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High speed in <u>both</u> directions for SMEs !

White Paper

Symmetrical High bitrate DSL for Small/Medium Enterprises –

SHDSL in

Ericsson ENGINE Access Ramp

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SHDSL in Ericsson ENGINE Access Ramp

1 Why another DSL flavor in ENGINE Access Ramp?

The small and mid-size business (SME) segment’s need for high bandwidth services on ordinary twisted copper pairs has been recognized for some time. It stems from the need for business applications like electronic data interchange, group video conferencing, connection between branch offices (remote LAN) and LAN-to-LAN connectivity.

The access need has up to now been supported by several digital subscriber line standards/would be standards (HDSL, SDSL, HDSL-2, ISDN, T1, E1 and IDSL). The new standard G.shdsl will replace many of the older DSL technologies and other transport options, and it will make it possible for Ericsson or other solutions providers to develop access equipment around a single global standard.

The globally accepted standardization of SHDSL will boost the customer premises equipment (CPE) market. It will make it possible to provide solutions for a broader spectrum of end customers. From Medium Size Enterprises, needing state of the art IADs with advanced voice functionality and full LAN support, to Small Office & Home Office (SOHO), with a need for high-speed data only.

2 End User Benefits

Since SHDSL offers high-speed data transmissions both upstream and downstream, many services that normally require fiber network or leased line become available for Small & Medium Enterprises and Small Office & Home Office. Because of its characteristics, SHDSL is an excellent replacement for old E1/T1 technology. SHDSL offers more multidirectional bandwidth than for instance ADSL or ISDN, allowing for services and applications such as:

High quality desktop and group videoconferencing

These applications help businesses reduce the high cost of travel, while still allowing for effective communications in meetings and training.

Remote LAN and LAN-to-LAN interconnection

Businesses with small branch sites often require cost-effective connections between branches and main offices to enable communications between all employees

Transmission of high resolution graphics, animated illustrations or film (video mail)

With SHDSL, sophisticated medical images and files can be quickly transmitted for analysis and diagnosis to remote experts, to surgeons, or to a patient's file in much less time than traditional methods like ISDN.

Housing your own "private" web server with multimedia applications and large amounts of "hits"

Voice over DSL

SHDSL allows multiple telephone and data channels on a single copper pair, offering lower calling costs and truly integrated data/voice network.
VoDSL can be realized as VoIP and VoATM.

Distributed networks applications

Making it possible to share files and system resources. A group of SMEs can share services like computer support/helpdesk.

The SHDSL technology will be a true enabler for these applications. Making it possible for the SME/SOHO segment to enter the new economy creating new business opportunities and increased revenue.

3 Standardization history

ISDN, which was introduced for about ten years ago, is the route to all digital transmission technologies. The line code 2B1Q is still used in today's HDSL systems (High Bit Rate Digital Subscriber Line). HDSL was the first introduced DSL technology, intended to replace T1 lines. HDSL advantage over existing T1 lines is the reach, serving the whole Carrier Serving Area over two twisted pair's whiteout repeaters (8000 feet). ETSI adopted this technology defining an E1 service over three twisted pairs. Later when data rate 1168 kbps was introduced E1 data rate could be transmitted over two pairs, but not serving the whole CSA because of reach limitations.

To better use the copper infrastructure a new standard called HDSL2 was established by ANSI, the standard is based on the more sophisticated Trellis Coded PAM line code. HDSL2 provide a T1 on one twisted pair over the full CSA.

After being "deployed" in T1/E1 applications, DSL also started to gain importance in the Pair Gain market. Because of the trade off between loop reach and data rate there was a demand for flexible bit rates to achieve optimum performance at all times. Multi Bit Rate DSL was brought up by several semiconductor suppliers based on the TC-PAM line code, but the MDSL has never become an official standard.

SDSL, based on the European SDSL standard TR-90 with proprietary pre-activation, has never become an official DSL standard either. As no standard exists there has been a number of spectral interoperability issues and other similar problems.

The next natural step in standardization has been Symmetric High Bit Rate Digital Subscriber Line (SHDSL), currently defined by ETSI and ITU. SHDSL combines the flexibility of MDSL with TC-PAM line code and transmission performance of HDSL2. The ETSI and ITU activities are expected to be finalized and ratified in October 2000 or February 2001.

Comparison of Symmetrical Data Technologies

	SHDSL	SDSL	HDSL2
Bandwidth	192 kbps – 2.3 Mbps or 384 kbps – 4.72 Mbps (4 wire mode)	192 kbps – 2.3 Mbps	1.5 Mbps
Pairs	1 or 2	1	1
Modulation	TC PAM	2B1Q	TC PAM
Standard	ITU	No	ANSI
Power Back-off	Yes	No	Yes
Rate Adaptation	Yes	Yes	No
Pre-activation	G.hs (G994.1)	Proprietary	Standard-based
Timing	Both	Synchronous	Plesiochronous
High density	Yes	Yes	No
Reach at 2.3 Mbps	2.3 km	1.9 km	N/A
at 384 kbps	4.5 km	3.9 km	N/A

4 Technical information

4.1 Transmission characteristics

Operators, regulators and solution suppliers have all realized that the frequency spectrum on twisted copper pairs is a finite resource. The choice of the TC-PAM line code secures spectral compatibility with present transmission technologies on twisted pairs.

The standardization bodies have agreed on a set of symmetric PSD (Power Spectral Density) masks. Example in figure below.

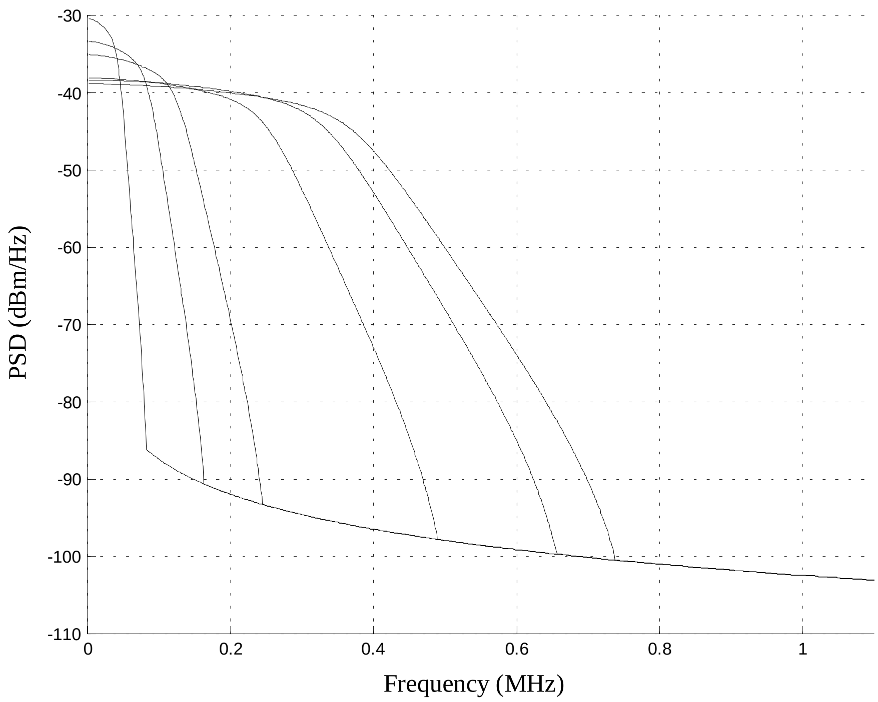


Figure shows the symmetric PSD masks for payload data rates 256, 512, 768, 1536, 2048 and 2304 kbps.

The PSDs are achieved by filtering a square wave at symbol frequency with a 6th order Butterworth filter with its 3dB cutoff at half symbol frequency. The PSD template is scalable enabling the bandwidth flexibility of SHDSL.

The set of PSDs has been designed to meet three major requirements:

1. Fitting under the PSD masks for HDSL 3-pair, HDSL-2 pair or ISDN. This requirement provides en excellent spectral compatibility, since at a comparable data rate the amplitude of the appropriate HDSL mask is filled but not the bandwidth.

2. Providing best performance on all defined loops for the Full Service Access Network (FSAN) noise models, including a scenario with 100% self-NEXT. This removes all limitations on deployment of SHDSL, when it comes to the number of lines in a bundle.

3. Creating a smooth PSD that allows low power consumption in the line driver, addressing issues like line card density and remote feeding.

When replacing HDSL 2-pair systems it is desirable to achieve the loop reach of 2400 meters at 2 048 kbps, as defined in TS 101 135. By using the symmetrical PSD mask described above this is not fully achieved. Therefore the standard allows asymmetrical PSDs as an option. Annex A (within the North American network) also allows the use of OPTIS shaping of HDSL2 at T1 rate. The appropriate ANSI standard is in this way incorporated. Other optional templates for certain data rates are still under study.

4.2 SHDSL rate/reach performance

When compared to currently used symmetric transport technologies such as SDSL and HDSL, SHDSL boasts approximately 30 percent greater reach. This reach quality means that signal repeaters are no longer needed to serve the whole Carrier Serving Area over two twisted pairs. A good example is that the highest bit rate defined by the G.shdsl standard - 2.3 Mbps - is supported at loop lengths of up to 2.3 kilometers. At lower rates, the distances are of course correspondingly greater, as shown in the table below.

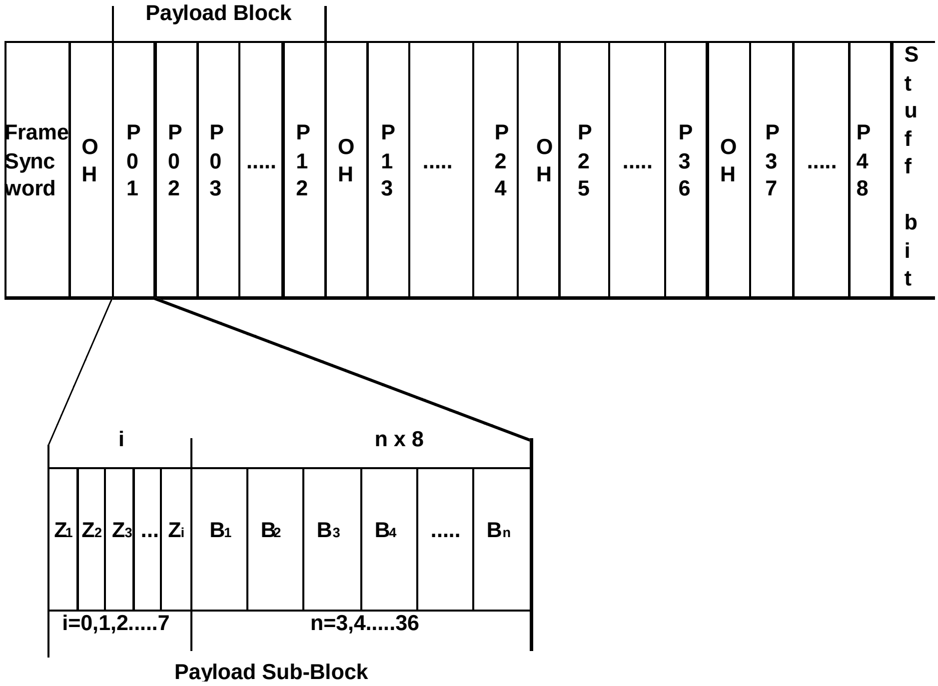
Table showing the relation between payload bit rate and SHDSL loop length.

Bit Rate kbps	Loop Length (m)
384	4.500
512	4.160
768	3.662
1024	3.323
1280	3.148
1536	2.776
2048	2.400
2304	2.273

The G.hs (G.994.1) initialization negotiates the best possible data rate given the existing loop length situation.

4.3 Framing structure

The payload of an SHDSL frame consists of 3 to 36 B channels with 64 kbps each and up to 7 Z-channels with 8 kbps each. An 8 kbps overhead channel is added to provide synchronization, as well as an ECO (Embedded Operation Channel) and the stuffing bits required for plesiochrounous operation. The channel architecture makes it possible to transmit different services independently and in parallel, e.g. a combination of TDM (Time Division Multiplexing) voice channels with an ATM bit stream. The standardization bodies are currently defining standardized mappings of different services like ATM, ISDN and POTS into the SHDSL frame. A detailed description of the SHDSL frame is provided in the figure below.



4.4 Initialisation

The ITU G.hs (G.944.1) has been chosen as the protocol for the initialization of the connection. This enables for example a pre-activation negotiation of bit rates and protocols. G.hs uses a very simple transmission method called DPSK (Differential Phase Shift Keying) at a low data rate. It does not need an initial training.

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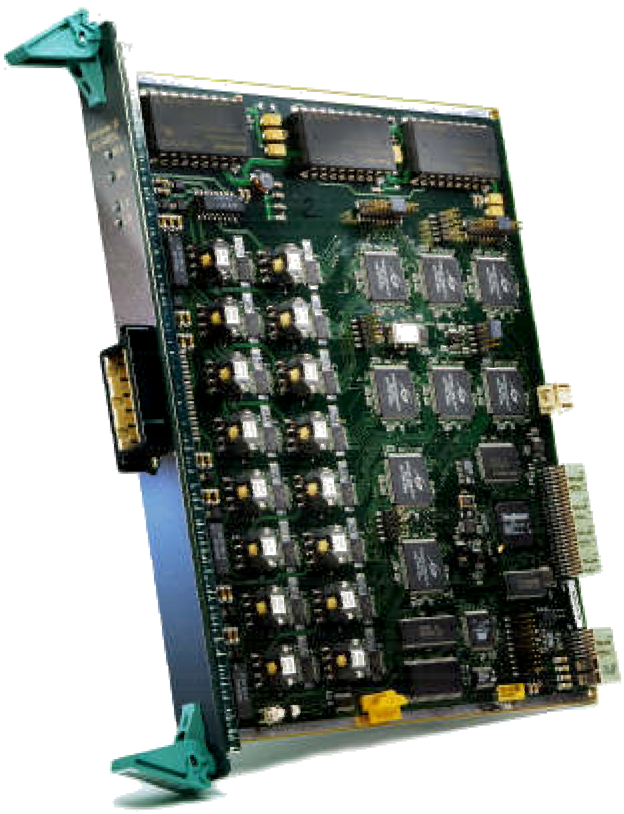
5 Ericsson's SHDSL implementation

Ericsson is at the forefront as regards SHDSL technology implementation and application development. A case in point is the high density SL540 SHDSL 16-transceiver line-card built on world-leading technology, fully compliant with the globally accepted SHDSL standard.

Since the card supports TC-PAM line code, sub-watts chipset can be used reducing the power needed. Having a very high density the card is cost efficient and easy to deploy for the operators. Since area limitation is a factor to take into consideration when the copper network is unbundled, the card provides the ideal solution for new operators - the high density per subrack provides maximized revenue opportunity from the Central Office area made available from the incumbent.



Incorporating SHDSL into the ENGINE Access Ramp makes it an integrated part of Ericsson's successful ENGINE family, and further manifests Ericsson's position as the number one network choice.

With SHDSL solutions from Ericsson the copper technology will evolve even further, sharpening the operators' competitive edge in the converging datacom and telecom market.