



International Telecommunication Union

ITU-T xDSL Standards

Study Group 15 - Question 4

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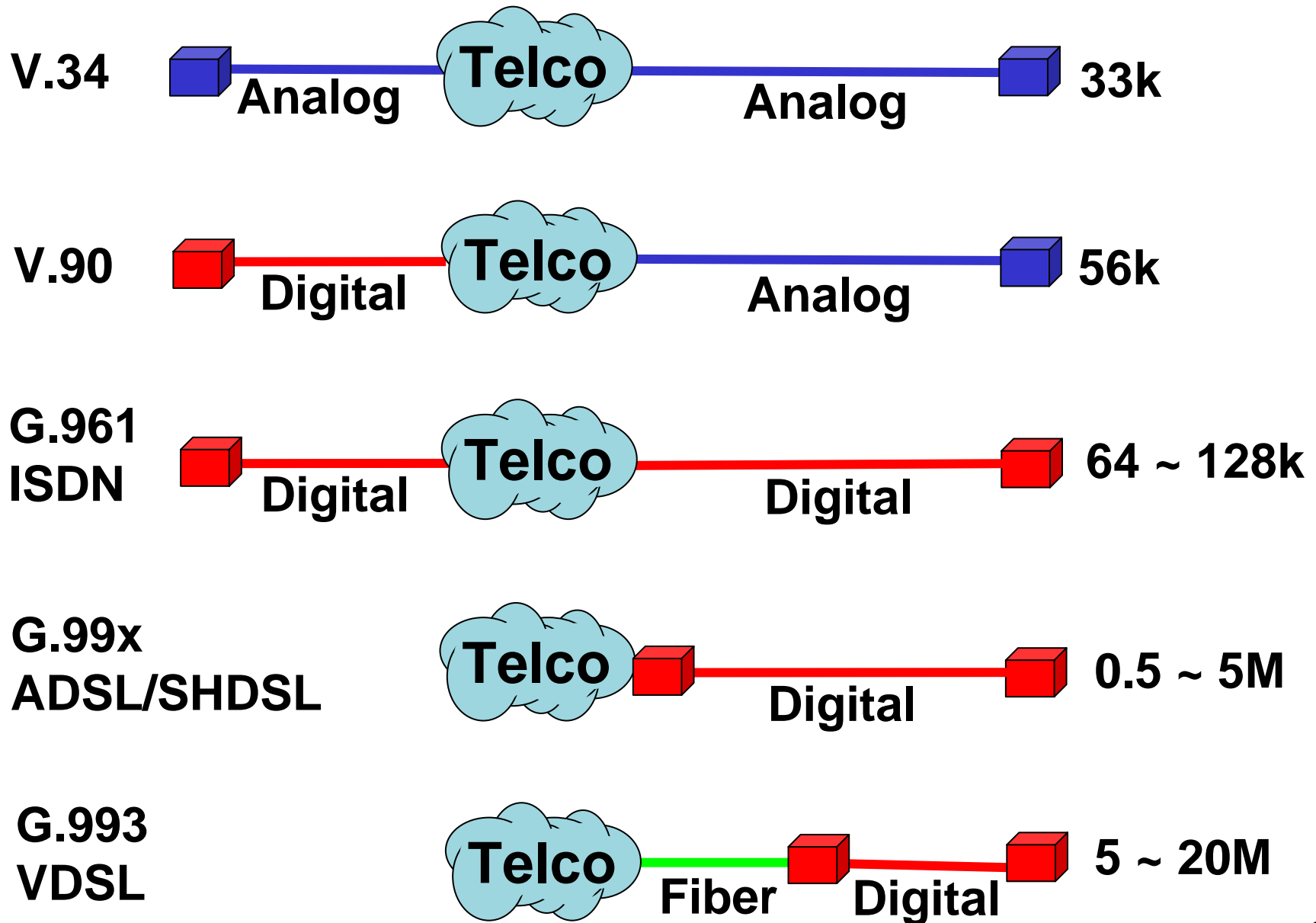
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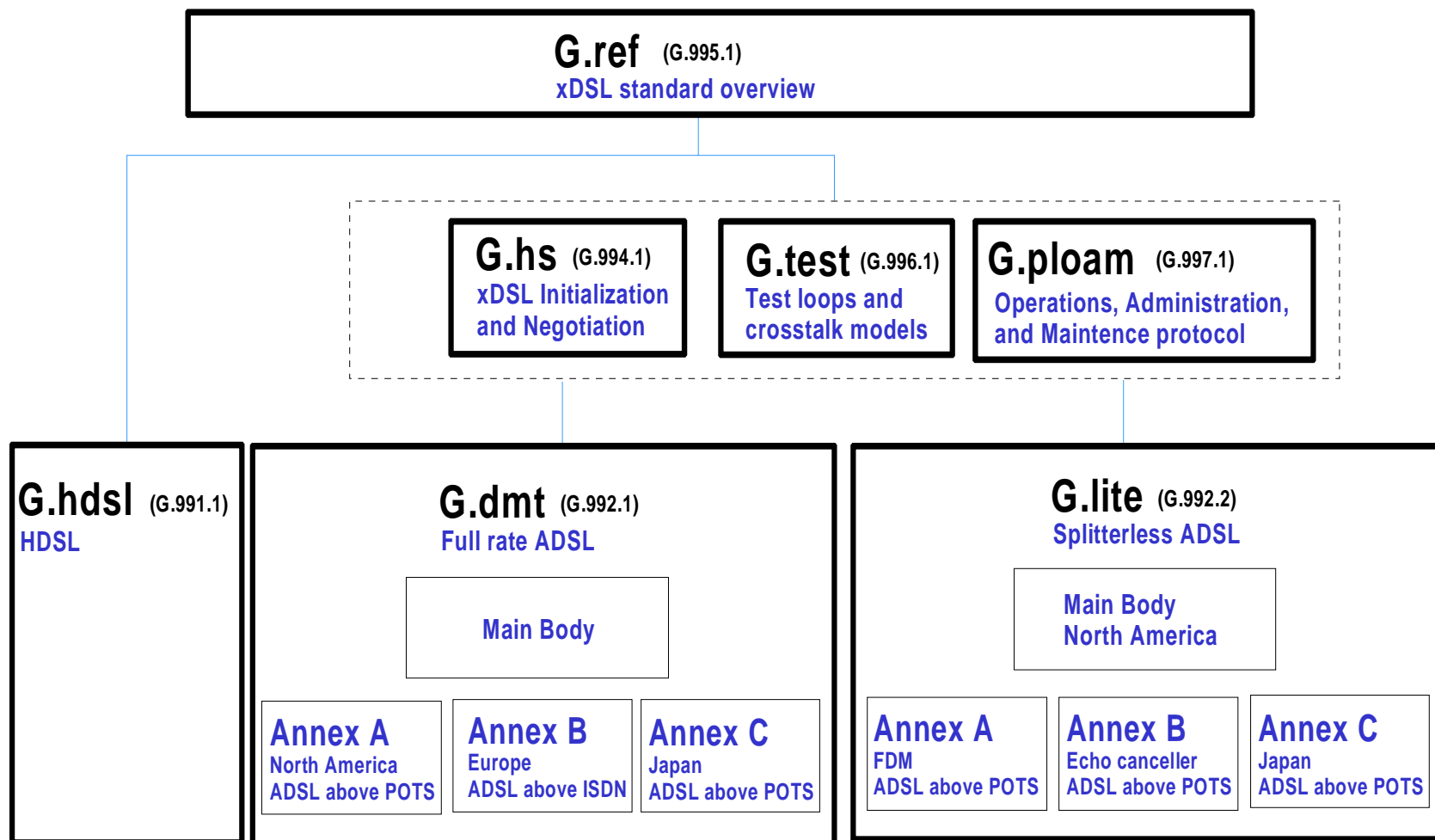
Access Trend



ITU Q4/15 Milestones

- o 1997 - First Meetings
- o 1998 - First Recommendation - G.hsdl
- o 1999 - ADSL set of Recommendations
- o 1999 - G.vdsl initiated
- o 2001 - G.shdsl
- o 2002 - ADSL2
- o 2003 - ADSL2+
- o 2004 - G.vdsl and line code decision

ITU-T xDSL Standards 1999



Splitterless ADSL (G.992.2 / G.lite)

- G.lite (G.992.2) similar to G.dmt (G.992.1)
- Two distinctions for consumer market:
 - Splitterless operation
 - Power management states
- Splitterless:
 - No truck roll to install splitter at NID
 - But need fast retrain and possibly microfilters
- Although “hot” in 1999, majority of deployments now use full-rate ADSL

ADSL (G.992.1 - a.k.a G.dmt)

- Asymmetrical Digital Subscriber Line
- Downstream (to the subscriber) rates ~0.5 to 5 Mbps
- Upstream rates of approximately 100 to 500 kbps.
- For a 1 Mbps downstream rate, the range is ~ 5 km (depends on cable gauge)
- ADSL modulation (line code) = discrete multitone (DMT).
- 3 Variants (Annexes) for North America, Europe, and Japan

xDSL Handshake - G.994.1

- Common activation (handshake) procedure for all xDSL modems.
 - ADSL, VDSL, SHDSL, ANSI, ETSI, IEEE EFM
- Extremely robust modulation
 - Works on all lines even with bridge taps
- Forward compatibility for all new xDSL modem standards.
- Higher layers can indicate service and application requirements
 - Select most appropriate DSL.
 - Flexibly tailor the service bandwidth and latency.

xDSL Support Recommendations

- G.996.1 (G.test) - testing procedures for DSL modems.
 - Useful during manufacturer design and development.
 - Not procedures for installing DSL modems.
- G.997.1 (G.ploam) - physical layer management protocol for ADSL systems.
 - Control data exchange on a sub-channel of the DSL modems.
 - Uses a SNMP MIB to easily integrate with existing network management systems.
- G.995.1 (G.ref) - provides a reference and overview of the DSL family of Recommendations.

ITU-T xDSL Standards 2004

<u>Rec</u>	<u>Anx</u>	<u>Description</u>	<u>Date</u>
G.991.1	A	Two Pair	Oct-1998
	B	CAP Modulation	Oct-1998
G.991.2	A	Requirements - North America	Feb-2001
	B	Requirements - Europe	Feb-2001
	C	Requirements - Japan	G.992.1 Anx H
	D	Signal regenerator	Feb-2001
	E	TPS-TC Framing	Feb-2001
	F	North America Rates to 5.696M	Dec-2003
	G	Europe Extend Rates	Further Study
	H	Warm Start	Dec-2003
G.992.1	A	ADSL over POTS	Jun-1999
	B	ADSL over ISDN	Jun-1999
	C	ADSL near TCM-ISDN	Jun-1999
	D	State Diagrams	Jun-1999
	E	Spiltters	Jun-1999
	F	Performance - North America	Jun-1999
	G	Performance - Europe (minimal)	Jun-1999
	H	Symmetric near TCM-ISDN	Oct-2000
	I	Short ADSL near TCM-ISDN	Mar-2003
G.992.2	A	Non-overlapped spectrum	Jul-1999
	B	Overlapped Spectrum	Jul-1999
	C	ADSL near TCM-ISDN	Jul-1999
	D	Performance - North America	Jul-1999
	E	Performance - Europe	Jul-1999

<u>Rec</u>	<u>Anx</u>	<u>Description</u>	<u>Date</u>
G.992.3	A	ADSL2 over POTS	Jul-2002
	B	ADSL2 over ISDN	Jul-2002
	C	ADSL2 near TCM-ISDN	Jul-2002
	D	State Diagrams	Jul-2002
	E	Spiltters	Jul-2002
	F	Performance - North America	Jul-2002
	G	Performance - Europe (minimal)	Jul-2002
	H	Symmetric near TCM-ISDN	Jul-2002
	I	All digital ADSL near POTS	Jul-2002
	J	All digital ADSL near ISDN	Jul-2002
	K	TPS-TC functional descriptions	Jul-2002
	L	READSL2 over POTS	Apr-2004
	M	ADSL system with extended upstr	Apr-2004
G.992.4	A	ADSL2 over POTS	Jul-2002
	B	void	N/A
	C	ADSL2 near TCM-ISDN	Further study
	D	State Diagrams	G.992.3
	E	No spiltters	N/A
	F	Performance - North America	Further study
	G	void	N/A
	H	void	N/A
	I	All digital ADSL near POTS	Jul-2002

<u>Rec</u>	<u>Anx</u>	<u>Description</u>	<u>Date</u>
G.992.5	A	ADSL2+ over POTS	May-2003
	B	ADSL2+ over ISDN	May-2003
	C	ADSL2+ near TCM-ISDN	Further study
	D	State Diagrams	G.992.3
	E	Spiltters	G.992.3
	F	Performance - North America	Further study
	G	Performance - Europe (minimal)	Further study
	H	Symmetric near TCM-ISDN	Further study
	I	All digital ADSL near POTS	May-2003
	J	All digital ADSL near ISDN	Further study
G.993.1	K	TPS-TC functional descriptions	G.992.3
	L	READSL2 over POTS	Further study
	A	Assymetric BandPlan	Nov-2001
	B	Symmetric BandPlan	Nov-2001
	C	Fx BandPlan	Nov-2001
	D	Requirements - North America	Further study
	E	Requirements - Europe	Further study
	F	Requirements - Japan	Further study
	G	ATM-TC	Nov-2001
	H	PTM-TC	Nov-2001
G.994.1	I	SCM	Jun-2004
		Handshake	Living
		xDSL Overview	Living
		Test Loops and Conditions	Living
		Operations and Maintenance	Living

VDSL - G.993.1

- Very-high-speed Digital Subscriber Lines
- Asymmetric and symmetric data rates as high as 5 to 20 Mbps.
- Typically combined with fiber to the curb/building access.
- Spectrum up to 12 MHz, so the length of the copper loops must be shorter than ADSL.
- Must overcome many ingress / egress issues.

VDSL Problems to Solve

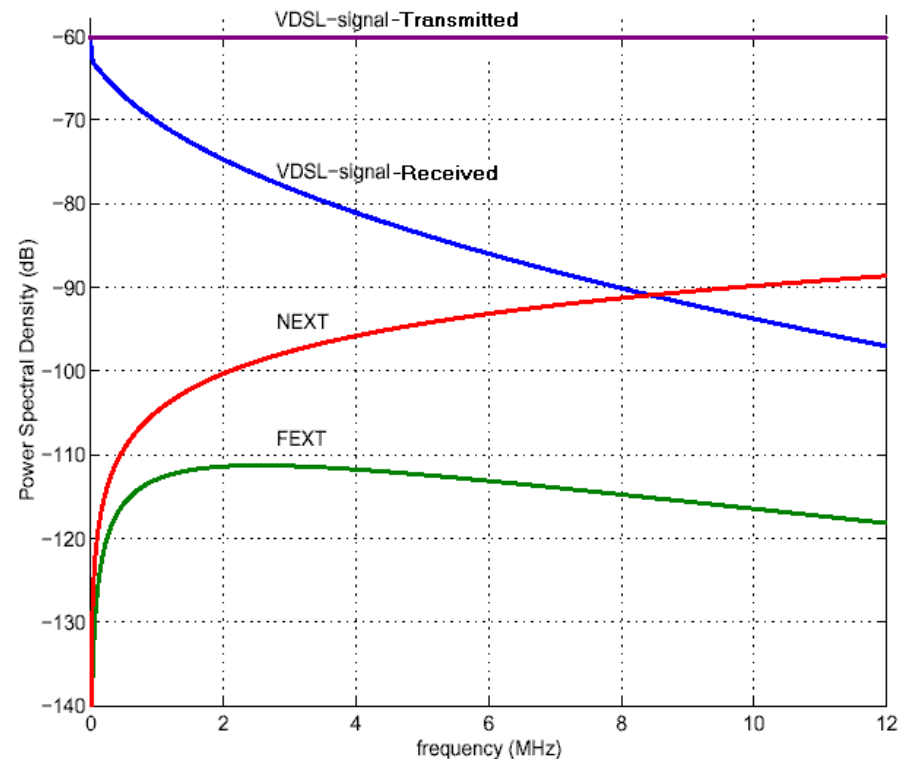
- o Application
- o Assymmetric vs Symmetric, rates
- o Spectrum / Band Plans
- o Line code

VDSL Typical Rate/Range tradeoff

VDSL service type	Reach [km]	Down [Mbit/s]	Up [Mbit/s]
Asymmetric			
Short	0.3	50	6.4
Medium	1.0	25	3.2
Long	1.5	13	1.6
Symmetric			
Short	0.3	25	25
Medium	1.0	13	13
Long	1.5	6.5	6.5

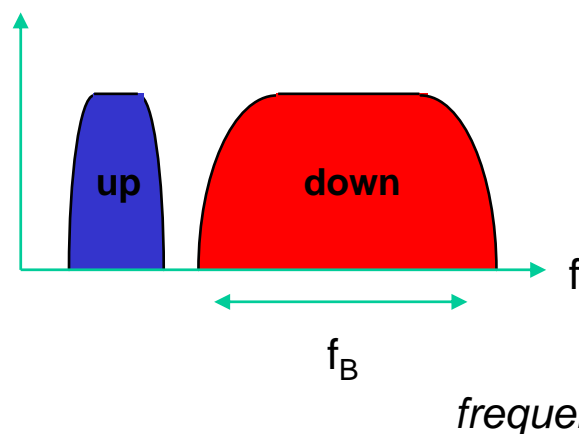
VDSL spectral issue

- o Different providers may want spectrally incompatible services
- o Unbundling is strongly influenced by spectral compatibility
- o At higher frequencies, signals in adjacent wire pairs are strongly coupled.
- o Maybe Dynamic Spectral Management (DSM) is the future?

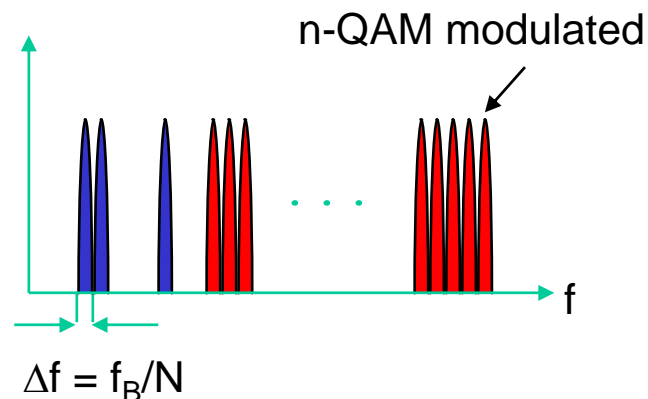


VDSL Line Code Selection

Single Carrier (QAM)



Multi Carrier (DMT)



- DMT Selected as the Line Code for VDSL2
- Compromise: QAM as an Annex to DMT Main Body in VDSL1
 - January 2004; Publish July 2004

G.shdsl - G.991.2

- Single pair high speed digital subscriber line
- Technology improvement of G.hdsl (G.991.1) that will work on a single pair.
- Symmetric bit rates to 2Mbps (2001)
- New Extended bit rates to 6 Mbps (2003)

Miscellaneous Q4/15 Projects

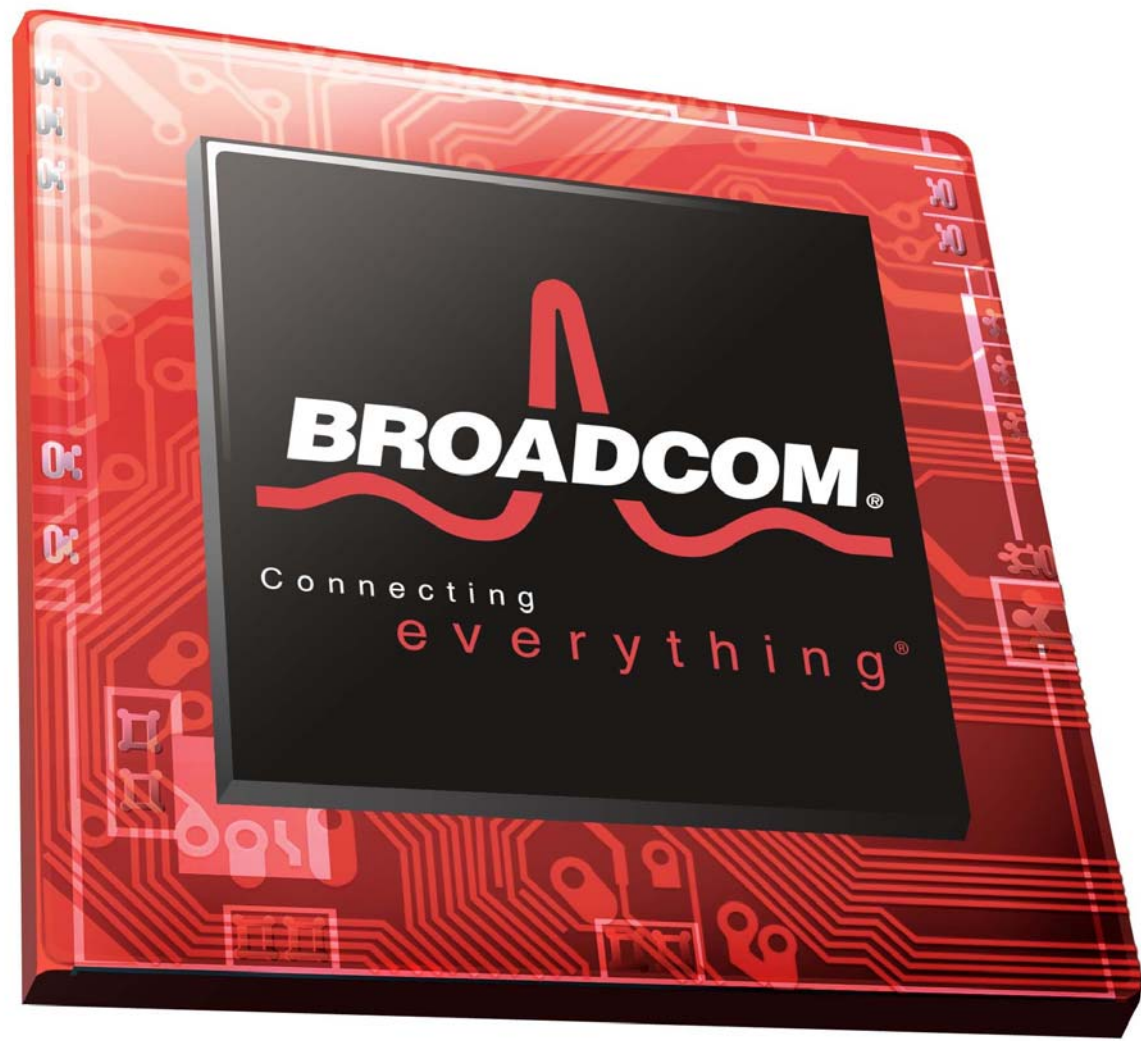
- o G.voice
 - Channelizing Voice on xDSL
- o G.selt
 - Single Ended Line Testing
- o G.bond
 - Bonding multiple pairs together
- o G.nm
 - Network Management
- o G.pnt
 - Phoneline Networking

Q4/15 Ongoing Work

- o VDSL2
 - DMT only VDSL based on VDSL1 and ADSL2
- o ADSL increments

Calls to Action

- Regulators: Uniform regulations lead to less variants worldwide
- Operators: Uniform requirements with clear applications
- Standardizers: Reduce the options and Annexes



xDSL Spectra

