Considerations in VDSL/VDSL2 Implementation

The Competitive Environment

Today's telcos face more competition than ever before. The boundaries separating services—voice, video, and data—are disappearing and customers seeking those services are being courted by cable, satellite, and wireless providers, each of which offers some or all of the components users want. The days of the single service provider are clearly numbered, and competition from providers who can deliver a full slate of services can be a very real threat to a telco's subscriber base. Cable companies clearly recognize this and are moving aggressively to provide voice and data services. Telcos need to respond if they are to remain competitive.

The technologies providers need to deliver a full range of services are readily available; the real challenge they face is finding bandwidth over which to deliver those services. From a purely technical standpoint the simplest way to maximize bandwidth for multi-service delivery would be all-fiber networking to the subscriber premise. Fiber has all the capacity a provider needs to deliver voice, video, and data for the foreseeable future, but for many providers, cost rather than technology is the limiting factor.

Replacing existing copper, particularly where customer density is low, can be prohibitively expensive. In some cases, providers might never recoup the cost, but even where there is a likelihood of payback over a number of years, the capital may simply not be available or may be required for other operations. For these providers, the solution is to enhance the capabilities of existing copper.

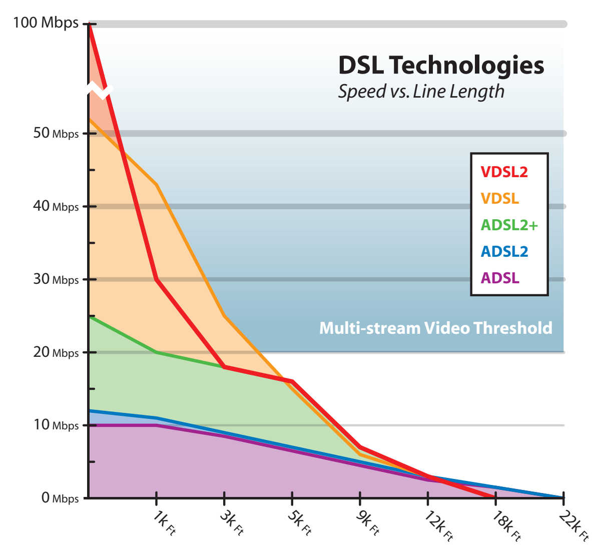
In appropriate applications, installing fiber to the node (FTTN) and completing the run over existing copper rather than installing fiber to the premise (FTTP) provides a number of benefits. It reduces capital expenditures, the equipment needed to support is less expensive to deploy and maintain, and battery backup equipment can be located at the node or the central office rather than at every premise. ADSL in a variety of forms has enabled telcos to expand the carrying capacity of copper, but has, in many ways, fallen short as a vehicle for bandwidth-hungry video. Fortunately, telcos now have new options for delivering the triple play of services that users demand.

The Solution

VDSL (very high bit-rate digital subscriber line) and its second-generation cousin VDSL2 are designed to allow delivery of triple play services over copper infrastructure originally designed for delivery of POTS. With better compression technology and advancements in copper DSL technology, such as pair bonding, vectoring and the latest phantom mode, these innovations allow DSL to deliver up to 300 Mbps at distances up to 400 meters ensuring DSL technology will be useful for years to come.

The evolution of these services began in 1999 with the release of ADSL standards. In 2002, a standard for ADSL2 was approved, and in 2003 ADSL2+ was approved, delivering the first real video-over-copper capability. An additional implementation, bonded ADSL2, was introduced in 2005. This technology extended the distance over which service could be provided but was actually less suitable for delivering video.

The introduction of VDSL began with the approval of the VDSL standard in 2004 and continued with the introduction of VDSL2 in 2006 followed by further advancements such as VDSL2 bonding, vectoring, and most recently Bell Labs' new innovation of DSL phantom mode which involves the creation of a virtual or "phantom" channel that supplements the two physical wires typically used. These offerings directly target the delivery of today's triple play services and are specifically designed to let carriers with significant investments in copper infrastructure compete with the offerings of cable companies.



A Complex Market

One of the challenges facing developers of these systems and the standards that define them is the varied nature of the markets being served. These can range from dense, multi-dwelling units to sparse suburban or even rural communities. Similarly, the distribution architectures of the central offices and distribution nodes within service areas vary widely. Clearly, no single service would be able to meet all these varied needs. For this reason, VDSL and VDSL2 standards define a range of annexes, bandplans, and profiles designed to meet the broadest variety of requirements under a single standard.

This approach has significant advantages but also presents challenges. By segmenting market requirements it offers cost-effective ways to meet a variety of needs, putting enough capability into each application to meet current and anticipated needs without overbuilding or overspending. This approach lets providers control capital outlay while meeting customer needs and maximizing their return on investment. At the same time, it requires that users understand their applications and options to make the right choices for both the present and future. The variety of options makes this a more complex process. And because vendors vary in the number and variety of options they support it can affect not just choice of equipment but choice of vendor as well.

The Challenges of Transition

Moving from existing technologies like ADSL to VDSL or VDSL2 is not an overnight process. Investment in the upgrade will typically begin where the return is most immediate or where it is needed to address competition. Conversion to VDSL will then move over time into areas where the need is less immediate and as capital becomes available and the investment becomes justifiable. Old and new technologies may coexist for years while VDSL is being rolled out. In fact, in some situations ADSL may remain preferable as a service delivery medium more or less permanently. It is therefore critical that old and new technologies be compatible within the provider's network.

Delivering the Goods

Providers have eagerly awaited the approval of VDSL and VDSL2 and with good reason. These technologies expand both the reach and rate of service delivery over existing copper infrastructure (though users cannot have both the highest rates and the longest reach in the same implementation). The system can provide data rates of 25 Mbps over loops of 4 to 6 Kft and symmetrical data rates of over 100 Mbps over loops of less than 1 Kft.

The VDSL2 standard incorporates many features of ADSL2+ including advanced diagnostics and the management interface. This significantly simplifies operations and management of systems using both technologies, while easing ongoing transition from one technology to the other. ADSL can continue to be used where video is not a competitive necessity, while any of a number of forms of VDSL2 are implemented where video is needed for competitive reasons or can be financially justified. VDSL implementations not only protect a telco's existing customer base from poaching by other triple play providers but can allow a voice and data service provider to woo cable customers with a competitive triple play option including advanced video services like video on demand (VoD) and high definition TV.

DSL Standards

The following standards define the various types of DSL

DSL Technology	Defining Standard
ADSL	ANSI T1.413
ADSL2	ITU G.992.3 ITU G.992.4
ADSL2+	ITU G.992.5
VDSL	ITU G.993.1
VDSL2	ITU G.993.2

Ring Trip Mitigation

The interaction of telephony and video signaling places special demands on the VDSL2 splitter. When a telephone is "off-hook," the battery at the central office provides -48VDC over the phone line. When the phone is ringing, peak ring voltage is 127 volts. If the subscriber answers the phone (a condition called "ring trip") at the negative peak of the voltage cycle, the instantaneous voltage —a combined -48VDC from the CO battery and -127 from the ringer— adds up to -175 volts. When this happens, an ordinary splitter can allow high-voltage, high-frequency transients to enter and interfere with the VDSL2 spectrum. This, in turn, can cause corruption or loss of data packets and interference with video signals.

The problem is not too significant in the case of data since TCP/IP can request packet retransmission. Video, on the other hand, is a streaming service and does not allow for retransmission. In order to provide uninterrupted video service and compete with video services on cable, the service provider must use high-quality video-grade splitters. These splitters work with the DSL chipset to reduce or eliminate problematic ring trip effects. Appropriate splitters must be configured at the CO and in the network interface device at the customer premise. Your equipment supplier should be able to help select appropriate splitters for the services you plan to provide and the customers you serve.

The Right Tool for the Job

When VDSL was the state of the art, VDSL applications were similar enough that a single implementation could address them all. VDSL2, on the other hand has been designed to address a far wider range of applications. The option of creating VDSL2 as a one-size-fits-all design was rejected as having to be far too complex and costly for practical use. Instead, to meet the wide range of demands placed upon it, the standard defines a variety of formats each suited to a particular type of implementation.

VDSL2 regional bandplan annexes define PSD Mask for regional bandplans, allowing coexistence with preexisting services. Annex A applies to the North American region, Annex B applies to Europe, and Annex C applies to Japan. The current standard increases VDSL2 bandwidth to 30 Mhz with configuration options at 8.5 Mhz, 12 Mhz, 17.7 Mhz, and 30 Mhz. It also defines asymmetric and symmetric bandplans for upstream and downstream signaling.

The standard further defines eight profiles, each addressing a specific deployment architecture. The various profiles specify upstream and downstream bandwidths and other characteristics defining the implementation.

Profiles 8a-d and 12a and 12b are designed for central office or cabinet-based installations and typically serve extended areas. To support these longer distances, they specify (except for 12b) mandatory support of upstream band 0 (U0). Profiles 17a and 30a are designed for higher speeds over shorter distances and are typically used in multi-dwelling (MDU) applications. They do not, therefore, require U0 support.

Profiles	8a	8b	8c	8d	12a	12b	17a	30a
Bandwidth MHz	8.5	8.5	8.5	8.5	12	12	17.7	30
Tones D/S	1,971	1,971	1,971	1,971	2,770	2,770	4,095	4,095
Spacing KHz	4.312	4.312	4.312	4.312	4.312	4.312	4.312	8.625
TX Power D/S dBm	+17.5	+20.5	+11.5	+14.5	+14.5	+14.5	+14.5	+14.5
Min netData rate Mbps	50	50	50	50	68	68	100	200

The Bottom Line

VDSL and VDSL2 are powerful tools that allow telcos to effectively compete in the competitive triple-play service market. Built on proven DSL technology, these services optimize the effectiveness of existing infrastructure, controlling costs, adding capabilities, and facilitating migration from existing technologies. Both require careful implementation, but the division of VDSL2 implementations into multiple bandplans makes deployment of that service particularly demanding.

Effective network design requires a clear understanding of both the technology and the provider's current and future plans. In addition, the advanced capabilities of VDSL2 increase vulnerability to ring trip interference, which can be effectively addressed only by deploying specialized equipment in the network.

The Suttle Difference

With over 100 years of experience, Suttle has become a leading supplier of connectivity components worldwide, with a particular focus on DSL filtering solutions. In 2010, just 10 years after delivering its first ADSL filter, the company will ship its 100 millionth DSL filter. We are committed to our telco service provider customers and to supporting VDSL2 as a competitive service. As the technology continues to grow and evolve, Suttle is committed to leadership in research, in the development of innovative products, and in the support of the customers and markets we serve.

To learn more about our company, products, and services, call us at 800-852-8662 or visit www.suttlesolutions.com.