PCC.I/RES. 98 (IX-06) [1]

ITU-T RECOMMENDATION G.993.2 "VERY HIGH SPEED DIGITAL SUBSCRIBER LINE 2 TRANSCEIVERS (VDSL2)"

The IX Meeting of the Permanent Consultative Committee I: Telecommunications,

CONSIDERING:

a) That there is a consensus that new forms of communication are fundamentally transforming the way in which people, communities, businesses and governments interact with each other;

b) That Resolution PCC.I/RES.4 (I-02) identifies broadband as a priority issue for examination by PCC.I;

c) That Resolution PCC.I/RES.21 (II-03) emphasizes the advantages of a prompt evolution towards a national broadband infrastructure in an environment of convergence, and

d) That Resolution PCC.I/RES. 86 (VII-05) creates a Technical Notebook on Broadband Access Technologies,

RECOGNIZING:

a) That the region's economy can be strengthened and its communities transformed by fostering the development of broadband Internet access throughout the Americas;

b) That today, the most advanced form of communications requires high bandwidth interconnection;

c) That ITU.T Recommendation G.993.2, "Very High Speed Digital Subscriber Line Transceivers 2 (VDSL2)" defines an access technology that exploits the existing infrastructure of copper wires that were originally deployed for POTS services;

d) That ITU-T Recommendation G.993.2, "Very High Speed Digital Subscriber Line Transceivers 2 (VDSL2)" allows operators to offer services such as high definition TV (HDTV), video-on-demand, videoconferencing, high speed Internet access and advanced voice services including VoIP, over a standard copper telephone cable;

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1 Document CCP.I-TEL/doc. 941/06

e) That the ITU-T Study Group 15 approved Recommendation G.993.2 in February 2006 under the "Alternative Approval Process" (AAP) and it is now in force,

RESOLVES:

To endorse ITU.T Recommendation G.993.2, “Very High Speed Digital Subscriber Line Transceivers 2 (VDSL2)” with no deletions, additions or modifications, and

RECOMMENDS:

1. That the Rapporteur Group on Standards Coordination continues to monitor the transceivers for customer access work of ITU-T Study Group 15 and determines its applicability for the Americas as this work evolves, and

2. That the Rapporteur Group on Standards Coordination continues addressing the broadband access needs of the Americas and provides additional recommendations for endorsing standards that meet customer demands for ever higher bit rate data services, high-speed Internet access and other innovative services.

ANNEX TO RESOLUTION PCC.I/RES. 98 (IX-06)

STANDARDS COORDINATION DOCUMENT FOR ITU-T RECOMMENDATION G.993.2 "VERY HIGH SPEED DIGITAL SUBSCRIBER LINE 2 TRANSCEIVERS (VDSL2)"

1. EXECUTIVE SUMMARY

The Working Group on Standards Coordination (WGSC) has addressed broadband access technologies as part of its studies of standards for Next Generation Networks (NGN), Services, Signaling, and Operations as they relate to the service access needs of the Americas. Part of this activity has included monitoring the work of the ITU-T. ITU-T Study Group 15 (Optical and other Transport Network Infrastructures) has been designated as the Lead ITU-T Study Group for Access Network Transport and on Optical technology. In this capacity, Study Group 15 approved, in June 2004, Recommendation G.993.1 called Very High Speed Data Subscriber Line Transceivers. VDSL is a Data Subscriber Line technology that allows the transmission of asymmetric and symmetric aggregate data rates up to tens of Mbps on twisted pairs. Recommendation G.993.1 was developed to cover the functional requirements for the transport of ATM (Asynchronous Transfer Mode) and PTM (Packet Transfer Mode) but having the capability of supporting future applications. Later on, Study Group 15 developed an enhancement to VDSL, G.993.2 (VDSL2) that promises to deliver 100 Mbps symmetrical traffic on short copper loops. The greater bandwidth of VDSL2 gives telecommunications operators the ability to offer advanced services such as multiple streams of interactive standard and high-definition TV over IP over the existing copper plant.

At the Eighth Meeting of PCC.I (Santo Domingo; May 2006), it was reported that SG 15 had approved Recommendation G.993.2 in February 2006 under the "Alternative Approval Process" (AAP). Therefore, this Standards Coordination Document (SCD) now presents ITU-T Rec. G.993.2 to PCC.I for its endorsement for the region of the Americas.

2. BACKGROUND

ITU-T Recommendation G.993.2 VDSL2 called "Very high speed Digital Subscriber Line Transceivers 2" (approved on February 2006) is an enhancement of VDSL1. VDSL2 gives telecom operators the possibility of offering Triple Play services such Voice, Internet and Video including High Definition Television (HDTV) and interactive gaming at a bi-directional net data rate up to 200 Mbit/s (i.e. up to 100 Mbit/s both up and downstream) on twisted pairs. Recommendation G.993.2 also designates frequency bands for the transmission of upstream and downstream signals, so that symmetric and asymmetric services can be provided using the same group of wire pairs.

During the development of VDSL1, several modulation techniques were proposed by different VDSL equipment vendors, however, ITU-T agreed in specifying DMT (Discrete MultiTone)[2] modulation in VDSL2 Recommendation G.993, being the major motivator for this choice, a goal of greater interoperability and compatibility with existing Asynchronous DSL (ADSL) installations. At present, there are very few and limited carrier deployments in Europe and North America using DMT-based VDSL2. However, Korea and Japan that chose QUAM (Quadrature Amplitude Modulation) for their VDSL implementations are well advanced in their vast deployments.

2.1. Advantages of VDSL2 in comparison with VDSL1 and ADSL

VDSL2 uses the existing copper-wire infrastructure and it can be deployed from central offices, from fibre-fed cabinets located near the customer premises, or within buildings. Its bandwidth can be up to 30 MHz (a fibre-like bandwidth) of the copper wire spectrum, while the Plain Old Telephone System (POTS) uses approximately the lowest 4 kHz and ADSL uses approximately 2 MHz of it.

As mentioned in the previous section, VDSL2 can transmit asymmetric and symmetric (Full-Duplex) aggregate data rates up to 200 Mbit/s on twisted pairs and although the transmission deteriorates quickly from a theoretical maximum at the source of 250 Mbit/s to 100 Mbit/s at 500 meters and 50 Mbit/s at 1 km, it does it at a much slower rate after this. Its performance is still better than VDSL1. Starting at 1.6 km, its performance equals the one of ADSL2+.

VDSL2 does not have the limitation of VDSL1 regarding its constraint to transmit within short loops. It has an ADSL-like long reach (LR) performance, which translates into the transmission at speeds of 1 to 4 Mbps (downstream) over distances of 4 to 5 km. As this distance shortens, the speed increases gradually up to a symmetric 100 Mbit/s. One important application of a VDSL2 system is its operation as an Ethernet LAN, where a 10 Mbit/s can be guaranteed over loops of 2 km.

The VDSL2 specification of eight profiles allows the support of a great variety of implementations and scenarios and also helps equipment vendors by giving them the possibility of implementing according to specific service requirements.

2.2. VDSL2 Reference Models

This Recommendation defines VDSL2 as an access technology and specifies Very High Speed DSL Transceivers. G.993.2 describes VDSL2 transceivers by defining a layered reference model with a distinction of a user plane protocol reference model and a management plane reference model.

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[2] DMT divides the available carrier band into 247 4-Khz channels, monitoring them and searching for the best quality channels for transmission and reception. Each channel bandwidth is partitioned by the modulator into a set of parallel sub-channels, being a sub-carrier, the center frequency of each of these sub-channels.

Recommendation G.993.2 also defines three separate application models:

1) Data service only.
2) Data service with underlying POTS service.
3) Data service with underlying ISDN service.

2.3. Operation and Management/Maintenance (OAM)

The Recommendation also includes OAM functionality that takes care of faults and performance of the transceivers.

The VDSL2 transceiver units (VTUs) are identified at each side of the network as follows:

VTU-O: VTU at the Optical Network Unit (ONU) (or at the central office, cabinet, etc., i.e. at the operator end of the loop)

VTU-R: VTU at the remote site (i.e. user end of the loop)

The peer OAM entities at the VTU-O and VTU-R exchange management information using OAM-dedicated communication channels arranged over the transmission entities.

2.4. Definition of profiles

Eight profiles are specified in order to allow transceivers, which support a subset of a wide range of settings based in different parameters, to be still compliant with the Recommendation.

In order for VDSL2 transceivers to be G.993.2 compliant, they should comply with at least one profile (they also have to be compliant with at least one annex (A, B or C) specifying spectral characteristics) specified in the Recommendation. Compliance with more than one profile is allowed

2.5. Support of Upstream Band Zero (US0)

VDSL2 supports an optional extension of the US0 to 276 kHz and provides performance improvements to US0 taking into account spectrum requirements of different carriers worldwide.

2.6. Support of Frequency Division Duplexing (FDD)

VDSL2 transceivers use FDD to separate upstream and downstream transmissions that means that upstream and downstream passbands cannot overlap.

2.7. Band plan below 12 MHz

VDSL2 specifies a 5-band plan for frequencies below 12 MHz as it is shown in Fig 7-1/G.993.2 reproduced here for convenience:

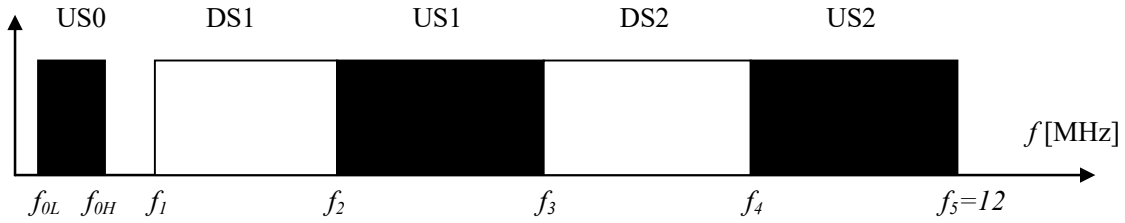

Figure 7-1/G.993.2 – Band plan in the frequency range up to 12 MHz

Where the band between f_{0L} and f_{0H} is called US0, which if used should be only for upstream transmission. The other bands are called first downstream band, DS1; first upstream band, US1; second downstream band, DS2 and second upstream band, US2. Annexes A, B and C specify the values of f_{0L}, f_{0H}, f_1, f_2, f_3 and f_4 for the regions of North America, Europe and Japan respectively.

2.8. Band plan above 12 MHz

Bands above 12 MHz are specified by additional band separating frequencies and the number of these depends on the number of bands defined between 12 MHz and 30 MHz. VDSL2 specifies at least one additional downstream or upstream band. The values of band separating frequencies between 12 and 30 MHz are also specified in Annexes A, B and C of Recommendation G.993.2.

2.9. Shaping of the frequency-domain transmit spectrum

The Frequency-domain transmit spectrum shaping (tss_i), both upstream and downstream, are vendor discretionary and they should be in the range of 0 to 1 (linear) and in steps of 1/1024. The highest tss_i value across all sub-carriers is 1. Smaller values of tss_i provide attenuation and when tss_i is 0 means that no power is transmitted on the particular sub-carrier. If there is no shaping of the frequency-domain transmit spectrum, the values of tss_i have to be equal to 1 for all sub-carriers.

3. CONCLUSIONS

The Working Group on Technology recommends that CITEL PCC.I endorses ITU-T Recommendation G.903.2, “Very High Speed Digital Subscriber Line 2 (VDSL2)” with no deletions, additions or modifications.

4. FUTURE WORK

The Rapporteur Group on Standards Coordination will continue to monitor the evolving broadband access work of the ITU-T (especially Study Group 15), and other relevant standards groups that address the broadband needs of the Americas. As appropriate, the RGSC will recommend endorsement of additional standards that serve to enhance broadband access technologies in the Americas.

5. RESOURCE DOCUMENTS

[1] ”Standards Roadmap – Asymmetric Digital Subscriber Line System (ADSL), CCP.1-TEL/doc.1472/02, May 2002.

[2] Technical Notebook on “Next Generation Networks – Standards Overview (May 2006), CCP.I-TEL/doc.0776, May 2006.

[3] ITU-T Recommendation G.993.2, “Very High Speed Digital Subscriber Line Transceivers 2 (VDSL2)”, February 2006.