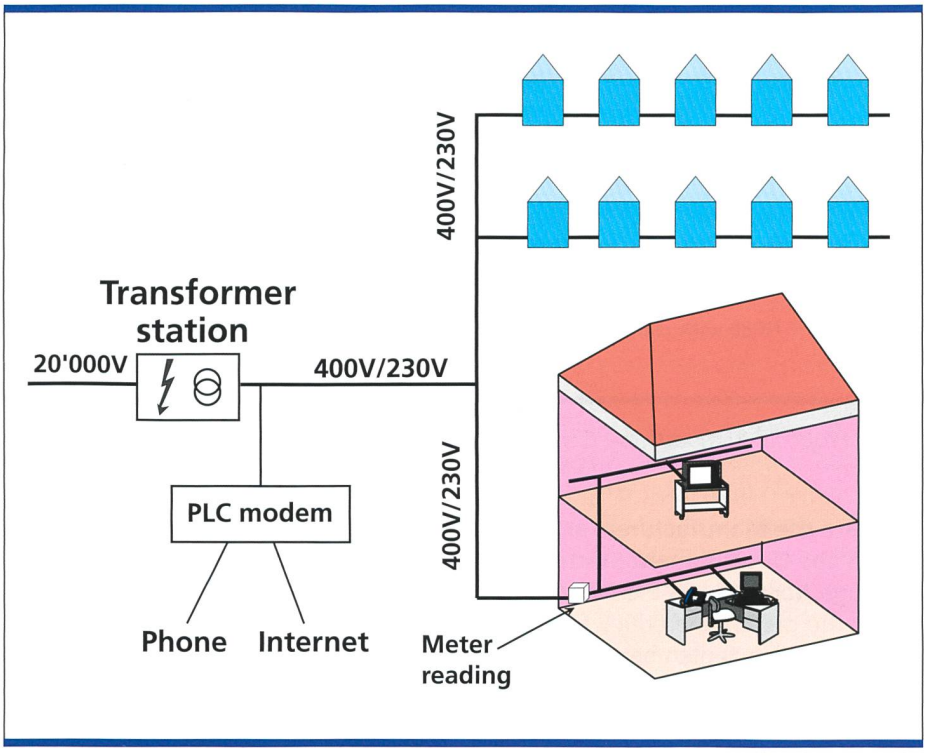

Fig. 3. Installation of a PowerLine modem.

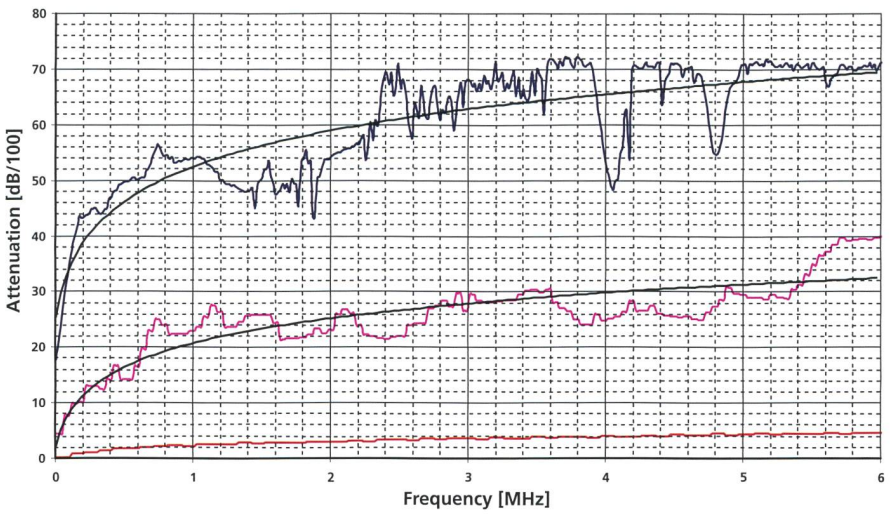

Fig. 4. Attenuation of 100 m electrical cable in 3 different configurations.

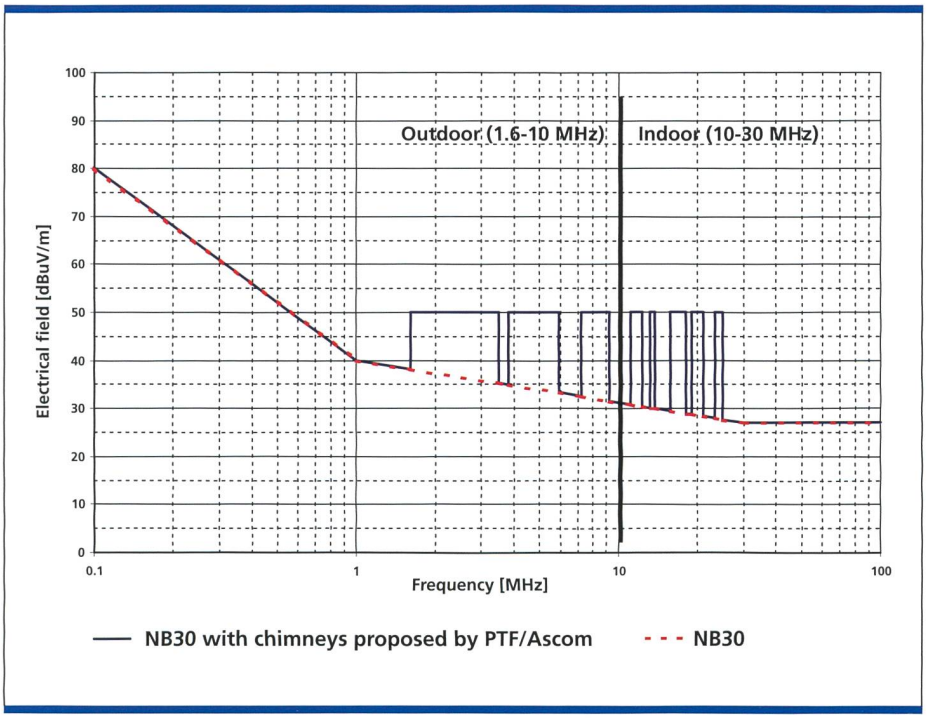

Fig. 5. Proposal to modify the German limits.

Who are the Manufacturers and what's the Development Status?

Although *Nor.web* was the first manufacturer to present a product, that company decided in September 1999 not to continue the development. A second one, *Siemens*, also decided in March 2001 to stop its development. There is at present only one manufacturer who has developed prototypes and performed trial tests: *ASCOM*.

A mass market product with a bit rate of 3 to 4 Mbit/s is announced for the middle of 2001. Other manufacturers have announced development and outstanding performance up to 2.5 Gbit/s, but a more realistic value will be some Mbit/s.

Business Case

The business case which was studied was based on the following parameters: Penetration rate of 5% in 2009 (taking into consideration CATV as a competing technology), discount rate of 10%, service price of 65 Euro (100 Fr.) in 2000 with price erosion of 10% per year. As a result, the Net Present Value (NPV) turned out to remain negative after 10 years (fig. 6).

This negative NPV means that the service is not profitable. This has also been corroborated by other, more detailed business cases performed by power distributors. A sensitivity analysis (fig. 7) shows that a penetration rate of 9% is necessary in order to reach a positive NPV.

Conclusions

The transmission of high bit rates on low voltage networks, called PowerLine Technology, is at its beginning and its future standardisation should allow mass production at lower prices.

This good news is tempered by two main issues: the first one is the radiated emission that does not fulfil the German, UK or any equivalent future European limits, and the second one is that CATV or satellite offer better quality and higher bandwidth. That's why the estimated penetration rate of the PowerLine modems is quite low and PowerLine technology will probably not be the alternative local loop.

However, this technology may be better suited for indoor applications. In fact, more and more households have more

Abbreviations

CATV:	Cable Television
EMC:	Electro-Magnetic Compatibility
ETSI:	European Telecommunication Standardisation Institute
Eurescom:	European Institute for Research and Strategic Studies in Telecommunications
IRR:	Internal Rate of Return
MVA:	Mega Volt-Ampere
NPV:	Net Present Value
PLC:	Power Line Communication
TN:	Earthing system TN
TT:	Earthing system TT

than one computer and there is a need to connect them. If the cost stays below that of a wireless solution, the future of the PowerLine technology may still end up being bright.

Outlook

Both the technical and the economical part of the study have shown that hurdles have to be overcome in order for PowerLine Modems to be successful in this market. The de facto ASCOM monopoly will not be an advantage since the company is now left alone for developing the market.

The market of PowerLine Technology will continue to be surveyed in order to minimise the risk of disturbances to Swisscom services. [7]

References

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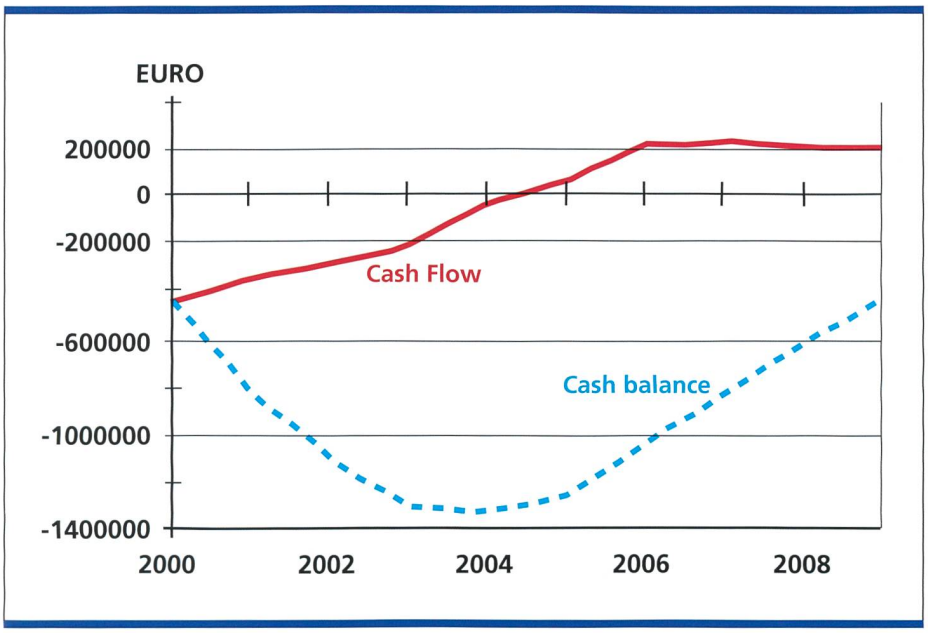

Fig. 6. Net Present Value of studied Business Case.

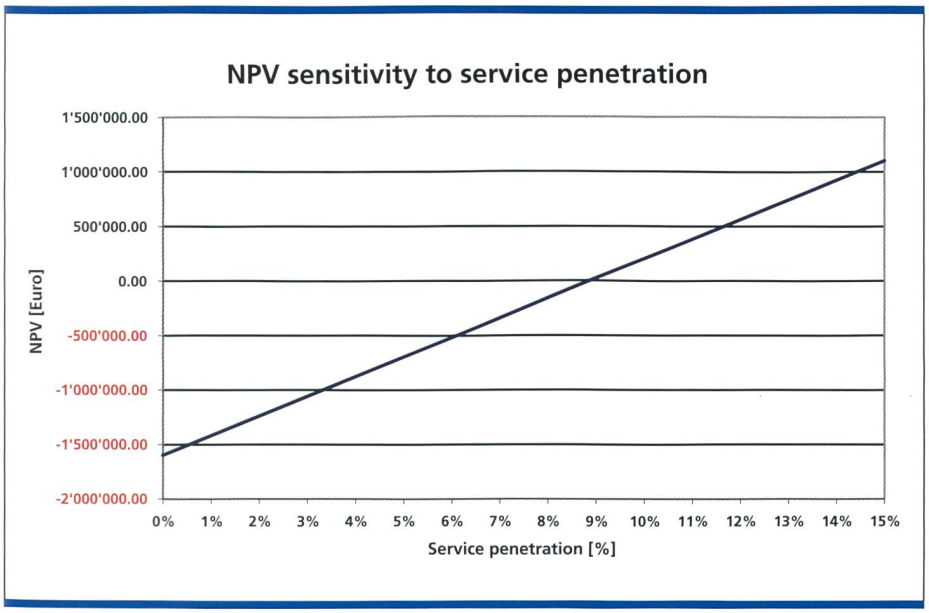

Fig. 7. Net Present Value as a function of service penetration rate.

Zusammenfassung

PowerLine wurde vor drei Jahren als bahnbrechende Breitbandtechnologie und Alternative Technologie für das Anschlussnetz angekündigt. Das überall verfügbare Niederspannungsnetz kann zur Übertragung hoher Datenraten verwendet werden und wird damit den Konkurrenzkampf beleben. Die Technologie hat bereits eine stürmische Entwicklung mit Rückschlägen hinter sich (Rückzug der Pioniere, massive Verzögerungen bei der Markteinführung). Obschon der Service in verschiedenen Städten bereits angeboten wird, ist die Frage der Rentabilität und der elektromagnetischen Verträglichkeit der Technologie bis jetzt noch nicht beantwortet. Die vorliegende Studie zeigt, welche Störeinflüsse existieren und dass nur eine hohe Marktdurchdringung zum finanziellen Erfolg führt.