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DSL Standards

Operators worldwide are now in the phase where new decisions are to be made on the next strategic steps of DSL deployment. This is driven from a need to provide additional applications over the DSL networks to increase profitability. There are several candidate DSL technologies available today which offer enhancements compared to ADSL, the most widely used DSL standard used today.

TIM SPRINGER

Currently there is a lot happening in the different DSL standardisation bodies that will change the DSL market as it stands today. This article will discuss the current status of the DSL standards and their most likely future developments. Although today it is not clear which technology will prevail in the coming years, it is certain that the choice of introducing new DSL flavours is not about technology, but a strict business decision where several aspects of how to build and run a network are to be considered.

Introduction

Over a number of years products offering ADSL services have dominated the broadband market. Other technology initiatives from vendors trying to break into the market or secure a market position have led to short-lived, niche technologies. In the end, market momentum was only achieved when standardised DSL was provided that was easy to use and provided full interoperability between DSLAM and CPE (Customer Premises Equipment).

Operators are now in the phase where new decisions are to be made on the next strategic steps of DSL deployment. This is driven from a need to provide additional applications over the DSL networks to increase, or reach, profitability. These needs include amongst others:

- High bandwidth, to be able to offer video applications.
- Symmetrical high bandwidth, to be able to provide good applications for business users.
- Better reach, to be able to service all users in the network.
- Lower CAPEX and OPEX, to increase profitability.

There are multiple technology candidates to solve the above needs, but in the end business aspects will be the deciding factor. The main available DSL technologies today are: ADSL, SHDSL, and VDSL. Other standards related to the above are: EFM Short and Long-Reach, 10Base-S/LRE, 10MDSL.

Situation in the Standardisation Work

ADSL

ADSL – G992.1

This is the basic ADSL standard that was agreed in the ITU in 1999. This is now a stable standard that most volume roll-outs worldwide are based upon. Interoperability is achieved via years of participation in so-called plug-tests. These are events organised by the University of New Hampshire (UNH) where all vendors meet and test with each other. Included in the ADSL standard you have three Annexes called:

- Annex A: Specifies ADSL over POTS
- Annex B: Specifies ADSL over ISDN
- Annex C: ADSL for the Japanese market

ADSL2 – G992.3

This is an updated version of the G992.1 standard and was agreed in June 2002. Primarily, this standard includes minor improvements to secure a more robust standard with slightly better performance. In most cases an ADSL2 chipset will interoperate with normal ADSL chipsets.

One of the key improvements in this standard is the annex J, also called symmetrical ADSL (SADSL). This annex enables services with symmetrical bandwidth up to 2.3 Mbit/s. Another important part of this standard is the annex K. This annex specifies how to run ADSL in packet transfer mode. This means that the standard allows a choice of which packet technology to use. This implies

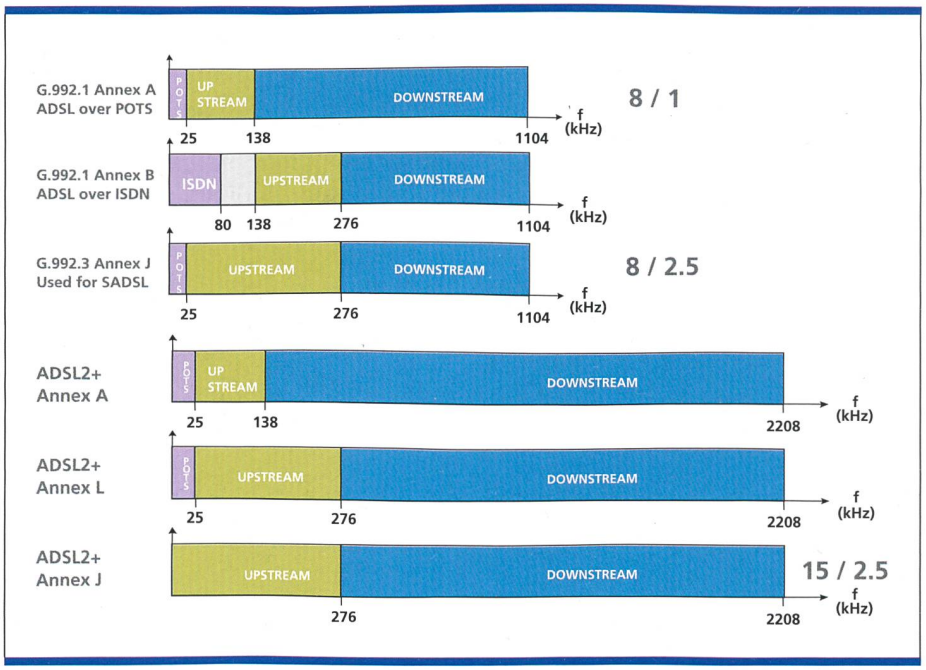

Fig. 1. The ADSL band plan.

that ATM is not the only means of delivering services but that, for instance, Ethernet may also be used.
Reach extended ADSL (RE-ADSL) will be added to G992.3 late 2003. This enables ADSL services up to 6 km with ISDN-like capacity.

ADSL2+ – G992.5
This standard was consented in the ITU early in 2003 and will be published during the spring. The main enhancements with ADSL2+ are that the frequency spectrum is doubled to 2.2 MHz, which means that it will be possible to deliver much higher bandwidths. It is expected that ADSL2+ will reach downstream speeds of up to 25 Mbit/s with similar loop lengths as ADSL today (up to 4 km). The upstream performance will be the same as today. There is, however, a strong push to get approval for the usage of a bigger upstream frequency band in the standard bodies. This would also improve the upstream performance to more than 2 Mbit/s, thus making ADSL2+ very flexible and easy for all kinds of symmetrical and unsymmetrical high bandwidth services, for both residential and business users, over one and the same line.
The key benefit with ADSL2+ is that the operators will be able to roll out the same basic HW as for ADSL. Next generation ADSL products will support ADSL and ADSL2+ on the same board. The choice of service will be made remotely from the management system, saving costly visits to the site when end users want to upgrade their basic ADSL service to higher speeds provided via ADSL2+. This also means that ADSL2+ will benefit from economies of scale from today's ADSL, thus becoming more favourable from a CAPEX perspective. Secondly, the network planning and utilisation of the installed base will be higher when only having to plan with one line card, resulting in lower CAPEX and OPEX. This may be seen when comparing the scenario that transpired for POTS and ISDN, where operators have had to invest in duplicate line boards and have had high costs when swapping customers from one service to the other.
With the ADSL standards it will be possible to run up to 25 Mbit/s downstream on loops of up to 4 km. It can also be used for a symmetric service with a least 2 Mbit/s and maybe more, depending on the standards developments.

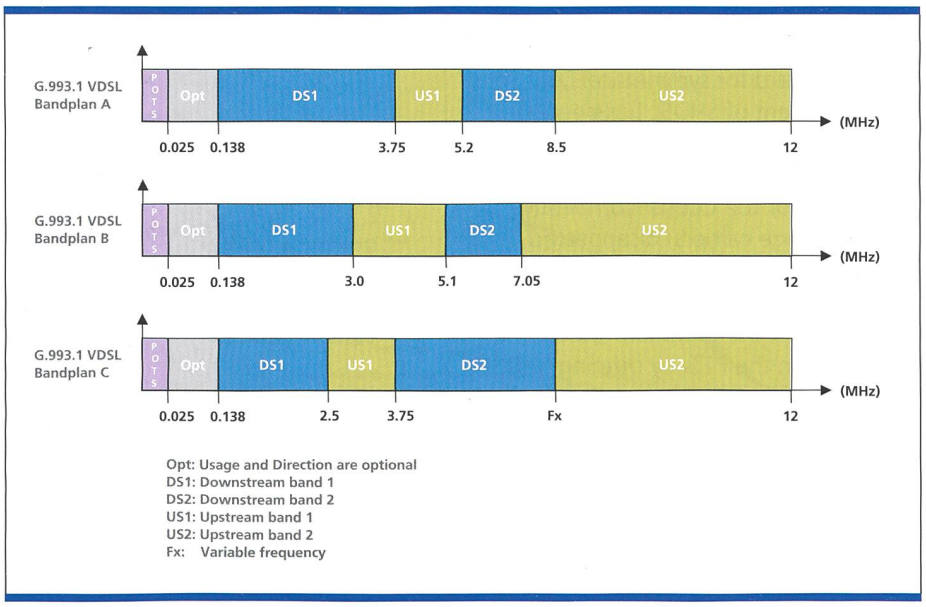

Fig. 2. The VDSL band plan.

VDSL
VDSL is currently being standardised in ANSI, ETSI, IEEE and ITU. In ANSI there is a pre-standard for trial use for which two different line codes, QAM and DMT, are specified. A few companies have implemented interpretations of the trial standard, but so far interoperability is only achieved when using the same vendor's chipset in both ends (DSLAM – CPE).

VDSL QAM
VDSL QAM is the most widely deployed version today. The reason for this is that it builds on a less complex technology and companies advocating this already had proprietary versions available that have been adapted to the pre-standard. The deployment figures are still relatively small and limited to a few markets. QAM is not seen as a good way forward due to:
– Co-existence with ADSL less favourable than with DMT
– Chipset costs higher due to lack of volume synergies with ADSL
– Technology-drive rather than business-drive

VDSL DMT
VDSL DMT has so far rather limited deployment in public networks. The reason for this is that a limited number of vendors have chipsets available. In general, VDSL DMT is the favourable technical solution given that basic technologies from ADSL can be re-used which gives a significant cost benefit.

VDSL Status
The situation in the VDSL market is similar to the one for ADSL in the early days when there were also two competitive ADSL technologies. When DMT was chosen as the way forward for ADSL, it was the start of real market momentum.
When looking at the VDSL deployments currently made globally it is interesting to note that most are using Ethernet rather than ATM, which is mainly used for ADSL today. This implies an upcoming paradigm shift where Ethernet will also take over in the first mile.
ANSI will decide on which line code the real standard will be around mid-2003. There is a strong push for the DMT version because it uses the same line code as ADSL. This would probably keep the costs of VDSL chipsets lower because they can re-use existing mass market technology. The ITU has stated that they will take their decision shortly after the ANSI decision. When ANSI has decided on the line code, this decision will be adopted by the IEEE 802.3ah, the Ethernet First Mile (EFM) standardisation body, for the EFM short reach solution.
With the VDSL standard it will be possible to run up to 50 Mbit/s downstream on short loops of up to 1 km. It can also be set as a symmetric service with 26 Mbit/s.

SHDSL
Initially there were multiple versions of symmetrical DSL, all called SDSL. These were all proprietary versions and de-

ployed in niche applications or enterprise networks. In 2000 SHDSL was approved as the standard for symmetrical DSL. So far deployment of SHDSL has been rather slow in takeup.
During the telecom crisis of the last years many of the CLECs (competitive local exchange carriers) disappeared from the market. CLECs were the key drivers for symmetrical offerings, aiming to cherry-pick the profitable leased-line services from the PTTs by offering SHDSL via unbundled copper loops. This has led to a weak deployment of SHDSL, and ADSL has been the prime offering also to business customers. The CLECs that are left in the market will have to choose between two strategies, either expand customer base and offer services for residential and business, or find a niche where critical market shares can be reached. One potential niche that can be of interest is when running SHDSL bonded with several copper pairs. Then higher bandwidth symmetrical services can be offered and/or long loop lengths.
SHDSL was standardised with a different competitive market landscape than the one seen today. SHDSL in connection with Voice over DSL was the prime candidate to be used for business customers. Today investments are more limited and the need to prolong the lifespan of the already installed base is crucial for the operator's profitability. This has led to SHDSL becoming a niche technology, squeezed between older existing Frame Relay and ATM/SDH offerings and new upcoming, more cost-effective, higher speed DSL flavours or even fibre. However, earlier this year SHDSL was chosen to be the EFM standardisation as technology for the EFM long reach standard. There was a strong debate between using SHDSL or ADSL with the annex J. Mainly because the decision was under time pressure the available SHDSL technology was chosen in favour of the unavailable ADSL annex J option.

SHDSL status

Enhanced SHDSL, a further development of today's SHDSL, is still being debated within the ITU and the ANSI. At least it will offer a bandwidth of 3 Mbit/s and 5 Mbit/s at a maximum.
With the SHDSL standard it will be possible to run up to 3 to 5 Mbit/s symmetrically on loops of up to 4 km.

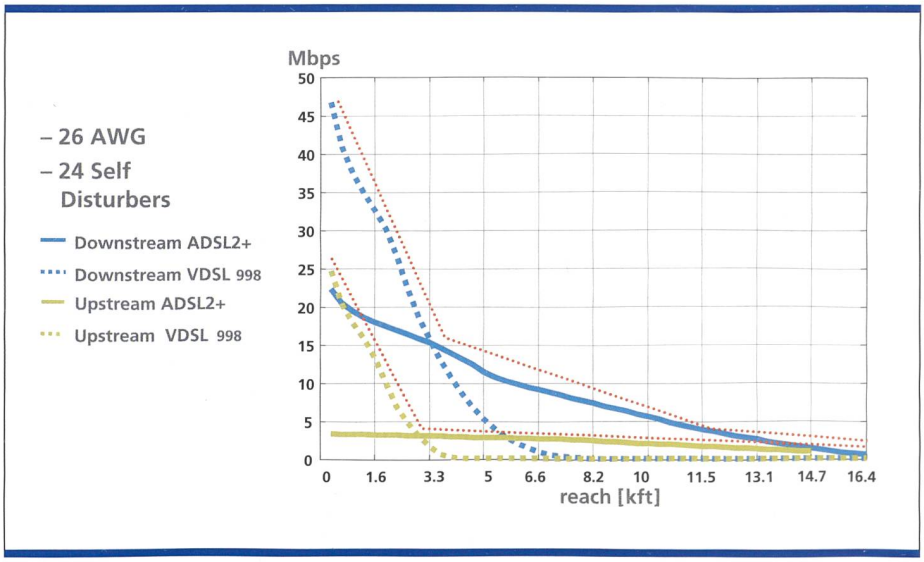

Fig. 3. ADSL2+ and VDSL Performance Comparison.

Business Needs

Today several operators are starting to review alternatives to ADSL in order to increase, or reach, profitability with DSL. The three key business drivers are:
– High bandwidth, to be able to offer, e. g., video applications.
– Symmetrical high bandwidth, to be able to provide good applications for business users.
– Better reach, to be able to service all users in the network.
– Lower CAPEX and OPEX, to increase profitability.

For high bandwidth VDSL is clearly the superior technology. However, VDSL has a reach limitation of 1 km and the average copper loop length in Europe today is typically more than 2 km. Therefore VDSL is unsuited to the central office type of deployment that is predominantly used in today's networks for the deployment of ADSL. In order for VDSL to take off, many more street side cabinets are needed in the network, which would impose an enormous cost for network buildout and will implicitly mean a poor business case for the operator. So considering high bandwidth both ADSL and SHDSL are viable technologies.
Business users typically require services with symmetrical bandwidth. Today operators use DSL connections to deploy LAN-LAN services between offices or as a replacement of more costly leased-line solutions available via ATM/SDH or Frame Relay. For symmetrical high bandwidths again VDSL offers the highest bit rates. However, SHDSL has been optimised for symmetrical services, which should not be neglected for business customers with well-defined service level agreements (SLAs).
Regarding reach, ADSL and SHDSL deliver similar loop lengths. However, SHDSL can deliver the double loop length, i.e. up to 8 km, when using two copper pairs instead of one.
Regarding CAPEX it is clear that today the ADSL components are by far the cheapest on the market thanks to the large volumes delivered worldwide. From an OPEX point of view it is interesting to see that both VDSL and SHDSL will be Ethernet based, whereas today's ADSL is ATM based. The industry consensus is that Ethernet is 3 to 14 times less costly in terms of OPEX compared to ATM. It may therefore be expected that also the ADSL installations will at least use Ethernet in the so-called 2nd mile transport.

Discussion

We have given a brief overview of the existing DSL technologies and the status of their standardisations. We have also taken a brief look at the business needs and the suitability of the different DSL technologies to fulfil these needs.
Based on the status of the different DSL technologies today it is clear that only ADSL and its further development are able to satisfy all four business needs. Its very limited reach significantly hampers VDSL, whereas SHDSL offers significantly lower bit rates compared to the other two DSL flavours. For both VDSL and SHDSL also the CAPEX will be a

major issue because these technologies will not be able to profit from the large volumes as reached today for ADSL. VDSL might profit slightly if the DTM line code is selected in favour of the QAM line code.
One of the key benefits with ADSL and its future enhancements is that the technology may be provided on the same basic hardware. Next generation ADSL products will support ADSL and ADSL2+ on the same board. This means that ADSL2+ will benefit from economies of scale from today's ADSL, thus becoming more favourable from a CAPEX perspective. Secondly, the network planning and utilisation of the installed base will be higher when only having to plan with one line card, resulting in lower CAPEX and OPEX. This may be seen when comparing the scenario that transpired for POTS and ISDN, where operators have had to invest in duplicate line boards and have had high costs when swapping customers from one service to the other.
When comparing bandwidth and reach capabilities between VDSL and ADSL2+ it becomes evident that ADSL2+ is much better suited to most operators' networks today. The average copper loop length in Europe today is typically more than 2 km. VDSL is destined to be a niche, or intermediate, application between ADSL today and fibre to the home (FTTH) sometime in the future. Therefore, today, VDSL is expected to find its main usage in areas with very dense populations such as in some Asian countries and in so-called Multi-Dwelling-Units (MDU). In addition, VDSL will find its use for some business applications, which will be enforced by VDSL being the underlying technology for the EFM short reach standard.
The future of SHDSL is very unclear today. The recent decision to use SHDSL as the technology for the EFM long reach standard ensures that SHDSL will continue to exist. However, SHDSL will merely be a niche technology for business applications requiring high symmetrical data speeds at long distances. It therefore remains questionable how many operators will use future ADSL variants in favour of SHDSL, even for the symmetrical high bandwidth business applications. The costs, both CAPEX and OPEX, will be the decisive factor for those decisions.

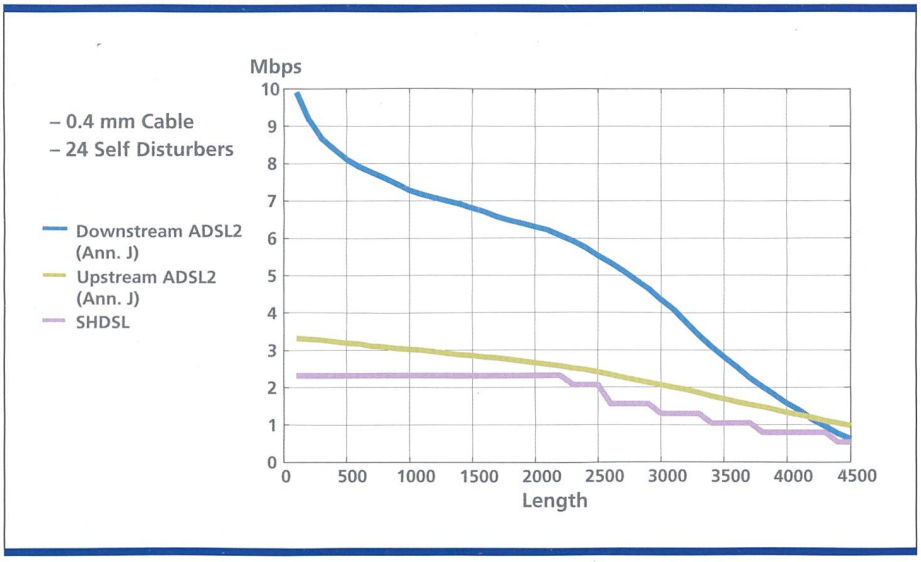

Fig. 4. SADSL and SHDSL Performance Comparison.

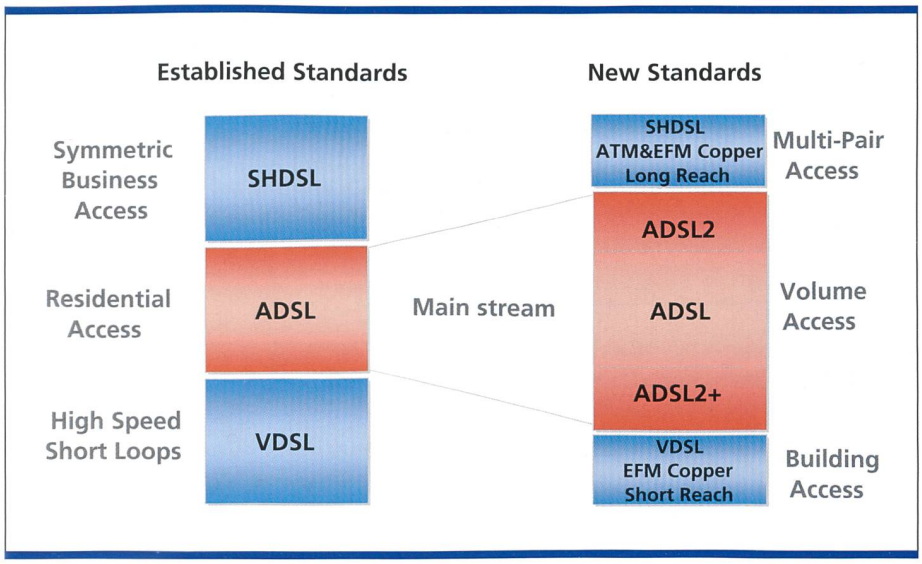

Fig. 5. The growing market position of ADSL.

Conclusion

The choice of introducing new DSL flavours is not about technology, but a strict business decision where several aspects of how to build and run a network are to be considered. The key to cost-effective DSL buildouts is to use volume products. ADSL is today shipped in considerable volumes and with the new ADSL2+ standard it is expected to take over more from the VDSL and SHDSL niches.
We are convinced that both SHDSL and VDSL will only be commercially interesting for niche markets, whereas ADSL and its further developments like ADSL2 and ADSL2+, will be the dominant residential mass market technology. The main reason for this is that ADSL and its derivatives will be on the same hardware board (chipset) and therefore will be produced in large volumes that will make the components very cheap. It will also enable the operators to offer higher bandwidth to their customers without having to change anything within their network. A change from ADSL to ADSL2+ will be a software change only.
Clearly there is little doubt about ADSL and its further developments being the main, if not the only, technology of choice for the residential market in the coming years. It is open which share ADSL will get in the business market.

This will mainly depend on the business case of VDSL and/or SHDSL for specific business applications. However, VDSL and SHDSL will face a very tough battle, being caught between ADSL and FTTH type of solutions.
Last but not least, there is a clear trend that the 2nd mile transport, the path from the DSLAM to the operators ATM or IP-backbone, will be based on Ethernet technology and not ATM technology as mainly used today for the transport of the DSL traffic. In both the SHDSL and VDSL standard ATM has been replaced by Ethernet, whereas for ADSL the first DSLAMs providing an Ethernet uplink have been launched. [6]

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Zusammenfassung

DSL-Standards

Angetrieben durch das Bedürfnis, die Rentabilität der DSL-Netzwerke durch zusätzliche Applikationen zu steigern, befinden sich die Operators weltweit in einer Phase, wo sie sich bezüglich der nächsten Schritte ihrer DSL-Strategie entscheiden müssen. Neben ADSL, dem heute meist verwendeten DSL-Standard, gibt es verschiedene DSL-Technologien, die deutliche Verbesserungen im Vergleich zu ADSL ermöglichen. Trotzdem besteht kein Zweifel, dass ADSL mit der entsprechenden Weiterentwicklung in den nächsten paar Jahren die wichtigste, wenn nicht sogar die einzige Technologie im Bereich der Heimanwender sein wird. Bezüglich der Verbreitung von ADSL im Segment der Geschäftskunden besteht jedoch noch Unklarheit. Diese wird hauptsächlich von der Rentabilität von VDSL und/oder SHDSL für spezifische Geschäftsanwendungen determiniert werden. Wie auch immer, VDSL und SHDSL sind als Zwischenlösung zu ADSL und Glasfaser (FTTH) mit einer starken Konkurrenz konfrontiert. Im Bereich der so genannten zweiten Meile ist jedoch heute ein klarer Trend sichtbar: In Zukunft wird sich für den Transport vom DSLAM zum ATM oder IP-Backbone Ethernet an Stelle der heute dominierenden ATM-Technologie durchsetzen. In der Anwendung der SHDSL- und VDSL-Standards wurde ATM bereits durch Ethernet ersetzt und bei ADSL gibt es mittlerweile die ersten kommerziellen DSLAM-Lösungen, die an Stelle von ATM einen Ethernet-uplink anbieten.

Mars Rover fertig für den Start

Ende Mai bzw. Mitte Juni 2003 – je nach Startfenster – wird die Marsmission der NASA fortgesetzt. Die dafür erforderlichen beiden Mars Exploration Rovers werden derzeit im Kennedy Space Center für die Reise zu unserem Nachbarplaneten fertig gemacht (Bild: KSC). Die Solarpanels für die Stromversorgung sind bereits für den Raumflug hochgeklappt. Die beiden identischen Rovers werden an unterschiedlichen Örtlichkeiten auf dem Mars arbeiten. Sie können pro Marstag etwa 150 m im unwegsamen Terrain zurücklegen.

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Kein Fisch namens Wanda ...

Wanda ist ein drahtloses Kommunikationsgerät von Texas Instruments, das auf den vollen Namen «Wireless Any Network Digital Assistant» hört. Es ist ein Multifunktionsgerät, mit dem man gleichzeitig telefonieren und ein schnelle Datenverbindung aufrechterhalten kann. Eingebaut ist ein GSM-Modul, ein GPRS-Modul, Bluetooth und eine Plattform für Informationsübertragung nach IEEE 802.11. Eingebaut sind zwei Speicher mit 64 MB (NAND Flash und DRAM). Das Display bietet eine Auflösung von 240 × 320 Pixeln (Q-VGA, 0,24 mm Pixelabstand). Die Lithiumpolymer-Batterie (3,6 V) verspricht acht Stunden Telefonieren und sechs Stunden Internetverbindung. Wo immer man sich aufhält, was man auch an Daten herunterladen will – es geht mit diesem einen Mobilgerät. Kaufen kann man es allerdings erst ab Herbst 2003.

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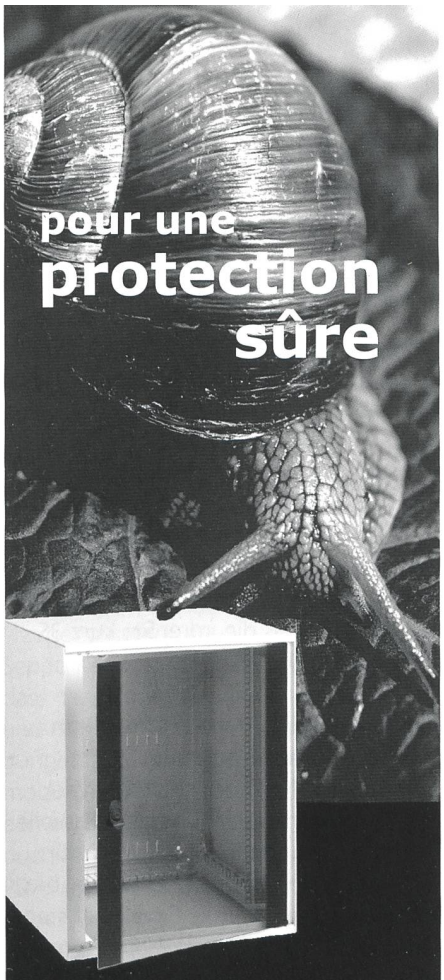

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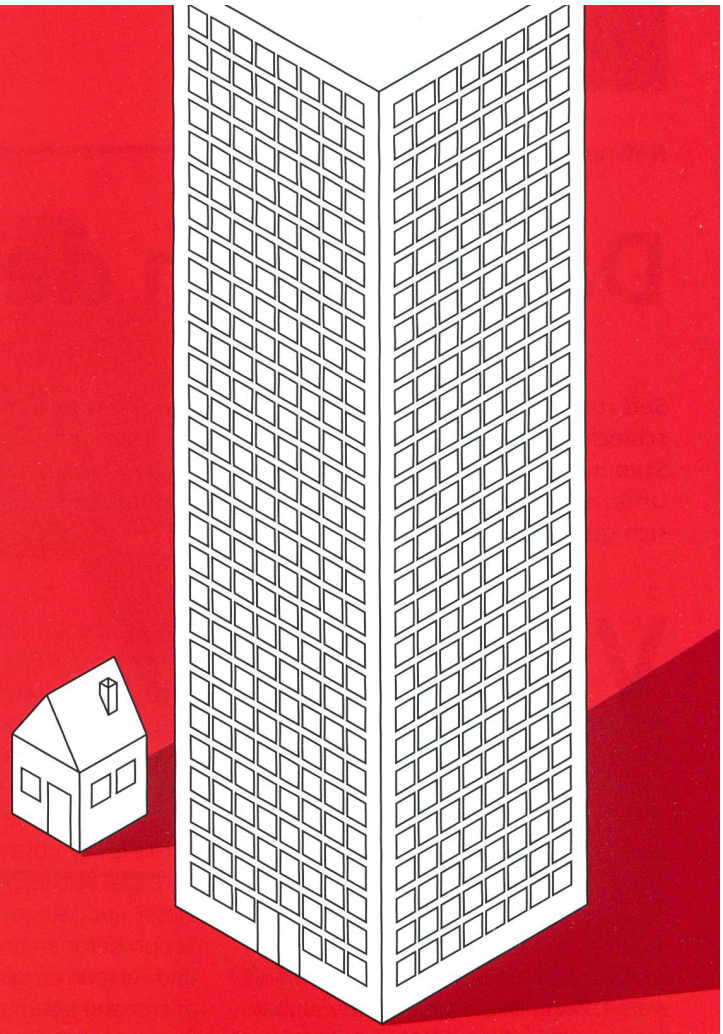

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