VDSL (VERY HIGH DATA BIT RATE DIGITAL SUBSCRIBER LINE)

INTRODUCTION

1. Recent events in the telecommunications environment are giving rise to a new class of service providers, setting the stage for how it will appear in the coming time. Telecom deregulation has sparked the emergence of the ever growing Competitive Local Exchange Carrier (CLEC) industry segment, delivering a host of long-distance, cellular and high-speed Internet services. The demand for faster access to the Internet, coupled with new competitive environment has heightened the need for providers to offer more complete, more differentiated services and is accelerating the telecom industry’s development of new technologies. Both users and Telecom Operators are utilizing the many benefits of the Internet, while innovative service providers are tapping into new convergent technologies to offer more complete and higher-speed services.

2. There is a new class of CLEC called the data CLEC which utilizes DSL technology for inexpensive tier-1 (T1) replacements and high-speed Internet access. Today, several Incumbent Local Exchange Carriers (ILECs), independent LECs, CLECs, Network Services Providers (NSPs) and Internet Service Providers (ISPs) have installed Asymmetrical DSL (ADSL) trials and some are beginning to roll out these services. The ADSL standard provides up to 6 MBPS downstream and 640 KBPS upstream over voice and has a transmission loop distance of over 3 miles on copper wire.

FULL SERVICE BROADBAND NETWORK

3. VDSL is the latest form of broadband internet that runs over the existing copper phone lines that already exist in our premises. VDSL allows small & medium businesses along with residential users to access the internet at Ultra Fast Speeds. For many users, Ultra Fast Broadband is still a few years away, whereas VDSL broadband is available for approx 60% of existing ADSL users now.

BENEFITS OF FULL FLAVOUR VDSL BROADBAND

4. (a) **Speed.** The most obvious benefit is the speeds of (up to) 50 megabit download and (up to) 10 megabit upload which allows us to easily:

   (i) Access "triple play" services - video, data & voice. We've got a number of business users running their entire multiple line phone system over their VDSL connection using VoIP technology which wasn't recommended with ADSL due to limited upload ability.
   (ii) Use online storage solutions such as Drop box or Crash plan for easily backing up important files.
   (iii) Upload large files (or large sets of small files) - particularly appropriate for media related uses (photography and video production).
   (iv) Support more users on the same internet connection.

   (b) **Unmetered.** Like a ISP, Full Flavor Media believes that the internet is essential for successful small and medium uses, with restrictions on data usage
hindering internet uptake, rather than encouraging use to its full potential. All our VDSL plans are "Unmetered" with a generous fair use policy in place.

(c) **Future Proof** The Inbox V50-U modem is backwards compatible with ADSL and forwards compatible with UFB Fibre. Once Fibre is available at our office or residential premises, we're happy to break the VDSL contract at no cost to us and upgrade to a Full Flavour UFB Fibre plan. We can remotely adjust the Inbox V50-U to the right settings for Fibre and once the UFB Fibre installation is complete, plugging in our Inbox V50-U modem to Fibre is a plug & play experience.

(d) **Technology Standard** The use of fast Internet connections has grown rapidly over the last few years. As more people buy home computers and create home networks, the demand for broadband (high-speed) connections steadily increases. Two technologies, cable modems and Asymmetric Digital Subscriber Line (ADSL), currently dominate the industry. While both of these technologies provide Internet connections that are many times faster than a 56K modem, they still are not fast enough to support the integration of home services such as digital television and video-on-demand. However, another DSL technology known as very high bit-rate DSL (VDSL) is seen by many as the next step in providing a complete home-communications/entertainment package. There are already some companies which offer VDSL service in selected areas. VDSL provides an incredible amount of bandwidth, with speeds up to about 52 MBPS. If we compare that with a maximum speed of 8 to 10 MBPS for ADSL or cable modem and it's clear that the move from current broadband technology to VDSL could be as significant as the migration from a 56K modem to broadband. As VDSL becomes more common, we can expect that integrated packages will be cheaper than the total amount for current separate services.

**BASICS OF DSL.**

5. A standard telephone installation consists of a pair of copper wires that the installed at our premises. A pair of copper wires has plenty of bandwidth for carrying data in addition to voice conversations. Voice signals use only a fraction of the available capacity on the wires. DSL exploits this remaining capacity to carry information on the wire without disturbing the line's ability to carry conversations. Standard phone service limits the frequencies that the switches, telephones and other equipment can carry. Human voices, speaking in normal conversational tones, can be carried in a frequency range of 400 to 3,400 Hertz (cycles per second). In most cases, the wires themselves have the potential to handle frequencies of up to several-million Hertz. Modern equipment that sends digital (rather than analog) data can safely use much more of the telephone line's capacity and DSL does just that.

**ADSL**

6. ADSL uses two pieces of equipment:

(a) At the subscriber's location, there is a DSL transceiver, which may also provide other services.
(b) The DSL service provider has a DSLAM to receive user connections. Most residential users call their DSL transceiver a DSL modem. The engineers or ISP call it an ATU-R, which stands for ADSL Transceiver Unit. Regardless of what it’s called, the transceiver is the point where data from the user’s computer or network is connected to the DSL line. The transceiver can connect to a user’s equipment in several ways, though most residential installation uses Universal Serial Bus (USB) or 10 Base T Ethernet connections. Most of the ADSL transceivers sold by ISPs and telephone companies are simply transceivers, but the devices used by commercial operators may combine network routers, network switches or other networking equipment in the same box. The DSLAM at the access provider is the equipment that really makes DSL happen. A DSLAM takes connections from many users and aggregates them onto a single, high-capacity connection to the Internet. DSLAMs are generally flexible and able to support multiple types of DSL as well as provide additional functions such as routing and dynamic IP address assignment for users.

DISTANCE-SENSITIVE TECHNOLOGY

7. DSL is a distance-sensitive technology. As the connection length increases, the signal quality and connection speed decrease. ADSL service a maximum distance of 18,000 feet (5,460 m) between the DSL modem and the DSLAM, though for speed and quality of service reasons, many ADSL providers place an even lower limit on the distance. At the upper extreme of the distance limit, ADSL users may experience speeds far below the promised maximums, whereas users close the central office or DSL termination point may experience speeds approaching the maximum and even beyond the current limit in the future. We might wonder why, if distance is a limitation for DSL, it's not a limitation for voice telephone calls, too. The answer lies in small amplifiers, called loading coils that the telephone company uses to boost voice signals. These loading coils are incompatible with DSL signals because the amplifier disrupts the integrity of the data. This means that if there is a voice coil in the loop between our telephone and the telephone company’s central office, we cannot receive DSL service. Several other factors might disqualify us from receiving ADSL.

(a) Bridge taps. These are extensions, between us and the central office, that service other users.

(b) Fiber-optic cables. ADSL signals can't pass through the conversion from analog to digital and digital to analog that occurs if a portion of our telephone circuit comes through fiber-optic cables.

(c) Distance. Even if we know where our central office is located as looking at a map is no indication of the distance a signal must travel between our house and the office. The wire may follow a very convoluted path between the two points. Fiber-optic cables, one of the major disrupting factors of ADSL are actually what enable VDSL technology.
VDSL SPEED

8. VDSL operates over the copper wires in our phone line in much the same way that ADSL does but there are a couple of distinctions. VDSL can achieve incredible speeds, as high as 52 MBPS Downstream (to our home) and 16 MBPS Upstream (from your home). That is much faster than ADSL, which provides up to 8 Mbps downstream and 800 KBPS upstream. But VDSL's amazing performance comes at a price: It can only operate over the copper line for a short distance, about 4,000 feet (1,200 m). The key to VDSL is that the telephone companies are replacing many of their main feeds with fiber optic cable. In fact, many phone companies are planning Fiber to the Curb (FTTC), which means that they will replace all existing copper lines right up to the point where our phone line branches off at our house. At the least, most companies expect to implement Fiber to the Neighborhood (FTTN).

9. Instead of installing fiber-optic cable along each street, FTTN has fiber going to the main junction box for a particular neighborhood. By placing a VDSL transceiver at our home and a VDSL gateway in the junction box, the distance limitation is neatly overcome. The gateway takes care of the analog-digital-analog conversion problem that disables ADSL over fiber-optic lines. It converts the data received from the transceiver into pulses of light that can be transmitted over the fiber-optic system to the central office, where the data is routed to the appropriate network to reach its final destination. When data is sent back to our computer, the VDSL gateway converts the signal from the fiber-optic cable and sends it to the transceiver. All of this happens millions of times at each second as ADSL and VDSL are just two representatives of the DSL spectrum.

COMPARING DSL TYPES

10. There are several variations on DSL technology. In fact, there are so many that we will often see the term XDSL, where x is a variable, when the discussion is about DSL in general.

(a) **Asymmetric DSL (ADSL).** It is called "asymmetric" because the download speed is greater than the upload speed. ADSL works this way because most Internet users look at, or download, much more information than they send, or upload.

(b) **High bit-rate DSL (HDSL).** Providing transfer rates comparable to a T1 line (about 1.5 Mbps), HDSL receives and sends data at the same speed, but it requires two lines that are separate from our normal phone line.

(c) **ISDN DSL (ISDL).** Geared primarily toward existing users of Integrated Services Digital Network (ISDN), ISDL is slower than most other forms of DSL, operating at fixed rate of 144 Kbps in both directions. The advantage for ISDN users is that they can use their existing equipment but the actual speed gain is typically only 16 Kbps (ISDN runs at 128 Kbps).

(d) **Multirate Symmetric DSL (MDSDL).** This is Symmetric DSL that is capable of more than one transfer rate. The transfer rate is set by the service provider, typically based on the service (price) level.
(e) **Rate Adaptive DSL (RADSL).** This is a popular variation of ADSL that allows the modem to adjust the speed of the connection depending on the length and quality of the line.

(f) **Symmetric DSL (SDSL).** Like HDSL, this version receives and sends data at the same speed. While SDSL also requires a separate line from our phone, it uses only a single line instead of the two used by HDSL.

(g) **Very high bit-rate DSL (VDSL).** An extremely fast connection, VDSL is asymmetric, but only works over a short distance using standard copper phone wiring.

(h) **Voice-over DSL (VoDSL).** A type of IP telephony, VoDSL allows multiple phone lines to be combined into a single phone line that also includes data transmission capabilities. The chart below provides a comparison of the various DSL technologies: As we can see, VDSL provides a significant performance boost over any other version. But for VDSL to become widely available, it must be standardized.

**VDSL STANDARD: DMT**

11. After a long standards battle between the VDSL Alliance, which supports VDSL using a carrier system called Discrete Multi Tone (DMT) and the VDSL Coalition that uses a pair of technologies called Quadrature Amplitude Modulation (QAM) and Carrierless Amplitude Phase (CAP), DMT won out. Most ADSL equipment today uses DMT technology. DMT divides signals into 247 separate channels, each 4 kilohertz (KHz, or 1,000 cycles per second) wide. One way to think about it is to imagine that the phone company divides our copper line into 247 different 4-KHz lines and attaches a modem to each one. We get the equivalent of 247 modems connected to our computer at once. Each channel is monitored and, if the quality is too impaired, the signal is shifted to another channel. This system constantly shifts signals, searching for the best channels for transmission and reception. In addition, some of the lower channels (those starting at about 8 KHz) are used as bidirectional channels, for both upstream and downstream information. Monitoring and sorting out the information on the bidirectional channels and keeping up with the quality of all 247 channels, makes DMT more complex to implement than other carrier technologies, but also gives it more flexibility on lines of differing quality.
CONCLUSION

12. As the Internet gains more users, the content becomes more graphical and the delivery of services becomes more ubiquitous, demand for faster access and more bandwidth is certain. Those service providers who capitalize on this new environment by offering a full suite of narrowband and broadband services to deliver voice, data and video will succeed. In the quest to deliver broadband services over the existing narrowband network, most of the large carriers are engaged in various types of Digital Subscriber Line (DSL) technology. VDSL is an emerging standard in the area of xDSL that will likely complete the DSL evolution early in the next century. Compared to ADSL, VDSL offers (much) higher bit rates at programmable upstream-downstream ratios. As such, it might fulfill the ultimate promise of the simple twisted pair invented by Alexander Graham Bell, possibly eclipsing the utility of his better known first invention.

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