



Association of Communication Engineers

*Applications, Challenges
and Emplacement
of
Broadband Services*

xDSL and Copper Pair Bonding

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Telecom Engineers

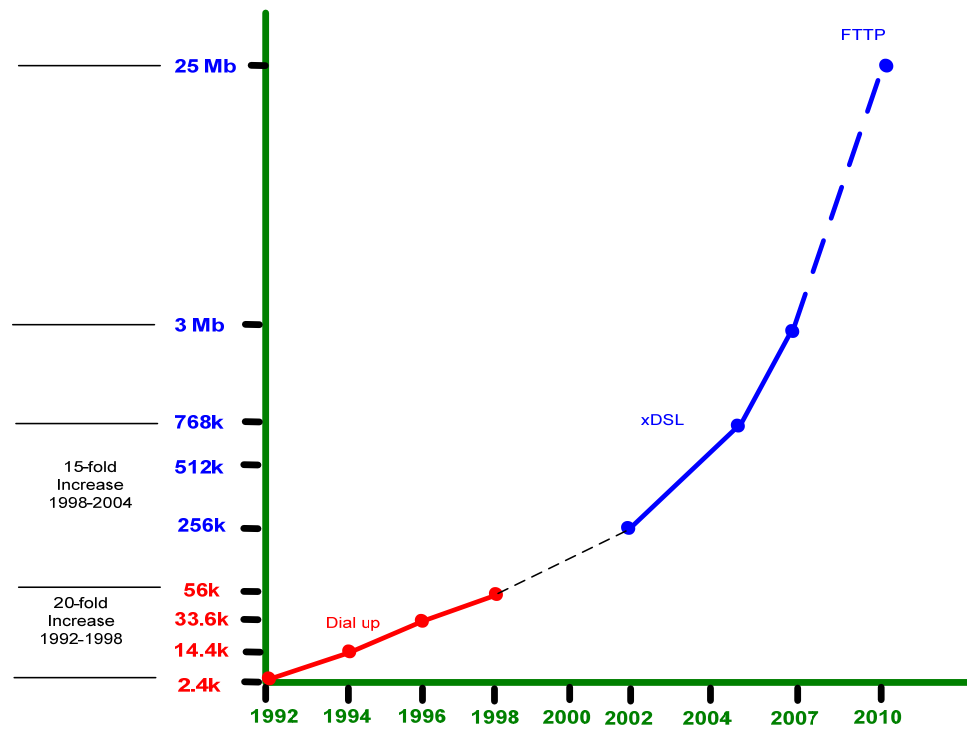
Columbia, MO



xDSL and Pair Bonding

- Objectives—what are we trying to do?
- What are the “big boys” doing?
 - Verizon FiOS
 - Qwest
 - AT&T U-Verse
- What is VDSL and how does it differ from ADSL?
- Rate and Reach
- How much do we get from pair bonding?

Common Bandwidths Available So Far

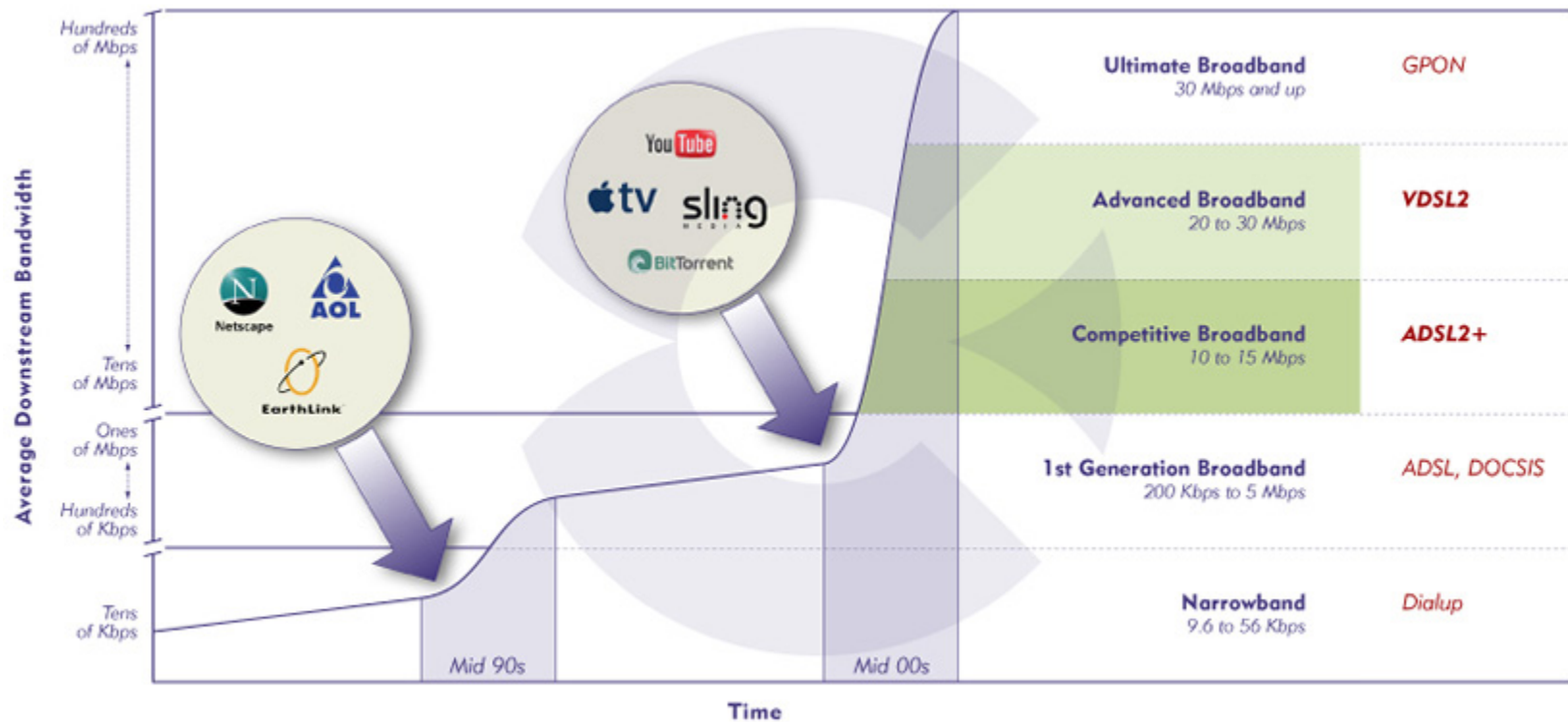


Common "Internet" Access Speeds Available

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Internet Access Technologies and Services

- From the Calix web site:





Service Objectives

- “Just” selling access or also delivering a product—e.g. IPTV or RF CATV
- An “Internet” access company that also offers access to the “telephone” network
- Bandwidth capabilities
- Verizon FiOS
- AT&T U-verse
- Qwest’s vision



Verizon FiOS

- A fiber to the premises . . . service . . . Verizon is also developing a television service with its fiber optic lines, and is expected to become a major competitor of local cable television companies over the next 10 years (for \$23 billion, they should become major players!). It will compete with current “Triple Play” offers, where the local cable company offers broadband Internet access, digital cable, and VoIP telephone service.
- Verizon added 1.5 million FiOS Internet customers and 943,000 FiOS TV customers in 2007, penetration rates of 21% and 16%, respectively. Its consumer sales are centered increasingly on selling a bundle, and that is helping the company retain wireline customers where it sells FiOS. . . Residential line loss for the fourth quarter was 616,000 lines, better than the third quarter of 2007 (664,000) but up slightly from a year ago.

Telephony Online --Jan 11, 2008



The Qwest Vision

- “We believe very much in video, and we also believe in the power of the Internet,” . . . “We are trying to look a little ahead. The young consumers of the future will want broadband on demand, and they are more interested in interaction and in the symmetry of the service. What we want to be able to provide is that 20-Megabit Internet connection that is more important to the younger consumers of today. –Qwest CTO Pieter Poll
- Ultimately, what Qwest expects to deliver is an Internet connection at speeds of up to 38 Megabits per second, using VDSL 2 technology and pair-bonding, and offering much faster upstream bandwidth than Internet services do today. And instead of using up part of that bandwidth to deliver its own IPTV service, Qwest will be open to allowing its customers to find what it believes will be available HD VoD on the Internet.

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AT&T U-verse

- AT&T's U-Verse is the “triple-play” provided over IP”, including television service, Internet access, and POTS service.
- “AT&T repeatedly has cited VDSL2 pair bonding in response to questions about whether its fiber-to-the-node (FTTN) architecture includes enough bandwidth to satisfy consumer demand, especially for multiple channels of high-definition television. . . in January an AT&T executive pegged “late 2008” for its introduction.”
- “Alcatel-Lucent, AT&T's FTTN supplier, said its VDSL2 bonding gear is ready, but in order to be deployed it must be integrated into CPE.”

--Telephony Online Mar 17, 2008



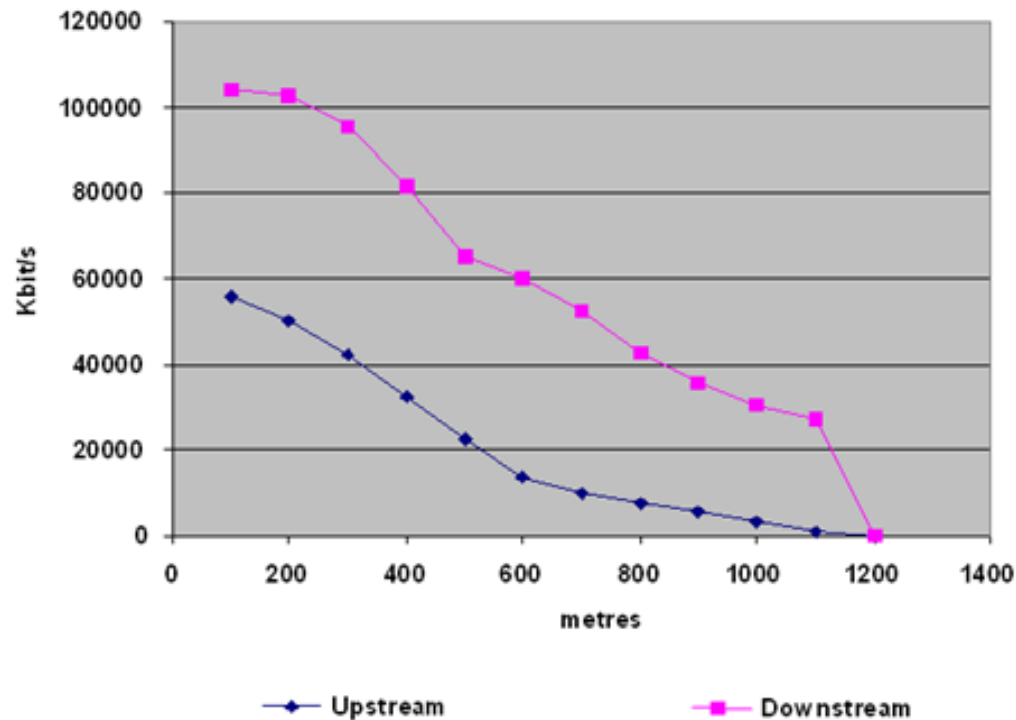
ADSL and VDSL Standards

- ADSL, ADSL2 and ADSL2+ are G.992.x ITU Standards
- VDSL and VDSL2 are G.993.x ITU Standards
- VDSL 2 ITU-T G.993.2 (VDSL2) is an enhancement to G.993.1 ([VDSL](#)) that permits the transmission of asymmetric and symmetric (Full-Duplex) aggregate data rates up to 200 Mbit/s on twisted pairs using a bandwidth up to 30 MHz.

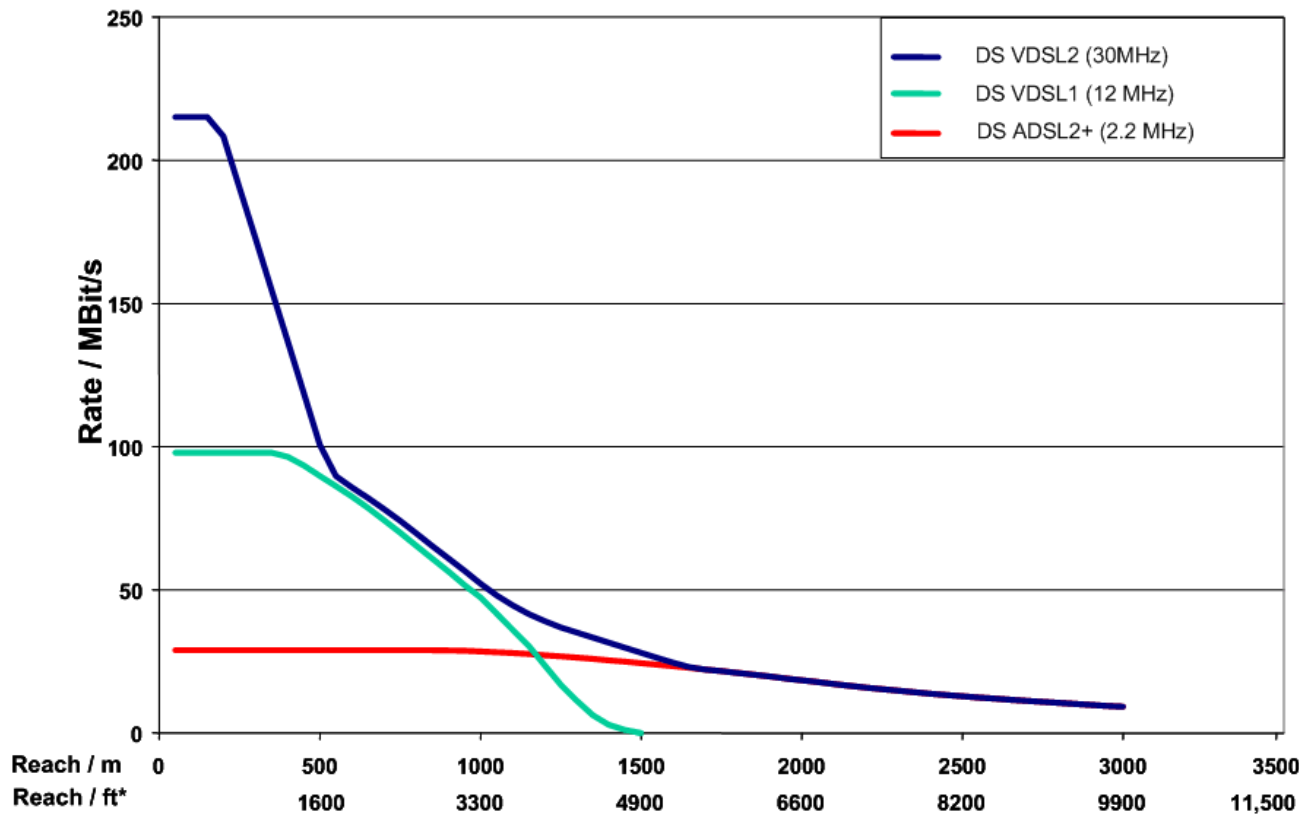
VDSL 2 rate/reach

from www.lightreading.com attributed to Ericsson

VDSL2, FTTCab M2, profile 17a (no U0)
14.5dBm, -130dBm/Hz AWGN, AWG26



Rate and Reach for ADSL2+, VDSL1 and VDSL2



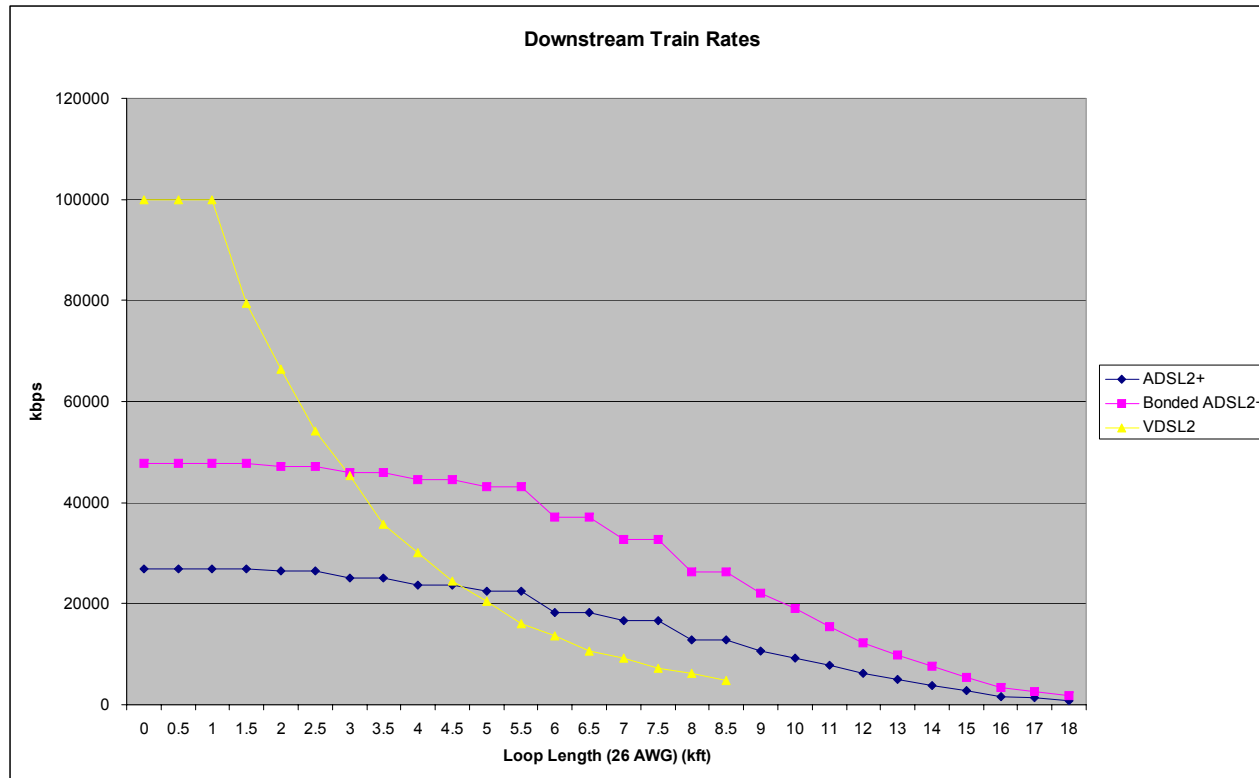
* Numbers are rounded

Comparison VDSL2, VDSL1 and ADSL2+, Downstream rate/reach performance

Source: www.netsys.com

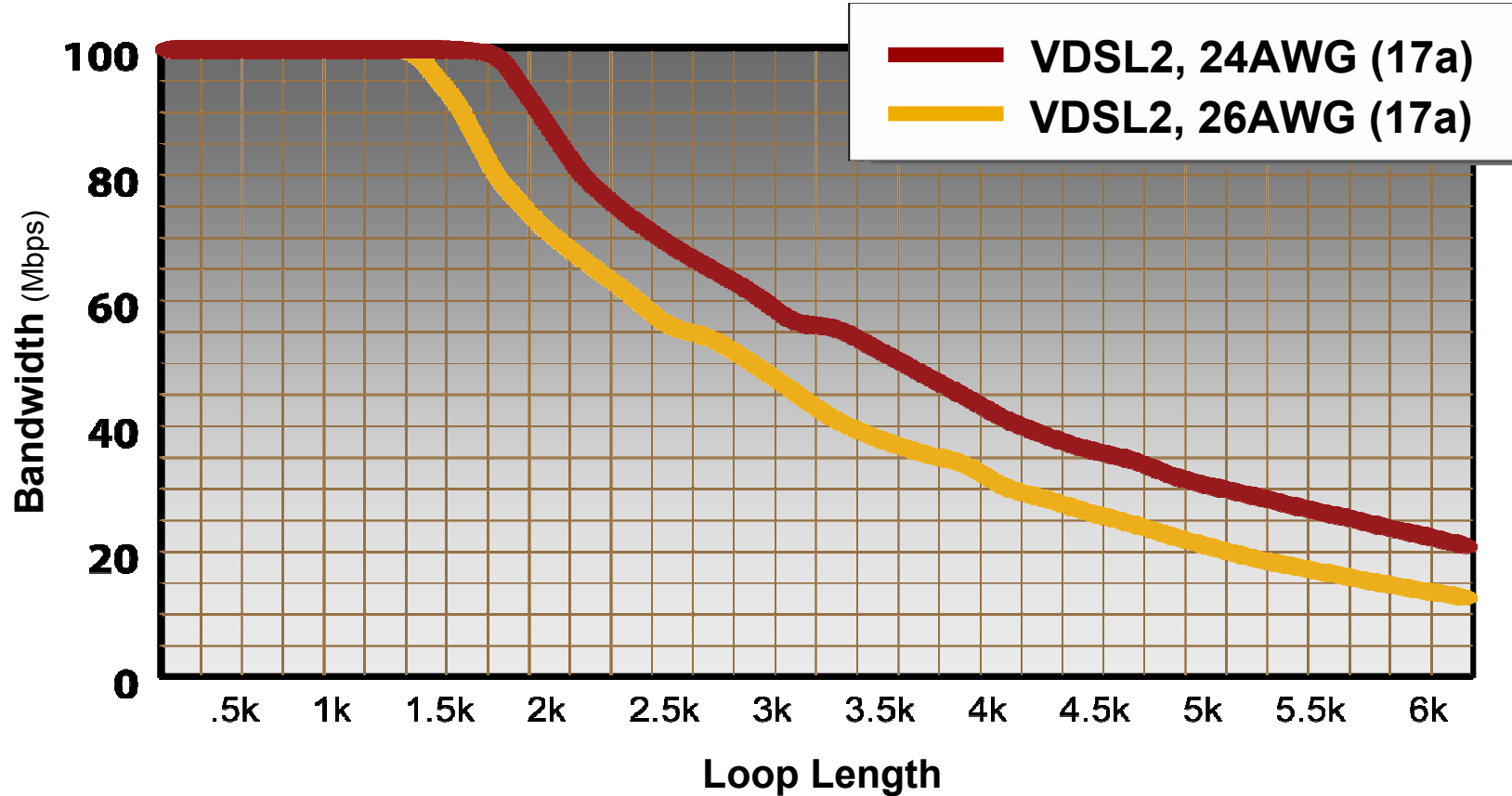
Rate and Reach for non-bonded and bonded ADSL2+, and VDSL2

- Courtesy of Calix:



Rate and Reach for VDSL2 on 24- versus 26-gage cable

■ Courtesy of Calix:





Results of Pair Bonding

How many cable pairs do you have available?

- Using pairs in separate binder groups we can almost double the bandwidth by using two pairs
- Using pairs in the same binder group we might get only a 25% bandwidth increase



VDSL2 modems

About \$130

- Fluke Networks
- Premier
- ZyXEL
- Siemens
- Several others



Conclusions

The access speed our industry provides is climbing exponentially with time

Consider objectives—raw bandwidth?, IPTV?

How much bandwidth do you *really* think you'll need to deliver in, say, 5 years? Won't that copper last you for a few more years?

VDSL is a short-range technology—5000 feet or less

Because of cross-talk, pair bonding is most effective using pairs from different binder groups

VDSL is available today and modems are relatively cheap