Versatile broadband - Deployment and special applications of SHDSL

In the digital age, wide area broadband coverage is more important than ever, particularly as ISDN-based basic and primary rate interfaces (E1) are being gradually discontinued. Their successors are expected to deliver high data rates at great distances with failsafe performance. Which is precisely what SHDSL offers. Thanks to its symmetrical nature, this technology enables an even distribution of down- and uplink and offers for instance respectable bandwidths of up to 6 Mbit/s over distances of 8 km via just four wires. This versatile technology can thus also be used successfully in a wide range of special applications.

Symmetrical Highspeed DSL (SHDSL) is much more than an old-fashioned DSL technology that is attractive solely as a narrow-band connection for businesses in remote locations. Rather, it is a proven alternative that is more robust compared to the usual broadband transmission methods. It is being continually developed and improved, and is becoming more and more attractive thanks to the deployment of increasingly more powerful modulation tools.

Symmetry rules

In particular, SHDSL technology is especially suitable for applications in which the quantity of data to be up- and downloaded is the same, for instance in telephony. In addition to the major carriers, a number of smaller providers today are capable of offering a full range of technologies, and often resort to SHDSL solutions.
Uniquely, SHDSL accesses can build on the ISDN legacy infrastructure of copper twisted pairs. Thanks to its special modulation technology, SHDSL is also significantly more stable and failsafe than ADSL2+ and VDSL2. In the latter two, the available bandwidth drops off noticeably after a distance of 300 m due to the use of higher frequencies (up to 30 MHz) (Fig. 1). Thus, at distances greater than 4 to 5 km, they can no longer be considered broadband connections. Additionally, the risk of lost connections and packets becomes so great that reliable operation is no longer ensured, especially in the upload direction.

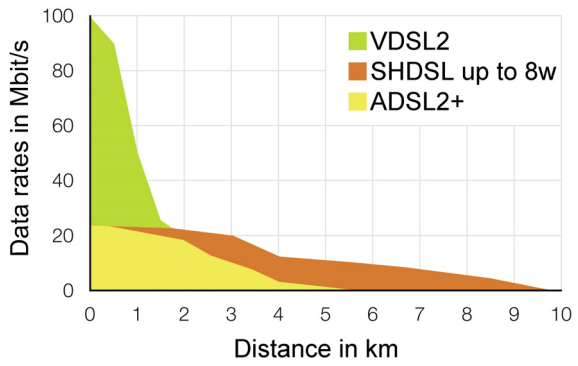

Fig. 1: xDSL data rates in dependence on the distance.

This is risky for businesses in particular, as they often send larger email attachments, upload large data volumes to servers or conduct multiple telephone conversations concurrently. Therefore, under certain circumstances the symmetrical division of down- and uplink that only SHDSL offers can also be attractive for individual users, for instance persons working from home. SHDSL fulfils all requirements according to ITU-T G.991.2.

SHDSL technology: versatile and dependable

Users can also benefit from the scalability of SHDSL: the data transmission rate improves when the core cross-sections and number of wires are increased. This also increases dependability, because - depending on the SHDSL variant deployed - even if individual pairs or wires should fail, communication is maintained via the remaining pairs. This fail-safety is particularly important for businesses. The possibility of remotely supplying power additionally provides a range reserve. Even if the power should fail, telecontrol devices, for instance, can still be operated using this kind of an emergency power supply. In this area in particular, SHDSL is clearly superior to mobile wireless and optical fibre technologies, as in the latter a comparable backup is not possible or only at great expense (e.g. copper-clad optical fibre).
Compared to ADSL and VDSL, the trellis-coded pulse amplitude modulation (TC-PAM) process used in SHDSL utilizes only a relatively narrow frequency band of up to 400 kHz, so that SHDSL connections are also better protected against high-frequency external interference.

Additionally, for back-to-back accesses and when connecting remote areas in particular, this technology is uncomplicated, inexpensive and offers clear advantages as an alternative to E1 and optical fibre technology, which must be laid to the access. Modem and DSL access multiplexer (DSLAM) technology are realised in the same way, which makes the integration of SHDSL lines e.g. in Ethernet-based networks a low-cost and technically straightforward undertaking. No expensive and complicated switching technology or exchanges in the conventional sense are needed, as is normal for network operators' multiport accesses. Only two simple SHDSL modems are required, one operating in STU-R (modem) and the other in STU-C (DSLAM) mode.

Suitable for special applications

In addition to day-to-day business operations, SHDSL is particularly suitable for special applications such as connecting grid or transformer stations and electrical power substations as well as telecontrol devices in the energy supply sector.
Particularly in the energy industry, high availability, scalability and short switching times are vital. Thus, SHDSL connections represent a strong alternative to optical fibre and wireless especially in less accessible regions, while also representing a fast, redundant and low-cost fallback communications infrastructure in regions that are already well equipped with these technologies.

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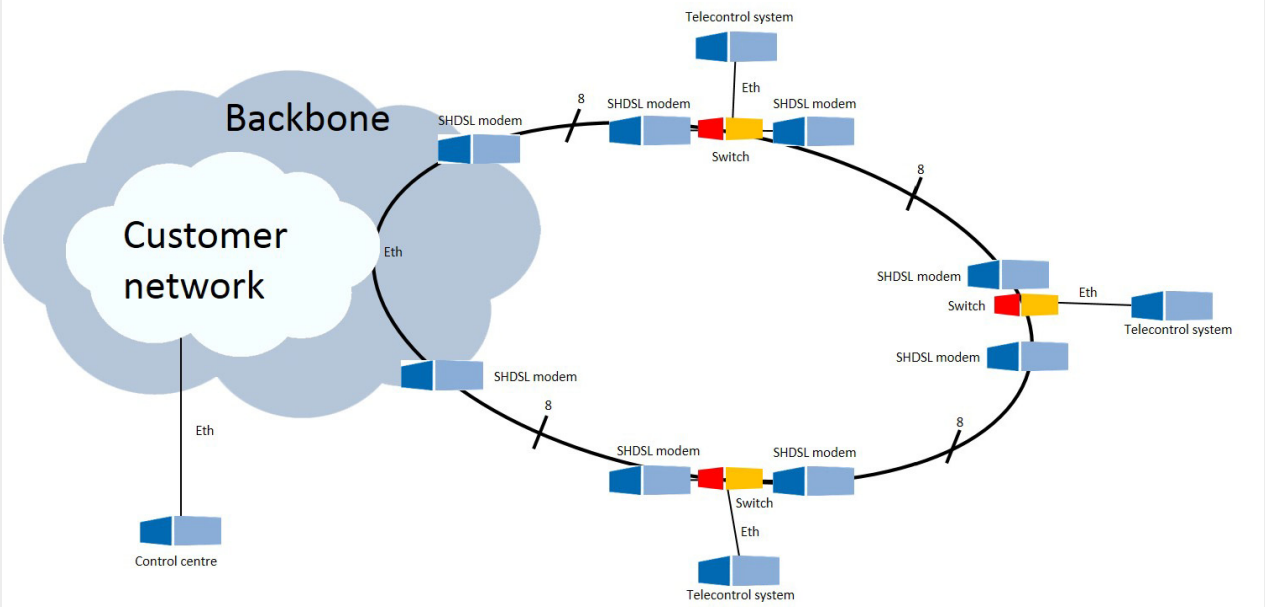

Fig. 2: SHDSL transmission technology for realisa ion of Ethernet rings to control telecontrol systems of up to 20 Mbit/s.

In this connection, the possibility of creating redundant Ethernet rings (Fig. 2) and sub-rings for transferring process data from switching and electrical stations in the energy supply region to an Ethernet backbone according to IEC 60870-5-104 is particularly attractive.
Linking up mobile telephony stations represents a further special application. For one thing, the further expansion of wireless coverage requires an increasingly tighter and higher-performance network of wireless stations; for another, bringing broad-band internet to rural regions and blank spots often requires a fallback connection as well as optical fibre. In emergencies, this not only assures a minimum bandwidth, but also forms the main connection of e.g. miniature mobile telephony base stations in rural locations when multiple twisted pairs are bundled.
Operators of telecontrol devices and remote maintenance systems outside the energy sector also appreciate the advantages of SHDSL. From monitoring of plant equipment to the control of signalling devices in rail, mass-transit, airport and road traffic (e.g. urban traffic guidance, tunnels with own telecommunications infrastructure and highway traffic monitoring systems) and even monitoring of water works and pumping stations - SHDSL is a secure, dependable technology. Thanks to the relatively simple realisation of Ethernet connections (LAN to LAN) over greater distances, SHDSL can also be used on major construction projects with poor infrastructure links and even in disaster areas. When equipped with the right measuring technology, specially trained telecommunications teams can rapidly put an interim SHDSL infrastructure into operation using modems that can be configured to operate in both STU-R and STU-C.

Boosting performance with repeaters and bonding

Yet SHDSL offers even more advantages. The use of two SHDSL repeater units (SRUs), which regenerate and forward the signal, enable line lengths of up to 24 km. Theoretically, up to eight repeaters are possible. The repeaters are installed in the line and divide the overall line into up to nine individual segments, which each represent a complete individual connection (Fig. 3).

Additionally, bonding according to EEE 802.3ah can be used for SHDSL-Ethernet in the first mile (EFM) links. The advantage of this bundling lies in its greatly enhanced stability. If one twisted copper pair fails, the remaining pairs maintain the connection. Thus, in this method even if one link fails, up to three more remain available.

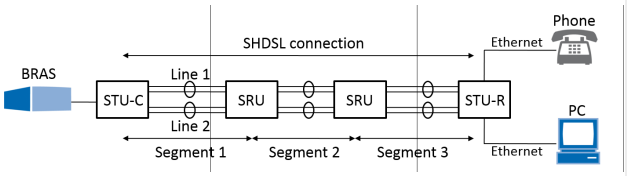

Fig. 3: SHDSL transmission technology with the use of repeater for bridging long distances (SRU - SHDSL repeater unit (BRAS - Broadband Remote Access Server).

High-quality testing equipment for stable performance

The broad range of SHDSL variants provides numerous advantages but also raises the level of complexity, particularly when it comes to commissioning and maintaining multi-pair systems. Testing a 2-, 4-, 8- or in rare cases a 6-wire interface quickly pushes simple meters and testing gear to their limits and beyond.
Suitable testing equipment supports variant diversity and enables simulation of the required network components thanks to extensive configuration options. Unlike ADSL or VDSL, this requires the possibility of STU-R and STU-C operation, especially when using repeaters on SHDSL lines. The measuring device should also be able to simulate the central office (CO) side so that the modem on the remote side or a repeater can be checked. Two devices from the same manufacturer should be able to work back to back and also enable tests in STU-C mode. In such configurations, they must synchronise with the remote station in both modes and be able to display the result of the comparison between STU-R and STU-C in a results log. In the handshake phase (ITU-T G.994.1, G.hs), the two sides exchange capability lists in order to determine important connection information (e.g. regarding power-back-off mode or for line probing). Information

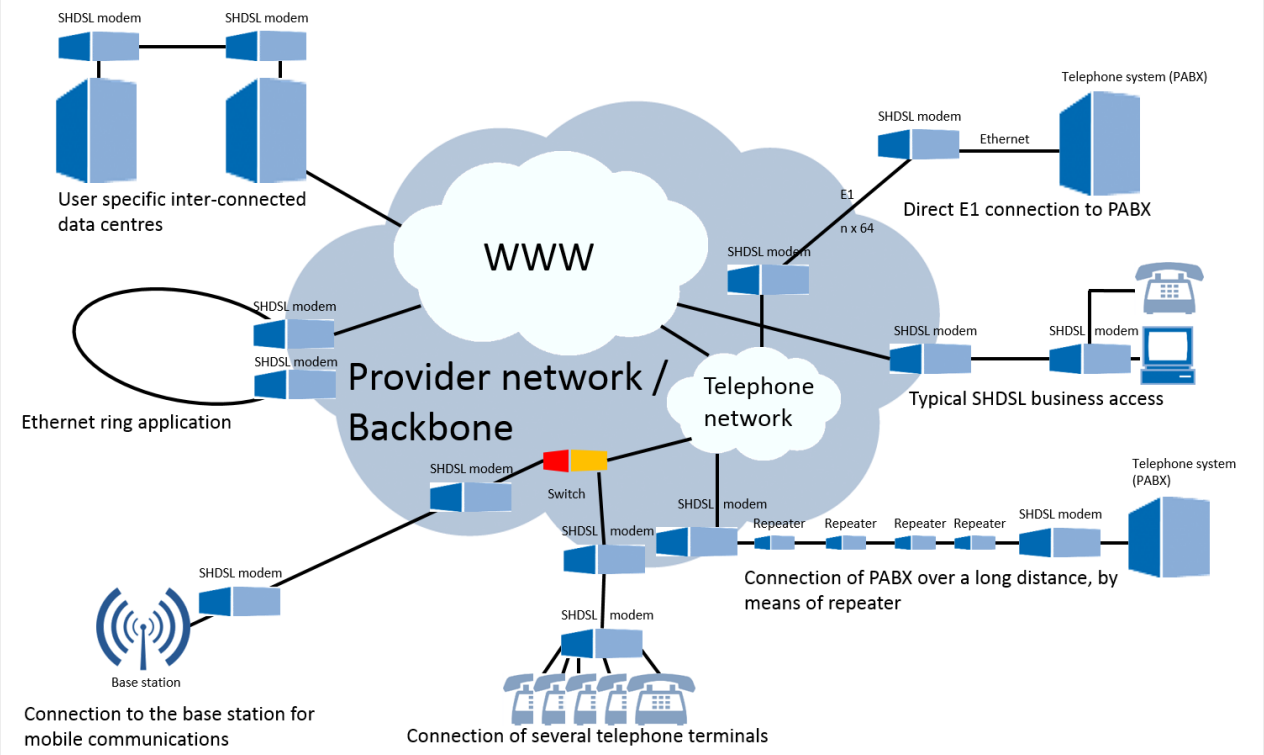

Fig. 4: Different SHDSL applications in practice.

on the data rate, any DC voltage that may be present and the attenuation and signal-to-noise ratio of the connection is also relevant. Access to error counters can also be relevant for troubleshooting. Ideally, the meter can additionally evaluate information from the EOC, a special channel for exchanging connection information during the connection between the CO and remote ends, as well. Together with a station count, this infor-mation reveals the number of repeaters deployed on the line. Once the SHDSL line is in operation, any remaining doubts as to the functionality of the connection can be eliminated using the broadband access server (BRAS) by means of PPPoE login. This enables download and upload tests of broadband connec-tions. The function and quality of service of voice services for instance can be tested by establishing a VoIP link.
To date, there are only a handful of portable testers on the market that provide the most important information. The ARGUS 155 xDSL combi-tester from intec, for instance, is designed for data tests as well and thus offers a comprehensive SHDSL test spectrum. In addition to SHDSL, this device is also equipped with interfaces for ADSL, VDSL, ISDN and POTS connections. These hand-held meters also support E1 connections and are helpful particularly when the customer's circuit-switched technology is to be connected with SHDSL. The even more sophisticated ARGUS 165 additionally supports a variety of tests on gigabit Ethernet, for instance throughput tests according to RFC 2544, generates traffic and loops with up to 1 Gbit/s.

Future-oriented solution

Researchers and the industry are continuing to work on enhancing the performance, stability and reliability of SHDSL even more. For example, there are advanced analytical mechanisms for EFM, noise suppression techniques and error-correction functionalities that boost performance further. This makes SHDSL the alternative of choice for future-oriented broadband networks and the replacement of E1. The network operators have already recognised this fact - and are offering SHDSL solutions on ever more attractive terms.

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