PacketFront®
The Future of Broadband. Today

PacketFront ADSL solution

Extending the reach of True Broadband Networks

Contents

1 Introduction

The number of users on high-speed Internet connections increase with hundreds of thousands of connections each month. The vast majority of these connections are based on ADSL or VDSL technology. The recent enhancements in ADSL-based technology has begun to make its way into the ADSL deployments world wide, opening up possibilities for new service offerings. The increased bandwidth capabilities of the technology enable more advanced services to be offered over existing copper lines, and ADSL technology has begun to move from best-effort Internet to the ability to support more advanced services such as video and voice.

ADSL technology fills another gap in the selection of access technologies, providing bandwidth ranging from the capabilities of fibre and Ethernet to the different DSL flavours. VDSL, with its high bandwidth, lacks what ADSL will give in reach. For some network owners, ADSL may be more viable than a fibre-based network, due to existing infrastructure or other obstacles such as demographics, rights-of-way etc.

The evolution towards what is known as Operator-Independent Networks (OIN), offers the service providers the possibility to access customers in networks built with OIN-enabling technology - without any major investments. A service portfolio, established by a service provider , can easily be introduced in multiple of these OIN-type networks with full transparency. The incentives for a PTT to build with OIN-enabled technology are mainly time-to-market and the ability to quickly deploy services into new areas and compete on the same level as small local service providers. PacketFront technology enables a PTT to roll out services quickly and cost-effectively, with all the traditional PTT values like brand, organisational strength and large resources intact in the service offering.

The functionality demands on a network carrying triple-play services are very different from the demands on simpler enterprise-type networks, and the technology and products needed to carry these services must be designed and developed to handle this complex environment in a manageable and automated fashion.

To be able to offer services such as TV and high bandwidth ISP services over a broadband network, there is an obvious need to provide enough bandwidth to carry these services. In networks based on Ethernet as access method, the bandwidth requirements are easily met. However, in areas where an Ethernet-based infrastructure does not exist or is impossible to deploy for economical or other reasons, there is a need for a complementing access technology. ADSL in its latest variants (ADSL2/2+) are reaching a bandwidth-capacity level that makes it possible to introduce limited TV and video services.

ADSL uses the same physical copper wiring as the old-world POTS telephony, and offers an excellent additional access technology for network owners and service providers trying to reach more customers.

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2 Scope of document

This document outlines PacketFront's ADSL solution and explains how it fits into the PacketFront offering. Furthermore, it gives the reader a basic understanding of the technology and the business opportunities enabled by the PacketFront ADSL solution. Intended audience for this document is technical executives, business development mangers, network architects and designers.

3 Technology overview

ADSL technology and the current standard is a mature technology, proven in the field all over the world, and the amount of written material describing the technology is vastly available on the Internet. This document will not provide detailed information on ADSL, but instead focus on the PacketFront ADSL solution and reviewing the latest additions to the ADSL world. The new ADSL options available will be reviewed in order to give the reader an understanding of the characteristics of the different, and sometimes confusing, ADSL flavours.

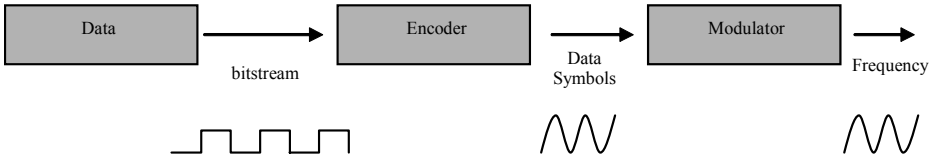
3.1 Frequency spectrum

ADSL generally uses a frequency spectrum from 20KHz to 1,1 MHz, where VDSL comes in and reaches up to 12MHz. ADSL 2+ actually invades on the VDSL spectrum by utilizing the 20Khz to 2,2 MHz spectrum, which effectively doubles the frequency spectrum compared to ADSL.

3.2 Line code & modulation

Modulation is the method of converting digital signals into waveforms and transmitting them over a wire. For the construction of these waveforms in an efficient way, 'modulation transform' employs the use of an encoder and a modulator . For ADSL, DMT (Discrete Multitone Transmission) is the defined modulation method. Digital signals are encoded and transformed into data symbols, the data symbols are then transmitted over the frequency band by the modulator. To recreate the original bitstream, the process is reversed at the receiving end.

.Illustration 2. Modulation example (extremely simplyfied)



3.3 DMT (Discrete Multitone Transmission)

DMT is a multicarrier-modulation system, where the frequency spectrum is divided into a defined number of narrow-band, sub channels, each of these channels are then encoded (using a QAM encoder) with data and transmitted in parallel. Each

subchannel has limited bandwidth, and thus uses longer symbol rates and slower baud-rate when tranceiving to reach high-bandwidth levels. DMT is the choice for ADSL and the encoder efficiency has been improved in the latest ADSL developments, such as ADSL2/2+, where new algorithms and various enhancements to QAM and the encoding process are greatly improving the data rates and overall performance of ADSL technology.

4 Current ADSL variants

This paper will not discuss the lesser-used, splitter-less variants of the different ADSL flavours.

4.1 ADSL (G.992.1)

The original ADSL standard G.992.1 is well known and widely deployed world-wide. The standard allows for up to 8Mbps downstream up to 1Mbps upstream with a reach of about 5km.

4.2 ADSL2 (G.992.3)

The ADSL2 standard contains numerous improvements compared to the previous standards. A majority of the improvements are based on experiences and feedback from the field.

Also known as G.dmt.bis, the standard specifies 800Kbps to 1,5mbps upstream bandwidth and 8 to 16 mbps downstream with the same 5km reach as ADSL. The frequency spectrum used by ADSL2 is still in the 1.1 MHz limit.

4.2.1 Major new features of ADSL2

In addition to faster startup times (from ~10s to ~3s) and native support for voice with VoDSL, the ADSL2 standard contains a number of important developments.

4.2.1.1 Line diagnostics

Built-in diagnostics functions in ADSL2 transceivers allow for more efficient troubleshooting of errors on subscriber services. Things that are measurable are interference, loop attenuation and noice ratios (signal/noise ratio) at both ends, giving the network operator real-time information on the quality of an individual ADSL2 line. The diagnostics data is an excellent tool used to determine whether a customer has a good-enough line to handle certain types of services, for example high-bandwidth Internet or video services.

4.2.1.2 Improved modulation

The improved modulation in ADSL2 gives the ability of a line to hold a higher data rate on long lines, compared to classic ADSL. The bandwidth drop-off is not as sharp with ADSL2 as in classic ADSL. This is accomplished by a greatly enhanced modulation scheme with higher gain rates; reduced overhead, better algorithms for signal processing and enhanced efficiency in the actual modulation.

4.2.1.3 Power management

During periods of inactivity and low traffic levels, an ADSL2 line can enter certain power-saving modes. Instead of always being on full power, the ADSL2 device reduces the power level, which in turn reduces the datarate significantly while giving a dynamic approach to power management. In addition to saving electricity in both ends, this feature will enhance the line quality of 'surrounding' lines, as the probability of crosstalk and near-end echo is reduced. This will effectively give users in the same area a better service. Keeping electricity consumption low will also have a positive effect on the cost of ownership and will save natural resources. Saving power is an especially important signal for companies with an environmental profile.

4.2.1.4 Improved rate adaptation

The aggregation points for ADSL lines are basically massive bundles of copper wire, terminated at a central location. Electromagnetical interference between individual wires in these bundles is inevitable, and has a negative effect on the line quality - this is known as crosstalk. Other elements of interference, such as bad copper, water or other RF transmitters, will also affect the quality of a line negatively. The improved rate adaption in ADSL2 enables the rate to be dynamically changed, as the quality of a given line changes. In times of heavy interference for certain lines the data rate will be adapted transparently to match the quality of the line, this will avoid the loss of service at the expense of bandwidth.

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4.3 ADSL2+ (G.992.5)

By using a larger frequency spectrum, ADSL2+ gives a great increase in data rates while still maintaining the characteristics and features of its parent, ADSL2. The total reach is slightly increased compared to ADSL2. The G.992.5 standard defines a reach of 18Kft, or around 6Km. ADSL2+ can reach bandwidths up to 26Mbps downstream and around 1-1,5Mbps upstream.

4.3.1 Major new features of ADSL2+

4.3.1.1 Bandwidth doubling

ADSL2+ uses a frequency range all the way up to 2,2Mhz, essentially doubling the frequency spectrum. The result is simply doubled bandwidth on shorter distances. The bandwidth doubling is generally only effective on distances below 3000m; longer lines will not be able to enjoy the doubled data rates. The use of frequencies above 1,1Mhz means that ADSL2+ cuts in on the frequencies defined for VDSL, as VDSL has a defined range of 1,1 to 12Mhz.

PacketFront would not recommend to run ADSL2+ and VDSL on the same wiring.

5 The PacketFront ADSL solution

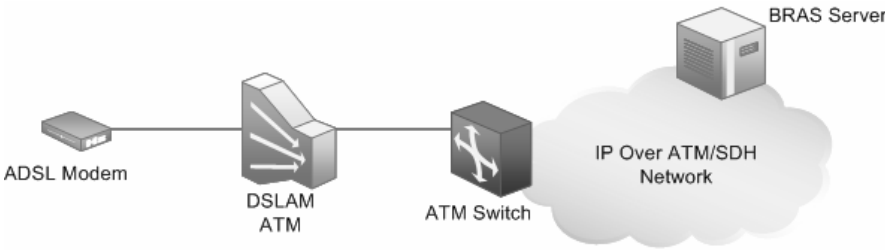
"In general, the DSLAM is only as valuable as the gear backing it up"
- Lightreading Technology Research Report, September 2003

The PacketFront ADSL solution offers the same values as those offered by the FTTx and VDSL solutions from PacketFront. The unique features of the centralized BECS™ system, together with totally integrated hardware, create an automated and innovative solution with all the features necessary to operate, control and maintain a broadband network over ADSL.

5.1 Overview

Traditional ADSL solutions tend to be ATM/SDH based with a BRAS functioning as the central device in the solution that terminates PPP sessions from the ADSL modems. The BRAS is usually a PC-based system, which takes a lot of space in the often cramped locations where the equipment is placed. The operational costs for all the BRAS systems required in large ADSL deployments, is one of the main obstacles towards reaching profitability for traditional ADSL deployments.

Illustration 3 – Generic/Classic ATM Based ADSL Solution



The combination of PacketFront's award-winning BECS™ system, the advanced IPD-series of IP DSLAMs and the ASR 4000 broadband routers make the PacketFront ADSL solution unique in the industry. PacketFront offers an all-IP ADSL solution, with transparency in service delivery over all access technologies supported by the PacketFront solution.

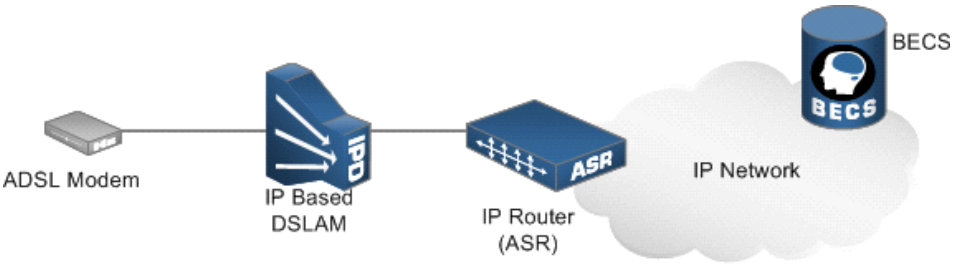
The PacketFront ADSL solutions removes the requirements for a BRAS to terminate the PPP connections. The PacketFront BECS™ system delivers all the necessary functions without the use of the often limiting PPP technology. The innovative technology provided within the BECS™ system is easily applied to an ADSL deployment, in order to handle the tasks of traditional PPP based BRAS. The functions for conditional access, service delivery, billing records, traceability and security are all handled by the PacketFront BECS™ system without the need for a complex and costly BRAS deployment. The values and functions of the PacketFront BECS™ system are well documented and available in other publications from PacketFront.

Being an all-IP-based solution, the IPD-series of DSLAM products from PacketFront interfaces with the backhaul network with *IP* instead of ATM as traditional ADSL deployments. The traditional DSLAM units have a backhaul of

ATM, which in turn is fed into an ATM/SDH network to provide BRAS functionality and service delivery.

The PacketFront solution delivers an IP-based DSLAM with Ethernet uplinking to a PacketFront IP broadband router (ASR 4000 series), and together with BECS™ this creates a more efficient way of deploying ADSL - without the use of old and expensive ATM equipment and without the need for a PPP based BRAS deployment.

Illustration 4 – PacketFront IP Based ADSL Solution



5.2 Unique PacketFront values

By bringing its ADSL solution in under the umbrella of the award-winning BECS™ system, PacketFront provides an out-of-the-box, fully automated, centralized provisioning and full-service, delivery solution. BECS™ handles services and provisioning exactly the same way as for fibre Ethernet, VDSL, copper Ethernet or any other supported access method for broadband networks. The access transparency of the PacketFront solution, without the use of PPP, enables our customers to add new access methods and reach new customers - without the need for additional provisioning and service-delivery systems.

The access independency of BECS™ ensures a common platform for all access methods, without additional system costs for each different access method. As the slower FTTH roll-out and PLC/WLAN deployments are managed by one and the same system, the network owner is provided with a very flexible, controllable and cost-effective solution.

PacketFront extends the deployment reach of true broadband services, managed by the same system as for the FTTx solution. Hence, by leveraging existing copper infrastructure, broadband operators can very rapidly reach new customers with lower initial investments, and still offer services - even into remote locations. This is possible thanks to the reach and capabilities of the latest ADSL technology.

5.3 Product offering

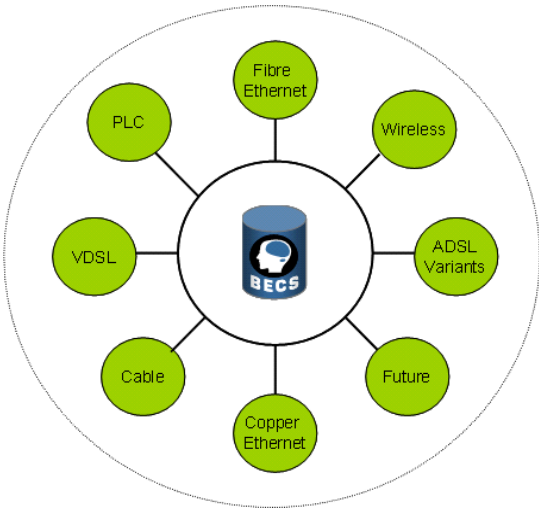
PacketFront is committed to the ADSL, ADSL2 and ADSL2+ standards. PacketFront launched its ADSL solution in November 2003 at the Next Generation Networks exhibition in Boston. The solution initially delivers classic ADSL with planned launches of ADSL2 and ADSL2+ in order to enhance the PacketFront broadband offering even further.

6 Summary and conclusion

By adding ADSL to the product portfolio, PacketFront strengthens its solution, while proving that the key values of the PacketFront solution are applicable to any access method - both existing and future. The Operator-Independent-Network paradigm that BECS™ supports and enables, is not dependant on any specific access method, but rather on the supporting systems and properly-designed products such as BECS™, the IPD-series of IP-DSLAM and the PacketFront ASR 4000 and ASR 3000 series of broadband routers.

The IP-based ADSL solution from PacketFront has proven to be very attractive to existing broadband network operators as a complimentary way of reaching new customers. It also attracts innovative and more aggressive ADSL providers who wish to deploy a more flexible and automated ADSL solution than the classic ATM-based solutions.

Illustration 5 – BECS™ access-independent control domain



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