ATTACHMENT D

BEAR STEARNS

Equity Research

SEPTEMBER 2003

U.S. Wireline Services

The DSL Report II
DSL as an Instrument of Competition

- **DSL REVISITED.** In our September 2002 study, *The DSL Report*, we examined the economics of providing DSL. Since we issued that report, the DSL market has evolved considerably. From a cost perspective, consumer premises and network equipment prices have continued to decline, and installation and provisioning have become more efficient.

- **IN A BUNDLE.** Perhaps more important than these operating cost savings is the emergence of DSL as a critical component of service providers' consumer bundles. By bundling DSL with other products, service providers lower marketing costs, which (along with other operational savings) allows for lower price points (which should drive higher penetration). Bundling also serves as a highly effective barrier to customer churn, thus preserving high-margin local voice service.

- **DSL VERSUS CABLE.** Improved DSL economics could not have come at a more crucial juncture. We believe that in the next 12-24 months, a fierce battle between cable providers and telecommunications providers for consumer expenditures will ensue. In this battle, three components will be necessary: telephony, video, and high-speed broadband. Since the spoils of war may very well be "all or nothing," it is imperative for providers to have all three components and to gain share in each of the components quickly. Hence the urgency on the part of telecommunications companies to quickly add as many broadband DSL subscribers as possible — and to also begin incorporating video into their stable of services.

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Our thanks to our summer intern Michael Schumacher for his assistance with this report.

Executive Summary

Bear Stearns acted as a financial advisor to General Motors Corp. (GM) in the pending acquisition of Hughes Electronics Corp. (GMH) by News Corporation LTD. The proposed transaction is subject to the approval of GM and GMH shareholders and the information provided herein is not intended to (i) provide voting advice, (ii) serve as an endorsement of the proposed transaction, or (iii) result in the procurement, withholding or revocation of a proxy or any other action by a security holder.

Bear Stearns acted as a financial advisor to Verizon Communications, Inc. in its announced transaction with Grupo Iusacell SA.

In September 2002, we published *The DSL Report*, an in-depth study of the economics of providing DSL service. Since the publication of that report, the cost of providing DSL service has improved significantly. First, modem and network equipment costs continue to decline. For example, we estimate the average DSLAM list price per port declined to $98 from $340 from the beginning of 1999 through the end of 2002, and some contracts with large carriers are being signed at below $60 per port. Service providers are also finding innovative ways to reduce installation costs (such as equipping trucks with GPS devices to locate customer addresses more quickly) and significant improvements have been made in automating the service provisioning process.

Perhaps more important than improvements in operational costs is the emergence of DSL as a critical component of service providers' consumer bundles. By bundling DSL with other products, service providers lower overall acquisition and fulfillment costs such as billing, call centers, and marketing. Together with the operational cost savings noted above, bundling allows for lower price points, which in turn should drive adoption. Bundling also serves as a highly effective barrier to customer churn.

In our opinion, improved DSL economics could not have come at a more crucial juncture. We believe that in the next 12-24 months, a fierce battle between cable providers and telecommunications providers for consumer expenditures will ensue. In this battle, three components will be necessary: telephony, video, and high-speed broadband. Since the spoils of war may very well be "all or nothing," it is imperative for providers to have all three components and to gain share in each of the components quickly. Hence the urgency on the part of telecommunications companies to quickly add as many broadband DSL subscribers as possible — and to also begin incorporating video into their stable of services. In our view (and based on recent announcements), satellite partnerships appear to be the stopgap video solution for the largest telecommunications service providers. Video over copper and video over fiber solutions have been deployed by some of the smaller and/or rural telecommunications service providers. Larger telecommunications service providers are not likely to deploy these wireline video solutions on a large scale for several years, due primarily to loop length limitations (average loop length in the U.S. is 11kft, by our estimation) and high programming costs.

The combination of improved economics, churn reduction, and the threat of competition have resulted in more aggressive deployment and pricing plans from the service providers. By way of illustration, Verizon expects 80% of households in its territory to have DSL service available to them by the end of 2003, up from 57% at the end of 2002. Sprint expects 58% of local service households to have DSL service available by the end of 2003, up from 50% at the end of 2002.

U.S. Residential Broadband Forecast

By the end of 2005, we anticipate there will be 30.4 million residential broadband subscribers in the U.S. (28% household penetration), up from 21.6 million (20% household penetration) at the end of this year. We expect the composition of installed broadband subscribers will remain roughly the same in 2005 versus 2003 (2.4x cable broadband to DSL in 2005, versus 2.6x in 2003). However, we expect cable to weigh less heavily in terms of net retail broadband additions in 2005 (1.5x DSL) versus 2003 (2.4x DSL).

Drivers of Improving DSL Economics

DECLINING ACQUISITION COSTS

DSL customer acquisition costs have been falling as a result of three key factors. First, CPE (customer modem) costs have been falling rapidly. We estimate large carriers pay no more than $50 per customer modem today, versus an average of about $60 last year and $107 in 2001. Second, telecommunications carriers have become much more savvy in terms of provisioning. Using improved software, carriers now attempt to group together activations for customers in the same region, service trucks are increasingly equipped with GPS systems to locate customer locations more quickly (thus turning around more installations per day), and more of the provisioning process has been automated. Finally (and perhaps most importantly), a growing number of DSL customers are acquired as part of a larger service bundle, and often via inbound service calls. BellSouth indicated to us that 50%-60% of DSL net adds in first-quarter 2003 were in a bundle. This greatly reduces sales and marketing costs and over time could eliminate other costs (e.g., call center costs).

Another form of acquisition cost avoidance is co-marketing agreements such as the one SBC Communications has with Yahoo! (SBC Yahoo! DSL). We estimate that SBC pays Yahoo! a bounty of about $3 per month for customers Yahoo! signs onto SBC Yahoo! DSL. We further estimate Yahoo! pays SBC 25%-50% of the advertising and commerce revenue generated by active SBC Yahoo! DSL users ($0.21-$0.42 per month). Net, we estimate SBC Communications' total annual marketing cost for an SBC Yahoo! DSL subscriber to be between $30.96 and $33.48 — far below our estimated marketing cost of $236 for a standalone DSL customer.

Exhibit 1 illustrates our estimate of the economics of a standalone DSL customer versus a customer acquired as part of a larger service bundle.

Exhibit 1. Economics of Standalone Versus Bundled DSL (monthly, in $)

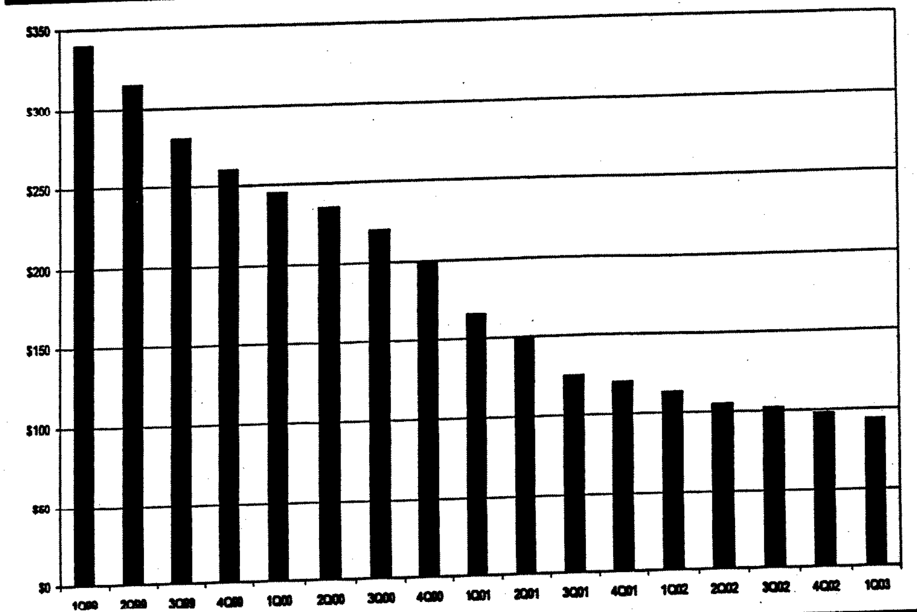
	Standalone	Bundled
ARPU	34.95	29.95
COST OF SERVICE:		
Amortization of modem/self-install kit costs	4.08	4.08
Ongoing maintenance costs	3.94	3.94
Amortization of non-capitalized network costs	3.21	3.21
Power and cooling	0.09	0.09
Total cost of service	11.32	11.32
Gross profit	23.63	18.63
Gross margin	*68%*	*62%*
SG&A:		
Billing & customer service	0.19	0.19
Amortization of acquisition marketing & advertising	17.69	6.19
Ongoing marketing & advertising	1.97	1.57
Bad debt	0.70	0.45
Overhead & OSS	0.09	0.09
Total SG&A	20.64	8.50
SG&A % revenue	*59%*	*28%*
DEPRECIATION	2.29	2.29
OPERATING PROFIT	0.70	7.84
Operating margin	*2%*	*26%*
EBITD	2.99	10.13
EBITD margin	*9%*	*34%*
Churn assumption	3.3%	2.0%
Lifetime revenue per subscriber	1,059	1,498

Source: Bear, Stearns & Co. Inc. estimates.

DECLINING EQUIPMENT COSTS

Another dynamic positively influencing the broader rollout of DSL broadband is the fact that equipment pricing continues to fall. For example, we track the average price per port of DSLAMs (DSL access multiplexers). From the beginning of 1999 through the end of last year, the average DSLAM price per port in North America fell more than 70%. Recently, per-port pricing has gotten even more aggressive. For example, we understand that when Alcatel extended (on June 2, 2003) its DSL equipment contract with Verizon through the end of 2005, the price per port under contract was $55. Also, when Qwest announced first-quarter 2003 results, the company indicated that it was switching DSLAM vendors. We believe that this switch was from Cisco and Lucent to Alcatel. Qwest disclosed that the average cost per DSLAM port from the new vendor was 40% below the cost of ports from the previous vendors (we estimate that the Alcatel contract got them a price per port of about $60).

Exhibit 2. Average DSLAM Price/Port in North America ($)

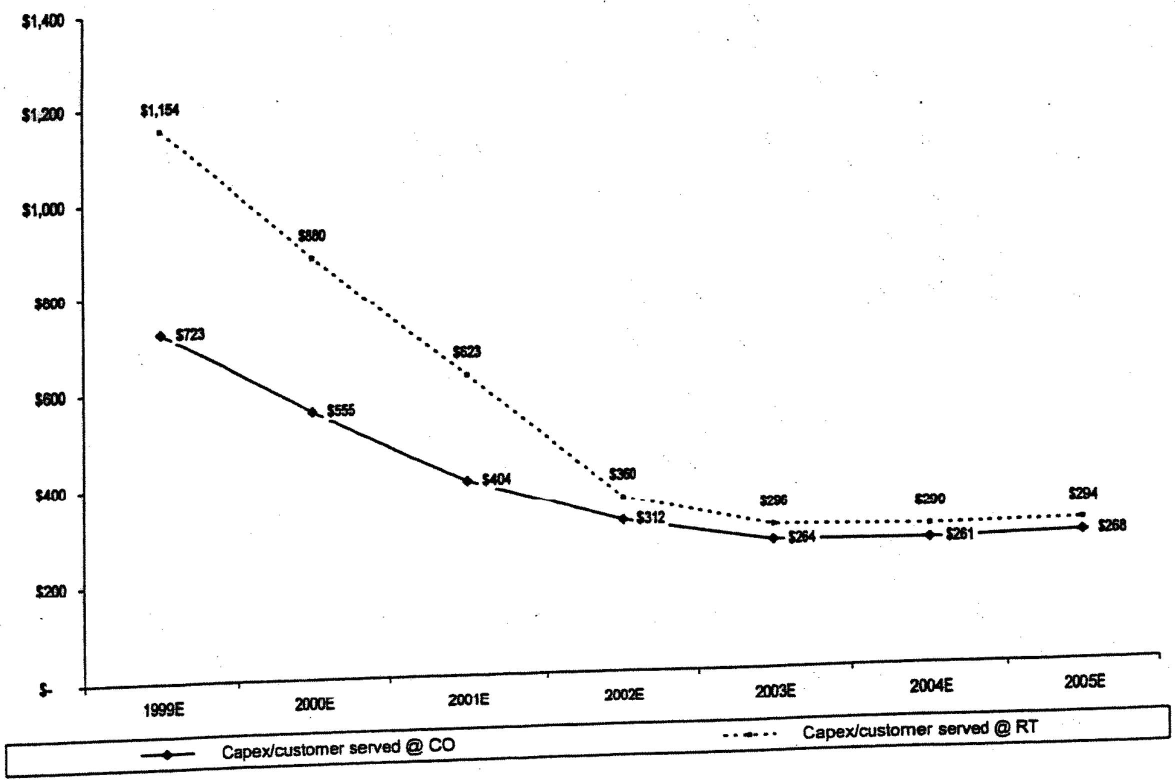


Source: Bear, Stearns & Co. Inc. estimates.

In total, we believe the average capital cost to deploy a new DSL customer (on an amortized basis) is $277 ($264 for a customer connected via a central office and $296 for a customer connected via a remote terminal). This compares to an average cost of $456 in 2001 and $329 in 2002.

Exhibit 3. DSL Capital Spending per Customer Continues to Decline

CAPITAL EXPENDITURES	1999E	2000E	2001E	2002E	2003E	2004E	2005E
Equipment costs:							
Customers within 18kft							
% customers within 18kft	80%	80%	80%	80%	80%	80%	80%
DSLAM price per port	300	225	140	100	60	55	50
Customers beyond 18kft							
% customers beyond 18kft	20%	20%	20%	20%	20%	20%	20%
Customers beyond 18kft served by DLC	18%	18%	18%	18%	18%	18%	18%
Customers beyond 18kft served by loop extension	2%	2%	2%	2%	2%	2%	2%
DLC line card cost per customer	700	525	340	135	81	74	68
Loop extension cost per customer	875	656	425	169	101	93	84
Total weighted access equipment cost per subscriber	384	288	182	108	65	59	54
Incremental bandwidth cost per user:							
Transport from RT to CO ($) [1]	14	12	11	10	8	7	7
Transport from CO to aggregation office ($) [2]	190	165	144	125	127	135	153
Connectivity to backbone per line ($)	121	101	84	63	54	48	43
Total incremental bandwidth cost per user	324	278	238	197	189	191	203
SMS:							
Networks using SMS	90%	90%	90%	90%	90%	90%	90%
SMS cost per subscriber	113	60	30	18	17	16	15
Total SMS cost per subscriber	102	54	27	16	15	14	14
Incremental ATM switching capacity per customer [3]	11	10	9	8	8	8	8
Total capital expenditures	820	630	456	329	277	273	279
Capex/customer served @ CO	$ 723	$ 555	$ 404	$ 312	$ 264	$ 261	$ 268
Capex/customer served @ RT	$ 1,154	$ 880	$ 623	$ 360	$ 296	$ 290	$ 294



(1) Annual cost of capacity required by the line capacity of the remote terminal equipment (usually 48) multiplied by a multiplexing factor.
(2) Annual cost of connectivity divided by the capacity per DSL customer of the bandwidth with a multiplexing factor applied.
(3) Assumes maximum configuration per platform, a configuration with DS-3 access and OC-3 trunking, and switch pricing at 75% off list.

Source: Bear, Stearns & Co. Inc. estimates.

DSL AS A TOOL OF CHURN REDUCTION

According to our conversations with management from several telecommunications companies, DSL is the most effective churn reduction tool in their product arsenal; customers who have DSL are least likely to terminate service in favor of a competitor. During the company's second-quarter 2003 earnings conference call, BellSouth management related that when a local/long distance customer adds just one additional service such as DSL, wireless, or dial-up, churn decreases about 45%. The vital result of this churn reduction is the telecommunications provider's ability to preserve the approximately 40% EBITDA margin of the residential customer's local loop (basic service). In other words, margin dilution from offering broadband is far outweighed by the telecommunications service provider's ability to maintain the high profitability of a local customer. Clearly, recent DSL price reductions indicate that service providers are far more interested in preserving profitable local loops than generating cash flow from DSL. At the same time, however, it should be noted that, from a lifetime-revenue-per-subscriber perspective, price reductions make economic sense (as opposed to just the strategic sense of preserving local loop profitability) if such price reductions are truly met with a reduction in DSL churn. The simple illustration in Exhibit 4 demonstrates what would occur if the DSL churn rate was brought to the RBOC average of about 2%. In this example, the price of DSL service is lowered by $10 per month, but if churn is brought down to 2% (i.e., the DSL customer does not churn any more quickly than an average customer since their DSL service is bundled with other services), the result is a higher lifetime revenue per subscriber.

Exhibit 4. Lowering DSL Pricing to Reduce Churn Yields Higher Lifetime Revenue

Assumptions	Unlimited Local/LD Customer	DSL Standalone	Total Lifetime Revenue
Churn	2.00%	3.30%	
Price	$50	$39	
Customer Life (months)	50	30	
Lifetime Revenue	$2,500	$1,182	$3,682

Assumptions	Unlimited Local/LD Customer	DSL Bundled	Total Lifetime Revenue
Churn	2.00%	2.00%	
Price	$50	$29	
Customer Life (months)	50	50	
Lifetime Revenue	$2,500	$1,450	$3,950

Source: Bear, Stearns & Co. Inc. estimates.

Exhibit 5 provides actual subscriber economics from a large carrier for 2002.

Exhibit 5. 2002 DSL Breakeven Analysis for a Large Carrier

MONTH --->	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Revenue		$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49
Nonrecurring Expense/Gross Add	$227																			
Recurring Expense		$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13
Depreciation & Amortization		$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4
Cumulative Customer Profit (Loss)	($227)	($195)	($163)	($130)	($98)	($66)	($34)	($2)	$31	$63	$95	$127	$159	$192	$224	$256	$288	$320	$353	$385

MONTH --->	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Revenue	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49
Nonrecurring Expense/Gross Add																					
Recurring Expense	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13	$13
Depreciation & Amortization	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4	$4
Cumulative Customer Profit (Loss)	$417	$449	$481	$514	$546	$578	$610	$642	$675	$707	$739	$771	$803	$836	$868	$900	$932	$964	$997	$1,029	$1,061

Source: Company reports.

The data illustrate several interesting points. Based on full-year 2002 data, a customer became profitable after eight months. Profitability likely has improved for this carrier (and other carriers) since then. Using the above data, we can also determine that a reduction in churn would have a significant positive impact on NPV, as illustrated in Exhibit 6 below.

Exhibit 6. Churn Sensitivity to Cumulative Customer Profit

Average Customer Life	Churn Rate 2.50%	2.75%	3.00%	3.25%	3.50%	3.75%	4.00%	4.25%	4.50%	4.75%	5.00%
40	$1,036										
36		$910									
33			$815								
31				$720							
29					$657						
27						$594					
25							$531				
24								$499			
22									$468		
21										$436	
20											$404

Source: Company reports; Bear, Stearns & Co. Inc. estimates.

Exhibit 7. Bear Stearns DSL Economics Model

(year-one economics of a non-bundled customer; incorporates average consumer, business, and wholesale mix; costs fully allocated to DSL)

NEW CUSTOMER IN YEAR...	1999E	2000E	2001E	2002E	2003E	2004E	2005E
ANNUAL REVENUE PER CUSTOMER							
Gross revenue	554	597	588	580	486	460	453
Gross weighted monthly basic service ARPU	*46.21*	*49.73*	*48.97*	*48.33*	*40.49*	*38.30*	*37.75*
Add: Activation and installation charges	78	78	54	46	40	40	40
Less: Service and promotion credits	94	101	100	90	68	58	58
Equals: Net revenue	539	574	541	536	458	442	436
Net weighted monthly basic service ARPU	*44.89*	*47.81*	*45.12*	*44.66*	*38.18*	*36.79*	*36.32*
COST OF SERVICE							
Modem/self-install kit	233	133	107	60	49	48	48
Installation costs [1]:							
Self install:							
Self-install success rate	0%	47%	86%	90%	90%	90%	90%
Self-install fail rate or truck roll required	100%	53%	15%	10%	10%	10%	10%
Cost per truck roll ($)	200	190	165	155	150	150	150
Required truck rolls per customer	2.50	1.88	1.25	1.25	1.00	1.00	1.00
Remote terminals:							
% DSL customers connected via remote terminal	20%	20%	20%	20%	20%	20%	20%
Cost per truck roll ($)	200	190	165	155	150	150	150
Number of RT customers provisioned simultaneously	1	1	2	4	4	5	6
Total truck roll cost factor for remote terminal customers ($)	40	38	17	9	8	6	5
Total average installation costs per customer ($)	540	228	46	28	22	21	20
Maintenance costs [2]	56	56	56	56	56	56	56
Non-capitalized network costs [3]	93	81	70	60	39	33	29
Power and cooling	1	1	1	1	1	1	1
Total cost of service	922	498	280	204	166	158	154
Gross profit	(384)	76	262	332	292	283	282
Gross margin	*-71%*	*13%*	*48%*	*62%*	*64%*	*64%*	*65%*
SG&A							
Billing & customer service	2	2	2	2	2	2	2
Marketing & advertising	275	279	275	264	236	234	234
Bad debt	11	11	11	11	9	9	9
Overhead & OSS [4]	1	1	1	1	1	1	1
Total SG&A	289	294	289	278	248	246	246
SG&A % revenue	54%	51%	53%	52%	54%	56%	56%
DEPRECIATION	194	106	71	44	27	21	20
OPERATING PROFIT	(867)	(324)	(99)	10	16	16	17
Operating margin	*-161%*	*-56%*	*-18%*	*2%*	*3%*	*4%*	*4%*
EBITD	(672)	(218)	(28)	53	43	37	36
EBITD margin	*-125%*	*-38%*	*-5%*	*10%*	*9%*	*8%*	*8%*

(1) Includes costs of field technicians, CO wiring, operations provisioning coordination, due date management, and wholesale operations centers.
(2) Includes help desks.
(3) Includes facilities re-arrangements, monitoring, and loop qualification costs (checking for metallic loop faults, bridge taps, load coils, noise).
(4) Includes cost of OSS programmer labor.

Source: Bear, Stearns & Co., Inc. estimates.

DSL Technology: Overview and Future Trends

Digital subscriber line is a copper-loop transmission technology that overcomes the bandwidth constraints associated with the local loop access network, sometimes referred to as "the last mile." DSL describes a broad group of copper-line based technologies (also described as "xDSL" technologies) where some variations can provide broadband speeds as high as 52 Mbps.

The two broad categories that these various technologies can be broken into are symmetric and asymmetric. Symmetric technologies provide the same data transmission rates upstream (from the user to the service provider) and downstream (from the service provider to the user). Symmetric technologies include high bit-rate DSL (HDSL), HDSL2, single-pair HDSL (SHDSL), symmetric DSL (SDSL), and ISDN DSL (IDSL). Asymmetric technologies provide data transmission rates that are faster downstream than upstream. Asymmetric data flow more closely matches typical consumer user needs where quick clicks to and from Web sites send small packets of command data upstream, which in turn result in a proportionately larger flow of data downstream in the form of pictures, videos, and text. Asymmetric technologies include asymmetric DSL (ADSL), rate-adaptive DSL (RADSL), G.lite, and very high data-rate DSL (VDSL). ADSL is the technology most often deployed in the U.S. for consumer use.

Exhibit 8. Symmetric and Asymmetric DSL Technologies

Symmetric	Asymmetric
HDSL	ADSL
HDSL2	G.lite
SHDSL	RADSL
SDSL	ADSL2
IDSL	ADSL2+
	VDSL

Source: Bear, Stearns & Co. Inc.

Exhibit 9. Summary of Key DSL Technologies

	Max. Downstream Rate	Max. Upstream Rate	Max. Reach	Analog Voice Support	ITU / ANSI Standard	Wire Pairs
Symmetric						
IDSL	144 kbps	144 kbps	18,000 feet	No	No	1
SDSL	1.168 Mpbs	1.168 Mpbs	18,000 feet	No	No	1
HDSL	1.544 Mbps	1.544 Mbps	12,000 feet	No	No	2 - 3
HDSL2	1.544 Mbps	1.544 Mbps	12,000 feet	No	T1.418	1
SHDSL	2.3 Mpbs	2.3 Mpbs	18,000 feet	No	G.991.2 (prev. G.shdsl)	1
Asymmetric						
G.lite	1.5 Mpbs	512 kbps	18,000 feet	Yes	G.992.2	1
ADSL	8 Mbps	864 kbps	18,000 feet	Yes	G.992.1	1
RADSL	8 Mbps	864 kbps	18,000 feet	Yes	No	1
ADSL2	8 Mbps	914 kbps	18,600 feet	Yes	G.992.3 / G.992.4	1
ADSL2+	20 Mbps	914 kbps	18,600 feet	Yes	G.992.5	1
VDSL	52 Mbps	6 Mbps	5,000 feet	Yes	No	1

Source: Bear, Stearns & Co. Inc.

SYMMETRIC TECHNOLOGIES

HDSL

High bit-rate DSL (HDSL) was first deployed in 1992 and is the most mature of the DSL technologies. HDSL delivers symmetric data rates of 1.544 Mbps over a copper loop of two twisted-pairs. HDSL's operating range is limited to approximately 12,000 feet (2.3 miles).

Prior to HDSL, T1 service of 1.544 Mbps speeds were provisioned primarily as a trunk service between LEC central offices. As customers began to demand this high-speed service, LECs had to recondition their local loops by removing existing bridge taps and loading coils (see technology discussion below) and splicing the line in order to insert repeaters every 3,000-6,000 feet (0.6 to 1.1 miles) as the high frequency transmission attenuated quickly with this technology. Over 18,000 feet (3.4 miles), a traditional T1 over copper line would require six repeaters (three repeaters per line). In addition, line/equipment placement considerations were problematic and increased the time needed for line deployment given the amounts of crosstalk created by the double twisted-pair line and equipment.

HDSL's main advantage versus traditional T1 copper services is relative ease of installation while maintaining equivalent data transmission rates. Local loop reconditioning for HDSL requires only the removal of loading coils, not bridge taps, and does not require repeaters over lengths of 12,000 feet (2.3 miles). If one repeater is added, HDSL doubles the distance its signal covers to 24,000 feet. As HDSL provides T1 data transmission rates with quicker, cheaper installation than traditional T1 over copper, LECs have used the technology to provision local access.

Given that HDSL uses a line consisting of two twisted-pairs, or four copper wires, HDSL's primary implementation is for corporate users. LEC central office reach extensions, university campus building-to-building connections, or business private data networks are common HDSL applications. We note that today, T1-speed service is often provisioned over fiber optics, not copper loops.

HDSL2

HDSL2 addresses HDSL's primary shortcomings of requiring two twisted-pairs and lack of an existing interoperable standard. Over one twisted-pair, HDSL2's performance is similar to that of HDSL with respect to data rates (1.544 Mbps), loop reach, and spectral compatibility.

Whereas HDSL lacked a clear technical standard, HDSL2 embraced standards for elements crucial to vendor interoperability such as line code, spectral shaping, system performance, and forward error correction.

SHDSL

Single-pair HDSL (SHDSL) technology supports bit-rates from 192 kbps to 2.3 Mbps. SHDSL achieves 20% better loop-reach than older versions of symmetric DSL and causes less crosstalk into other transmission systems in the same cable. SHDSL does not carry voice and is primarily deployed for business data applications.

SDSL

Symmetric DSL or single-line DSL (SDSL) evolved, similarly to HDSL2, as a single twisted-pair alternative to HDSL. Prior to HDSL2 and SHDSL's standardization, SDSL budded into many different nonstandard variations. Given that SDSL's maximum data rate and reach (which vary amongst vendor models) remain inferior to HDSL2 and SHDSL, SDSL has since been largely subsumed by the HDSL2 and SHDSL standards.

IDSL

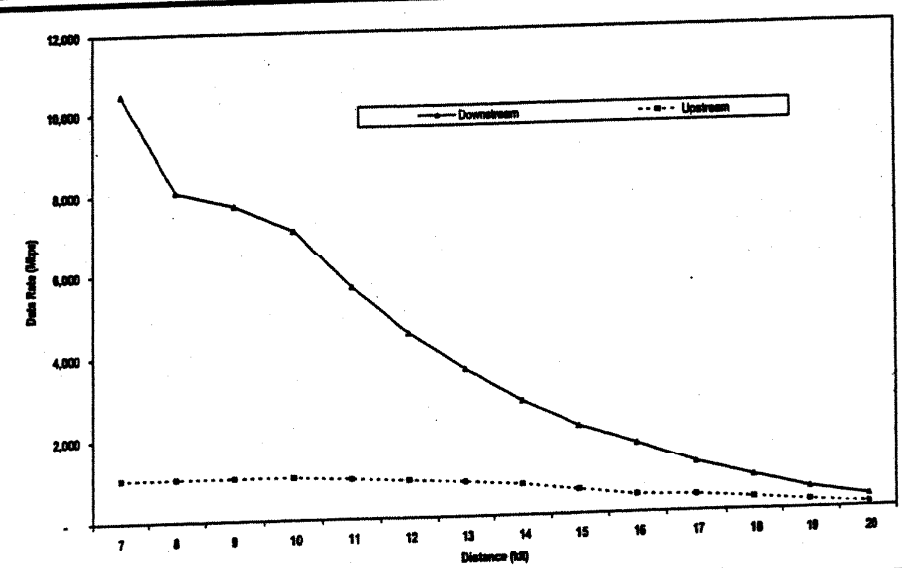
ISDN DSL (IDSL) delivers up to 144 kbps of symmetric bandwidth. IDSL can service customers up to 18,000 feet (3.4 miles) from a central office over a single pair of wires. IDSL is a dedicated data service, whereas regular ISDN integrates voice, data, and video.

ASYMMETRIC TECHNOLOGIES

ADSL

Asymmetric DSL (ADSL, or full-rate ADSL) delivers data rates downstream of six to eight Mbps and upstream of 16-864 kbps. While ADSL's maximum length reach is over 18,000 feet (3.4 miles), data transmission rates decrease for users the further they are from a central office.

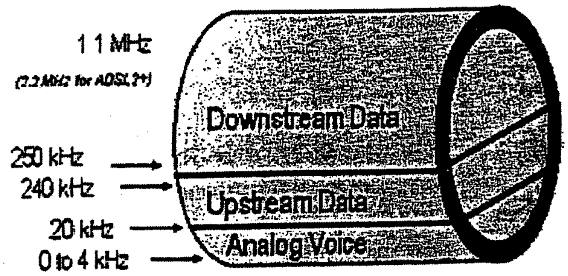
Exhibit 10. ADSL Data Rate Performance



Source: Net to Net Technologies; Bear, Stearns & Co. Inc.

Distinct from the symmetric technologies discussed earlier, asymmetric technology is able to provide plain old telephone service (POTS), which is analog voice service, alongside broadband services. This is achieved by ADSL technology transmitting its signal above the POTS frequency of zero to four kHz. ADSL upstream traffic is carried on the frequency band of 20-240 kHz, while downstream traffic is carried at frequencies from 250 kHz to one MHz.

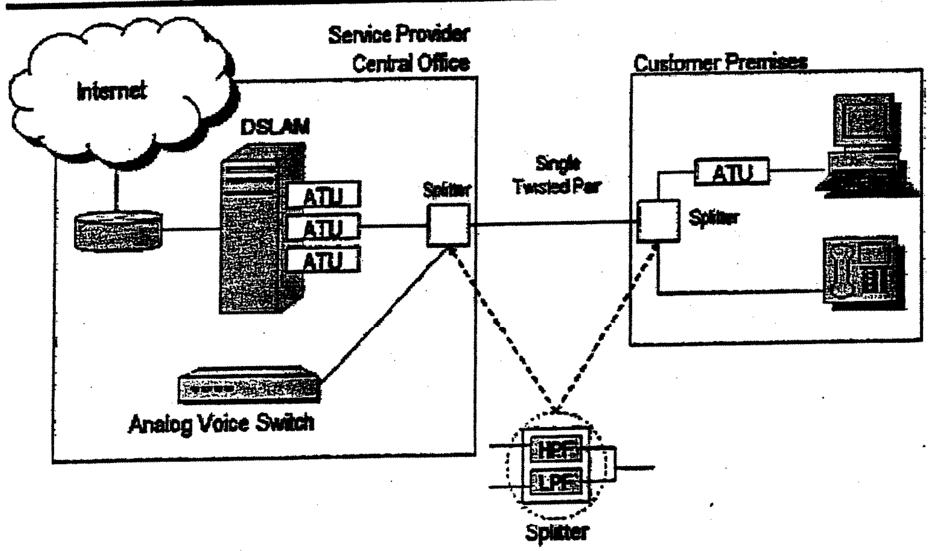
Exhibit 11. ADSL Frequency Allocation



Source: Bear, Stearns & Co. Inc.

As noted, ADSL is the technology of choice for most service provider deployments. As depicted in Exhibit 12 below, both telephones and personal computers are hooked up by phone lines to a DSL splitter that ensures voice signals are sent on the low frequency portion of the line and that DSL is transmitted over the high frequency portion. Signals travel over the POTS network to a carrier's central office where voice signals are terminated on a voice switch and data signals are terminated on a DSLAM.

Exhibit 12. Basic ADSL Configuration



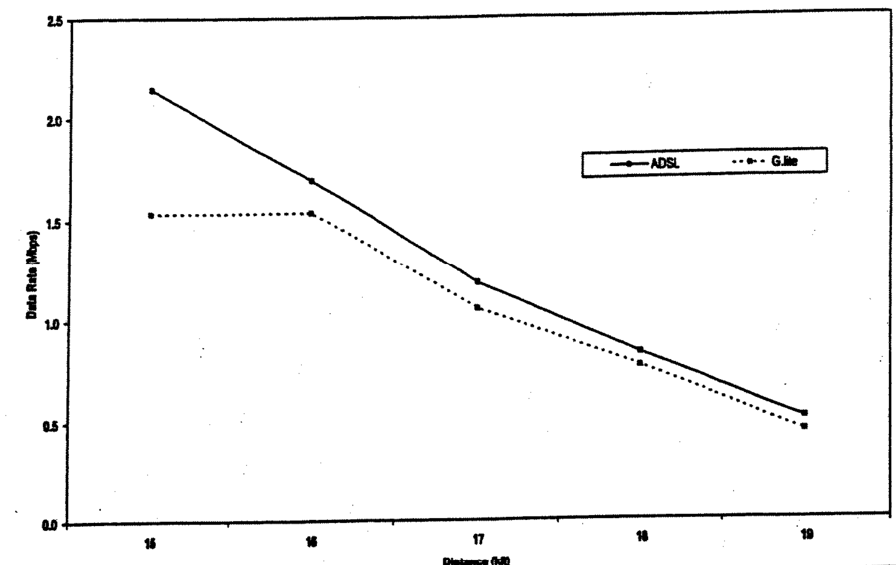
ATU: ADSL Transmission Unit
HPF: High Pass Filter for high speed data
LPF: Low Pass Filter for analog voice

Source: Bear, Stearns & Co. Inc.

G.lite

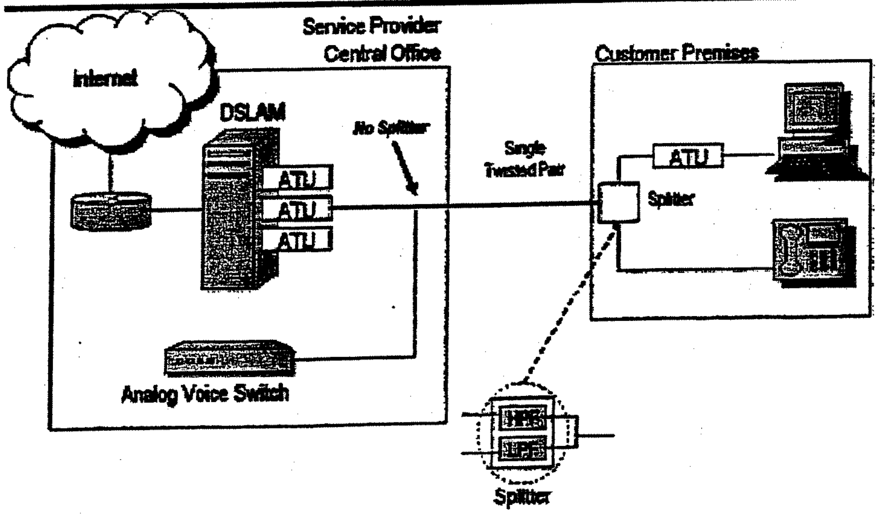
G.lite DSL delivers downstream data rates of 1.5 Mbps and upstream rates of 512 kbps. While G.lite delivers substantially lower data rates than ADSL at short distances, G.lite and ADSL perform at very similar levels at distances greater than 16,000 feet. Furthermore, G.lite does not require a customer premise splitter (as ADSL does) and is faster and cheaper to provision than ADSL. G.lite is a lower powered, less complex technology, engineered specifically for consumer market use.

Exhibit 13. ADSL Versus G.lite Data Rate Performance



Source: Net to Net Technologies; Bear, Stearns & Co. Inc.

Exhibit 14. Basic G.lite Configuration



ATU: ADSL Transmission Unit
HPF: High Pass Filter for high speed data
LPF: Low Pass Filter for analog voice

Source: Bear, Stearns & Co. Inc.

RADSL

Rate-adaptive DSL (RADSL) is a non-standard version of ADSL that can adjust power to the copper loop according to performance fluctuations. We note that standard ADSL also permits the ADSL modem to adapt speeds of data transfer.

ADSL2

ADSL2 is designed to improve the rate and reach of ADSL. ADSL2 delivers 50 kbps more than the prior ADSL standard or, equivalently, extends ADSL's reach by 600 feet.

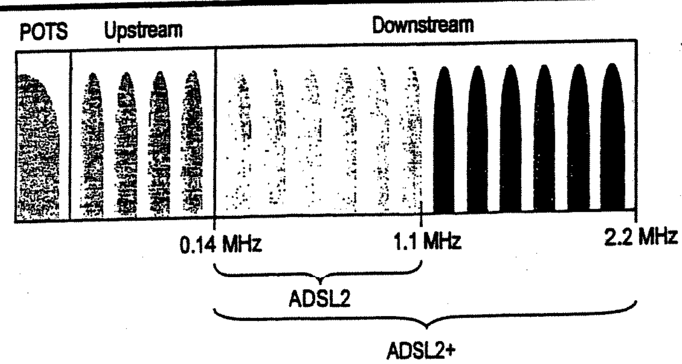
Beyond bit-rate and reach improvements, ADSL2 also enhances ADSL's efficiency, affordability, and functionality, including:

- improved performance with bridged taps and local loop interference;
- interoperability with other ADSL technologies (both full-rate and G.lite);
- diagnostic capabilities that provide precise measurements of line noise, attenuation, and noise at either end of the line;
- reduced initialization time (from approximately ten seconds for ADSL to three seconds);
- power savings and stand-by/sleep modes that reduce overall power consumption and reduce equipment heating problems in remote DSL equipment; and
- optional all-digital mode, which allows for data transmission in the voice bandwidth, adding 256 kbps of upstream data rate.

ADSL2+

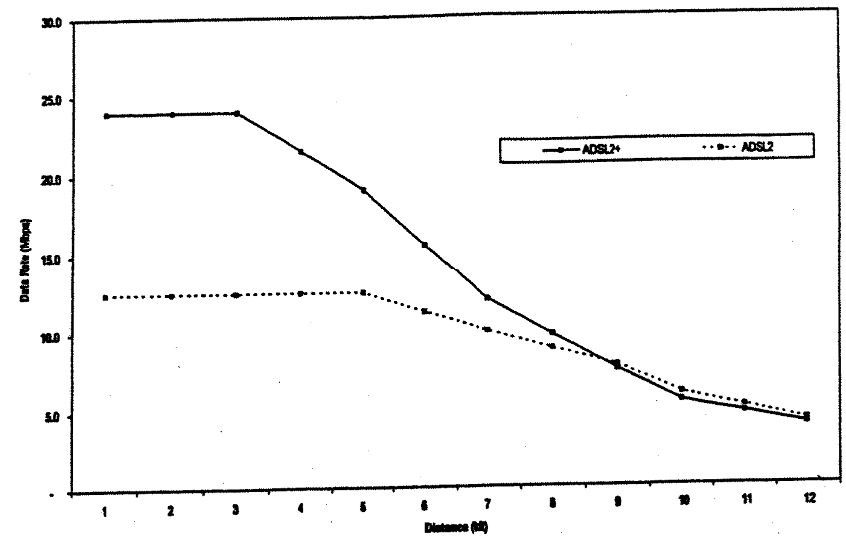
ADSL2+ is an extension of ADSL2 and is the most recent ADSL standard. ADSL2+ doubles the bandwidth used for downstream data transmission, effectively doubling the maximum downstream data rates, thus achieving rates of nearly 20 Mbps on phone lines of less than about 5,000 feet (one mile) from a central office or remote terminal. While ADSL2 specifies a downstream frequency band up to 1.1 MHz, ADSL2+ specifies a downstream frequency up to 2.2 MHz, which doubles data rates over shorter distances.

Exhibit 15. ADSL2+ Downstream Frequency Band Doubles ADSL2



Source: DSL Forum; Bear, Stearns & Co. Inc.

Exhibit 16. Data Transmission Rate Performance: ADSL2 Versus ADSL2+

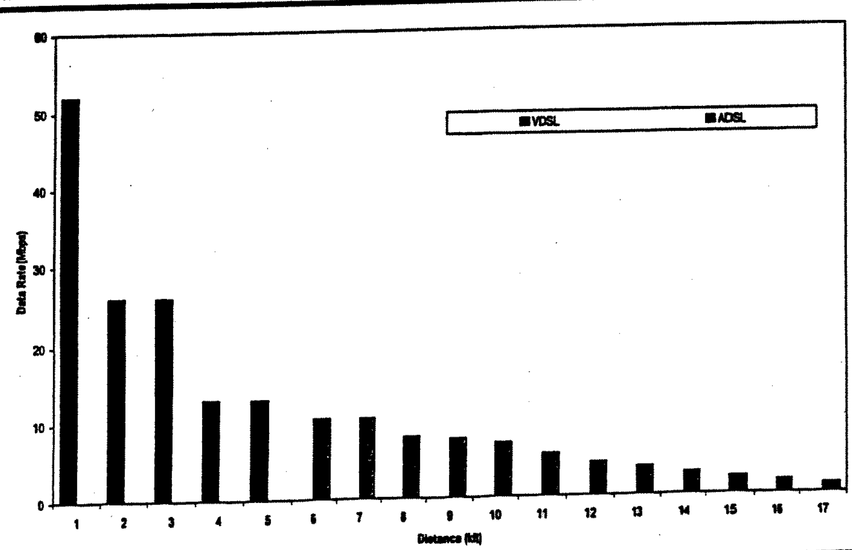


Source: DSL Forum; Bear, Stearns & Co. Inc.

VDSL

Very high bit-rate DSL (VDSL) delivers bit-rates from 13-52 Mbps downstream over short distances on a single twisted-pair, and 1.5 to six Mbps upstream, and operates over distances of 1,000-5,000 feet (0.2-1.1 miles). VDSL is highly sensitive to loop length, and bit-rate performance decreases dramatically at longer distances. Thus, VDSL solutions are likely to incorporate fiber deployment close to the end user. Such combinations make sense as fiber can be short-dropped to a large tenant building with an existing copper infrastructure, and service providers can then run VDSL over the building's copper lines.

Exhibit 17. VDSL and ADSL Data Transmission Rate Performance



Source: DSL Forum; Bear, Stearns & Co. Inc.

VDSL's promise to deliver multimedia applications and possibly allow telephone carriers to compete with cable broadcast has created considerable attention and has spurred continued research. Beyond reach issues, spectral compatibility with other DSL technologies and interference with other services caused by VDSL power levels are still issues. As such, VDSL has yet to be standardized by the ITU.

TODAY'S LOCAL LOOP: THE CHALLENGE OF BROADBAND OVER COPPER

Over the past 120 years, the public switched telephone network (PSTN) has been architected primarily for analog voice transmission. Recently, some of this PSTN backbone has been replaced with fiber optic cable that has, in turn, increased network capacity, efficiency, and quality of service. The legacy network upgrades have largely improved operations up to the local exchange carrier central office. However, the portion of the network from the central office to the end user has been largely left without full-scale upgrades by the local exchange carriers due to high costs. A recent study by Millennium-Skyline found that, as of 2001, 76.3% of all U.S. access lines were served by baseband copper (copper from a central office to end-user premises) and 23.7% of access lines were served by a remote terminal. Of lines served by remote terminals, 75% were fiber-fed (fiber from the central office to the remote terminal). In other words, only about 18% of all access lines in the U.S. are fiber-fed.

Because the local loop remains largely copper-based, many of the issues that face DSL technology deployment center around making the technology compatible with a copper wire that was originally designed for analog voice services. Importantly, over time, modifications were made in the local loop to enhance delivery of voice service. Often, these modifications hinder an LEC's ability to offer the highest speed DSL technologies or prevent these carriers from providing broadband service altogether. Some key barriers to providing copper-based broadband service are highlighted below. We note that over the past several years, tremendous inroads have been made overcoming these technical hurdles.

Loading Coils

One standard problem of both voice telephony and DSL is attenuation, which is the natural loss of signal strength over distance. This is a common problem as local loop length averages about 11,000 feet. Loading coils address copper wire's attenuation problem and have been employed in local loops exceeding 18,000 feet as induction devices that compensate for wire capacitance by boosting voice grade frequencies. Loading coils are usually removed to provide higher speed data services, since these coils block the higher frequencies used for broadband.

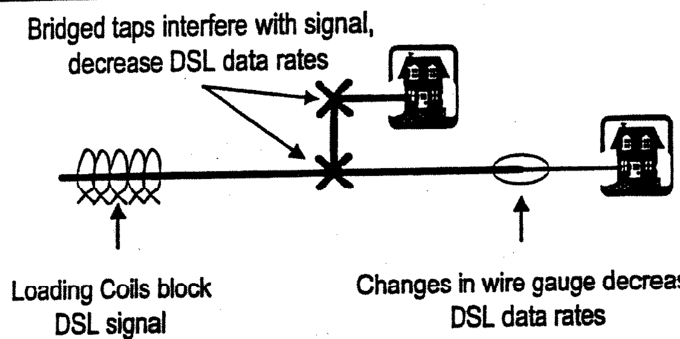
Bridged Taps

Bridged taps are extensions of copper wire from a main line. Since a neighborhood usually has lines in service, it is usually cheaper and easier to tap into existing lines to provide new service than to roll a completely new line to a central office. While bridged taps do not significantly impair voice transmissions, the speed of data transmissions is reduced though their use as electrical signal echoes can occur at the point where the wire terminates at a pair of terminal lugs. A recent study performed by Telcordia estimated that approximately 75% of all telephone lines have some form of bridged tap.

Mismatched Copper Wire

Older networks used a thicker copper wire known as 24 gauge (0.5 mm in diameter), while newer wire is typically thinner (26 gauge, 0.4 mm in diameter). Thinner wire creates more resistance to a signal than thicker wire, so when a signal flows over a connection that employs two different wire gauges, signal energy is lost. Mismatches in wire gauge cause a degradation of DSL signal integrity, which lowers the rate at which data can be transmitted.

Exhibit 18. Local Loop Challenges for DSL Deployment



Source: Bear, Stearns & Co. Inc.

WHERE IS DSL TECHNOLOGY HEADED?

Today, ADSL deployment represents approximately 90% of the DSL market, and the technology will likely continue to dominate in the near term. However, VDSL and ADSL2+ technologies are expected to gain an increasing share of the DSL market and have been a significant focus for continued technological development.

VDSL Versus ADSL2+

VDSL came to market earlier than ADSL2+ and was widely perceived as the DSL technology that would enable "telco TV." With the advent of ADSL2+, a viable DSL video delivery alternative to VDSL emerged. Broadcast quality video speed requirements are approximately three to four Mbps per channel, and ADSL2+ advertises 24 Mbps at 1,000 feet, providing enough bandwidth for several channels. (ADSL2+ lab tests indicate speeds of 23.0-23.5 Mbps, but these tests were running on "clean" laboratory copper. Additionally, wire gauge disparities in the network will play a role in the ultimate speed of the service. It is reasonable to assume, in our opinion, that ADSL2+ throughput should be above 20 Mbps at 1,000 feet.)

VDSL greatly outperforms ADSL2+ at short distances (and recent announcements by chipset manufacturers point to increasing VDSL data rates from 52 Mbps at 1,000 feet to 150 Mbps at the same distance). But as loop lengths increase to 5,000 feet, ADSL2+ performs better than VDSL, and beyond 5,000 feet, VDSL is out of its operability range.

Exhibit 19. Advertised Data Rate Performance of VDSL Versus ADSL2+

Distance (feet)	VDSL (Mbps)	ADSL2+ (Mbps)
1,000	52	24
3,000	26	24
5,000	13	19
7,000	NA	12

Source: DSL Forum.

Beyond reach, ADSL2+'s interoperability with deployed ADSL infrastructure and global standardization make it attractive relative to VDSL. VDSL's wider-spread acceptance and deployment have been inhibited by its lack of a globally recognized, interoperable standard despite being first to market. The ITU is expected to standardize VDSL in the second half of 2003 as code line modulation standards are put in place.

In the near term, ADSL2+ developments will continue to focus on extending the technology's reach, as reach is ADSL2+'s primary comparative advantage relative to VDSL. The ITU is presently considering reach-extended modifications to the ADSL2+ standard, and approval is expected by October 2003. The modified standard will allow a 20%, or 2,500-foot, extension of reach over regular ADSL, while providing equivalent downstream data rates.

As ADSL2+ is largely without a significant commercial track record, VDSL has been selectively deployed in various U.S. cities. Qwest has rolled out the U.S.'s highest-profile VDSL deployment. Qwest has been test marketing this service in the Phoenix, Arizona, and Boulder/Douglas County, Colorado, residential markets. The service utilizes fiber-to-the-neighborhood and then VDSL over the last 4,000 feet to the customer's home. The video service provides 190-250 channels of digital programming including basic, premium, pay-per-view, and music channels; an on-screen interactive program guide with pay-per-view ordering via remote; and on-screen caller ID and voice messaging. The broadband Internet service delivers speeds of up to one Mbps.

Future deployments of DSL technology will increasingly incorporate DSLAMs that are able to utilize both ADSL2+ and VDSL. VDSL will continue to service customers less than 5,000 feet from the LEC central office, and ADSL2+ will be relegated to servicing customers who fall within a 5,000-8,000 foot radius. ADSL2+ will likely not deliver higher data transmission rates than VDSL, but as ADSL2+ continues to extend its reach providing higher bit-rates, ADSL2+-ready DSLAMs will be increasingly deployed as the challenges of local loop length are more effectively addressed by subsequent ADSL2+ versions.

Telecom Versus Cable

DSL IS A STRATEGIC IMPERATIVE

Telecommunications companies use DSL more as a churn reduction tool and means of keeping away competition than a cash flow driver. Improved DSL economics allow telecommunications companies more flexibility in executing these goals and could not have come at a more crucial juncture. We believe that in the next 12 to 24 months, a fierce battle between cable providers and telecommunications providers for consumer expenditures will ensue. In this battle, three components will be necessary: telephony, video, and high-speed broadband. Furthermore, since the spoils of war are likely to be "all or nothing," it is imperative for providers to have all three components and to gain share in each of the components quickly — hence, the urgency on the part of telecommunications companies to quickly add as many broadband subscribers as possible.

Exhibit 20. Residential DSL Versus Cable

	2000A	2001A	2002A	2003E	2004E	2005E
U.S. residential DSL subscribers (millions)	1.5	2.7	4.1	6.0	7.5	9.0
U.S. cable broadband subscribers (millions)	3.6	7.4	11.2	15.7	19.0	21.3
Total U.S. residential broadband subscribers (millions)	5.1	10.1	15.3	21.6	26.5	30.4
U.S. household penetration	*5%*	*10%*	*15%*	*20%*	*25%*	*28%*
New adds – cable:residential DSL ratio	2.0x	2.9x	2.8x	2.4x	2.1x	1.5x
Installed base – cable:residential DSL ratio	2.5x	2.7x	2.7x	2.6x	2.5x	2.4x
Cable – growth in installed base	170%	105%	53%	40%	21%	12%
Residential DSL – growth in installed base	325%	88%	50%	45%	26%	21%

Note: Our residential DSL forecast represents lines in service provided by a vendor directly to a customer. Residential service provided via resale (such as an Internet service provider) falls within the wholesale category.

Source: Bear, Stearns & Co. Inc. estimates.

THE NEED FOR VIDEO

The obvious corollary to the need to quickly add broadband subscribers is telecommunications service providers' requirement to offer video. In our view (and based on recent announcements), satellite partnerships appear to be the stopgap video solution for the largest telecommunications service providers. Video over copper and video over fiber solutions have been deployed by some smaller and/or rural telecommunications service providers. Larger telecommunications service providers are not likely to deploy these wireline video solutions on a large scale for several years.

Satellite: The Interim Solution

As we noted, it is our belief that partnering with a satellite-based multichannel video provider is the most viable and practical way for telecommunications service providers to compete with cable service providers and their impending ability to offer voice, video, and broadband Internet access. For example, three recent deals point in this direction.

On July 21, SBC Communications and EchoStar Communications announced a strategic partnership that will give SBC the ability to market co-branded "SBC DISH Network" multichannel television services as a fully integrated part of SBC's bundled services.

The two companies have begun work on integrating operations, including order entry, customer service, and billing. In our opinion, this is a crucial component for success: Previous telecommunications company/satellite deals were merely co-marketing arrangements that lacked the back-office integration necessary for a seamless customer experience. When SBC DISH Network service is rolled out, customers will be able to place their order, arrange for installation, and activate their service with one phone call. SBC DISH Network customers will be billed for their television services on a single SBC bill along with their other SBC voice and data services. As part of the multi-year agreement, SBC Communications will also help fund the development of the co-branded bundled video services.

Also important is that SBC will manage the customer relationships for SBC DISH Network service. In other words, SBC will "own" the customer from a marketing and lifetime customer-relationship perspective.

The newly announced partnership is mutually exclusive for single-family residences throughout the SBC 13-state traditional service area (i.e., SBC cannot strike a similar deal with another satellite provider and EchoStar cannot strike a similar deal with another telecommunications service provider in those territories). SBC provides service to more than 56 million access lines in its 13-state operating region.

Current plans call for SBC DISH Network service to be available to new and existing DISH subscribers beginning in first-quarter 2004. Pricing for the service has not yet been released. SBC also has not disclosed the length of the agreement, revenue, or profit sharing arrangements with EchoStar, or the investment in back-office integration that will be required for the venture to be successful.

SBC and EchoStar also disclosed that the companies are jointly developing co-branded set-top boxes that will ultimately integrate DSL, video, and wireless home networking capabilities. The timing of the release of such a device has not yet been determined.

Also on July 21, Qwest announced that it has signed a strategic marketing agreement with EchoStar. Qwest will make DISH Network satellite TV services available to its customers in single-family homes in Colorado and Nebraska, and will roll out these services to more markets throughout the remainder of 2003 and into 2004. Qwest and EchoStar are exploring migrating to a more integrated model in the first half of 2004, where Qwest will be the primary interface for various customer interactions including service and billing. This is in contrast to the SBC deal in which back-office integration of order entry, customer service, and billing will be present from the onset.

Under a separate strategic marketing agreement announced on July 21 with DIRECTV, Qwest will make satellite TV services available to its customers in single family homes in Phoenix and Tucson, Arizona, and Seattle. The company expects to roll out these services to more markets throughout the remainder of 2003 and into 2004. As with the EchoStar deal, Qwest and DIRECTV are exploring migrating to a more integrated model in the first half of 2004 where Qwest will be the primary interface for various customer interactions including service and billing. In addition, Qwest and DIRECTV have extended their existing agreement for DIRECTV to be the exclusive digital satellite TV provider for multiple dwelling unit (MDU) properties in those territories where Qwest provides video programming services.

On August 27, BellSouth and DIRECTV announced a strategic marketing alliance to sell digital satellite television as part of the BellSouth Answers product bundle. The offer covers residential service; DIRECTV will be BellSouth's exclusive partner for DBS digital satellite television in-region, though DIRECTV will still be able to market directly to customers in the BellSouth territory. BellSouth will also continue to market its Americast wireline video service in the areas where the service is offered. BellSouth currently has about 200,000 video customers in the Atlanta and Miami areas.

Under the terms of the agreement, BellSouth will market, sell, and schedule the install for DIRECTV service, and DIRECTV will install the DIRECTV System hardware. Customer revenue will be recognized by DIRECTV, and BellSouth will receive some fees and commission revenue. Service will begin in early 2004 throughout the entire nine-state BellSouth region.

Customers will be able to call one number to order DIRECTV and BellSouth services, and will be able to include DIRECTV video service on their BellSouth bill. Customers will receive product discounts and bundling multiple service offerings. Pricing and programming details have not yet been announced.

DIRECTV and BellSouth also announced plans to begin exploring the integration of digital satellite and DSL technology, including options for enhanced networking solutions over the BellSouth fiber network. BellSouth expects fiber-to-the-curb to pass about one million in-region homes by year-end 2003.

Video over the Copper Last Mile

Offering video over their own plant could offer telecommunications service providers more service flexibility and cost effectiveness versus a satellite partnership. Conversations we have had with network and engineering executives at telecommunication service providers indicate that while video over DSL may be technically feasible in the next 24 months, there are several practical hurdles.

- **Loop Length Limitations.** Based on our research and discussions with equipment providers, we believe that service providers could comfortably provide two video streams, 1Mb of data, and one voice channel over 8.7Mb of capacity utilizing ADSL2+ technology. This assumes a 3.8 Mb requirement per video channel (though several service providers we spoke with found that they could provide high-quality MPEG2 video using 3.5 Mb of capacity per channel) and accounts for overhead and less-than-ideal network environments. A solution requiring 8.7 Mb of capacity would limit service to loop lengths under 9.5-10.5 kft from a central office (depending on the wire gauge and quality of copper in the network). We estimate that 55%-60% of loops in the U.S. are in this distance range.

- **Programming Costs.** We estimate providing video service would cost a service provider $12 per subscriber per month in programming fees.

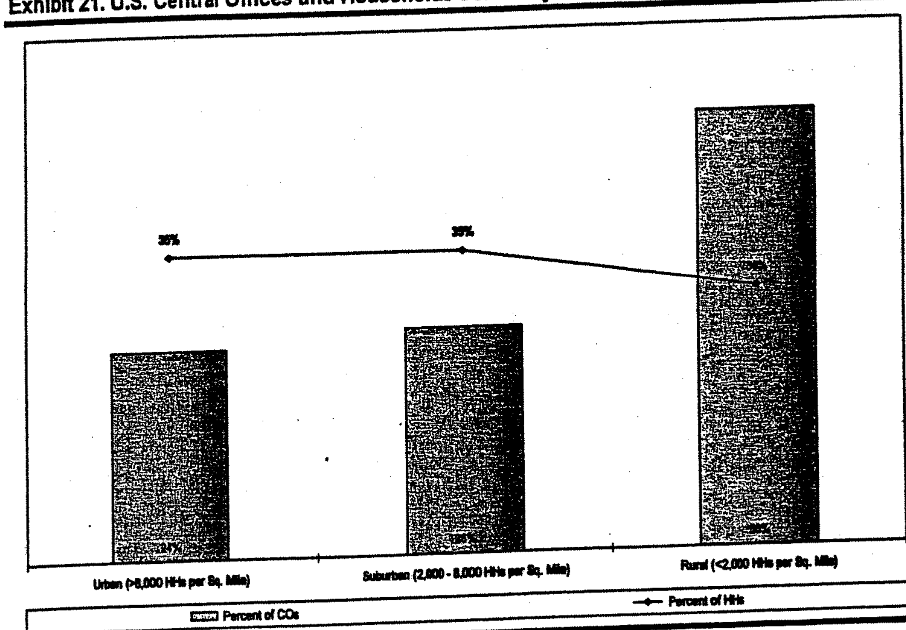
- **Additional Infrastructure Required.** Video over DSL solutions require the installation of set-top boxes that are particular to DSL-based service. Because initial video over DSL implementations will be limited, the cost of these boxes will be high versus mass-market cable boxes.

DSL Households Passed and Penetration

DSL households passed is being driven by the economic factors noted previously, namely falling CPE and provisioning costs, increased marketing (bundling) of DSL alongside other product offerings, and declining equipment pricing. At the end of 2002, we estimate 63% of U.S. households had DSL service available to them. Driven by improving economics, and partly by fear of the cable companies, telecommunications services companies are continuing their DSL buildouts. We anticipate 70% of U.S. households will be passed by the end of 2003, and that 80% of households will be passed by the end of 2005.

In addition, two technical trends are driving increased penetration. First, service providers are pushing deeper into their footprint into more rural areas. Approximately 30% of U.S. households and 50% of central offices are in rural areas.

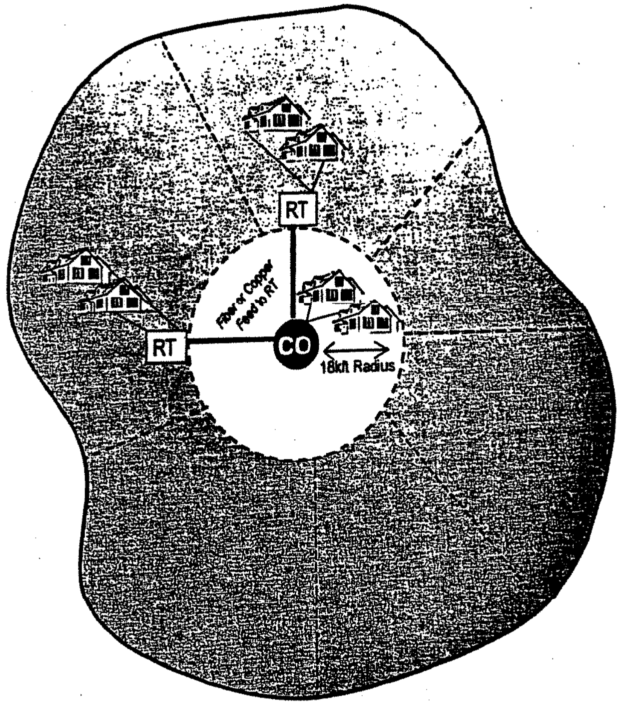
Exhibit 21. U.S. Central Offices and Households Served by Density



Source: TMNG Strategy.

The second driver of increasing household coverage is the deployment of remote terminals. As we have noted, most customers can receive DSL service if they are within a radius of about 18,000 feet of a central office. Remote terminals are essentially smaller facilities (often the size of a large cabinet) that function as a central office in areas where a full central office is not warranted or available. Where a remote terminal has been fitted with special equipment, DSL service can be extended beyond the traditional 18 kft radius to additional customers. Verizon, for instance, has indicated that it plans to upgrade 3,500-4,000 RTs to have DSL capability in 2003. These upgrades account for 50%-60% of Verizon's planned household coverage improvement (to 80% of households by year-end 2003 from 57% at year-end 2002).

Exhibit 22. DSL Deployment from Central Offices and Remote Terminals



Source: Bear, Stearns & Co. Inc.

Exhibit 23. DSL-Enabled Remote Terminals in Service by Service Provider, 2Q03

Provider	Remote Terminals
BellSouth	12,000
Cincinnati Bell	144
Quest Communications (1Q03)	1,562
SBC Communications	7,608
Verizon	675

Source: Company reports.

Exhibit 24. DSL Households Passed by Service Provider, 2Q03

Provider	Households Passed
ALLTEL	57%
BellSouth	74%
CenturyTel	60%
Cincinnati Bell	85%
Citizens	60%-65%
Commonwealth	~65%
SBC Communications	66%
Sprint	53%
Verizon	67%

Source: Company reports.

Exhibit 25. DSL Penetration of Qualified Lines, 2Q03

Provider	Penetration of Qualified Lines
ALLTEL	5.8%
BellSouth	8.1%
CenturyTel	4.7%
Cincinnati Bell	9.0%
Citizens	6.1%
Commonwealth	5.2%
SBC Communications	9.0%
Sprint	5.3%
Verizon	3.3%

Source: Company reports; Bear, Stearns & Co. Inc. estimates.

Exhibit 26. Bear Stearns DSL Subscriber and Subscriber Penetration Forecast

	1999E	2000E	2001E	2002E	2003E	2004E	2005E
INSTALLED LINES							
Total installed DSL lines (millions)	0.5	2.2	4.3	6.4	9.2	11.8	14.4
Growth in installed lines	*1193%*	*341%*	*92%*	*50%*	*43%*	*29%*	*22%*
Net adds (millions)	*0.5*	*1.7*	*2.0*	*2.1*	*2.7*	*2.7*	*2.5*
Growth in net adds		*269%*	*19%*	*5%*	*27%*	*-3%*	*-4%*
Installed residential lines (millions)	0.3	1.5	2.7	4.1	6.0	7.5	9.0
% total DSL lines	*68%*	*66%*	*64%*	*64%*	*65%*	*64%*	*63%*
Growth in installed lines	*1156%*	*325%*	*88%*	*50%*	*45%*	*26%*	*21%*
Net adds (millions)	*0.3*	*1.1*	*1.3*	*1.4*	*1.8*	*1.5*	*1.5*
Growth in net adds		*253%*	*14%*	*8%*	*34%*	*-16%*	*-1%*
Installed business/wholesale lines (millions)	0.2	0.8	1.5	2.3	3.2	4.3	5.3
% total DSL lines	*32%*	*34%*	*36%*	*36%*	*35%*	*37%*	*37%*
Growth in installed lines	*1279%*	*374%*	*101%*	*50%*	*39%*	*35%*	*23%*
Net adds (millions)	*0.1*	*0.6*	*0.8*	*0.8*	*0.9*	*1.1*	*1.0*
Growth in net adds		*303%*	*28%*	*0%*	*16%*	*24%*	*-10%*
RESIDENTIAL PENETRATION							
U.S. households (millions)	102.1	103.2	104.3	105.5	106.6	107.7	108.8
U.S. household penetration of DSL	*0%*	*1%*	*3%*	*4%*	*6%*	*7%*	*8%*
U.S. residential access lines (ILECs only, in millions)	115.9	117.8	119.1	115.9	112.4	109.0	106.3
Access lines per household	1.1	1.1	1.1	1.1	1.1	1.0	1.0
U.S. households passed for DSL service	25%	40%	50%	63%	70%	77%	80%
U.S. households passed for DSL service (millions)	26	41	52	66	75	83	87
U.S. DSL penetration of homes passed	*1%*	*4%*	*5%*	*6%*	*8%*	*9%*	*10%*

Note: Our residential DSL forecast represents lines in service provided by a vendor directly to a customer. Residential service provided via resale (such as an Internet service provider) falls within the wholesale category.

Source: Bear, Stearns & Co. Inc. estimates.

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