PCC.I/RES. 244 (XXVI-15) [1]

STANDARDS COORDINATION DOCUMENT (SCD) FOR ITU-T RECOMMENDATION G.9701: "FAST ACCESS TO SUBSCRIBER TERMINALS (FAST) – PHYSICAL LAYER SPECIFICATION"

The XXVI Meeting of Permanent Consultative Committee I: Telecommunications/Information and Communication Technologies (PCC.I),

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 PCC.I identifies broadband access as a priority issue for examination;

c) That PCC.I emphasizes the advantages of a prompt evolution towards a national broadband infrastructure in an environment of convergence; and

d) That the Working Group on Deployment of Technologies and Services (WGDTS) maintains 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 forms of communication require high bandwidth interconnection;

c) That ITU.T Recommendation G.9701, "Fast Access to Subscriber Terminals – Physical Layer Specification" defines an access technology that exploits the existing infrastructure of copper wires that were originally deployed for plain old telephone service (POTS) services;

d) That the ITU-T Study Group 15 approved Recommendation G.9701 in December 2014 under the "Alternative Approval Process" (AAP) and it is now in force,

RESOLVES:

To endorse ITU.T Recommendation G.9701, "Fast Access to Subscriber Terminals – Physical Layer Specification" with no deletions, additions or modifications; and

INSTRUCTS:

1. That the Working Group on Deployment of Technologies and Services continues to monitor the broadband access work of ITU-T Study Group 15 and determines its applicability for the Americas as this work evolves; and

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2. That the Working Group on Deployment of Technologies and Services 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. 244 (XXVI-15)

STANDARDS COORDINATION DOCUMENT FOR ITU-T RECOMMENDATION G.9701, "FAST ACCESS TO SUBSCRIBER TERMINALS (FAST) – PHYSICAL LAYER SPECIFICATION"

1. EXECUTIVE SUMMARY

The Working Group on Deployment of Technologies and Services (WGDTS) 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 (Networks, Technologies and Infrastructures for Transport, Access and Home) has been designated as the Lead ITU-T Study Group for Access Network Transport and Optical Technology. In this capacity, Study Group 15 (SG 15) approved, in 2014, Recommendations in the G.9700 series, specifying a gigabit broadband access technology that exploits the existing infrastructure of wire-pairs that were originally deployed for Plain Old Telephone Service (POTS). Equipment implementing this Recommendation can be deployed from fiber distribution points (FTTdp) located very near the customer premises, or within buildings (FTTB). This Recommendation supports asymmetric and symmetric transmission at an aggregate net data rate up to 1 Gbit/s on copper telephone lines and specifies all necessary functionality to support far-end crosstalk (FEXT) cancellation between multiple wire-pairs.

At the XXV Meeting of PCC.I (Asuncion; August 2014), it was reported that SG 15 had approved G.9700, "Fast Access to Subscriber Terminals – Power spectral density specification" in April 2014. The WGDTS discussed this technology and the implications of this broadband technology – allowing higher bandwidth communications using existing copper infrastructure.

At the XXVI Meeting of PCC.I (Cusco; May 2015), the WGDTS discussed the latest formal specifications for G.FAST - Recommendation G.9701, "Fast Access to Subscriber Terminals – Physical Layer Specification", approved by Study Group 15 in December 2014. The technology is now ready for implementation and the WGDTS now presents this Standards Coordinated Document (SCD) in order to endorse ITU-T Recommendation G.9701 for implementation in the Region of the Americas.

2. BACKGROUND

Introduction

User demand for broadband Internet access, personal communication, cloud services, video conferencing and other bandwidth-intensive services are constantly driving bandwidth requirements. In addition, governments see universal broadband as a priority for socio-economic development and as critical infrastructure for services such as telemedicine, remote care for the elderly, online learning, and building security. To meet customer demand, competitive pressures and government targets, service providers need to deploy access technologies that can meet the demand for bandwidth.

Digital Subscriber Line (DSL) technology has been used to provide high-speed networking over ordinary phone lines since the 80's. Traditional copper networks, with their limited access rates designed to primarily carry voice services, provided data services using dial-up modems and integrated services digital network (ISDNs). With the rapidly growing demand for bandwidth driven by data services these networks struggled to keep up this demand. The first technology to bring people into the broadband access era, with downstream access rates of up to 8 Mbit/s, was ADSL and later on, ADSL2+ with a maximum downstream rate of 24 Mbit/s.

Very high speed digital subscriber line (VDSL) technology came next, improving on both upstream and downstream rates and making symmetric access possible. VDSL evolved to VDSL2 providing access rates of up to 100 Mbit/s transitioned copper access technology into the "Fast Broadband" era.

Although VDSL2 can ideally provide speeds up to 100 Mbit/s, it is challenging for VDSL2 to reach 100 Mbit/s access speeds due to crosstalk between lines. To address this issue, *vectoring technology* was developed. Vectoring provides self-crosstalk cancellation for increased net data rates on wire-pairs that experience far-end crosstalk from transceivers in the same vectored group operating on other wire-pairs in the same cable or operating on other wire-pairs originating from the same network equipment. VDSL2 technology, however, is a bottleneck to increasing transmission rates because vectoring technology is both a crosstalk cancelation technology and a VDSL2 technology. The maximum rate vectoring technology can reach is the maximum rate that a noiseless, single copper pair applying VDSL2 can reach.

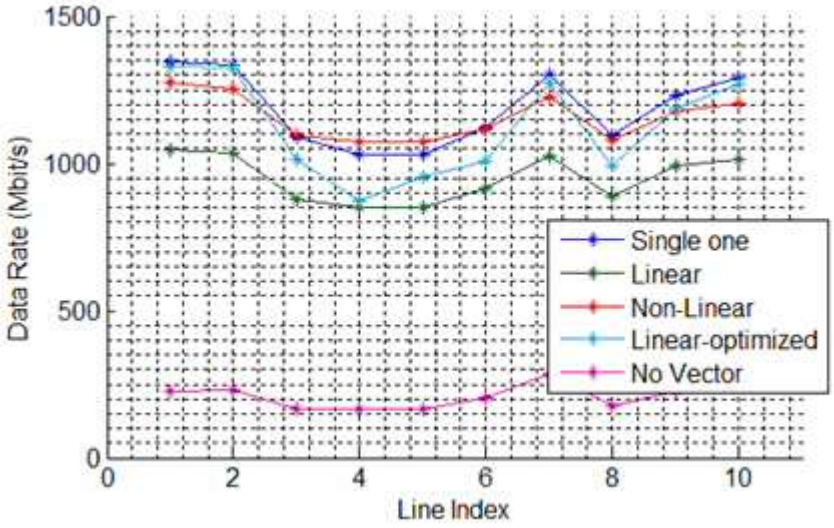
To help enable copper access to reach 1 Gbit/s rates, G.FAST technology emerged and will transition copper access into the gigabit era. The name G.FAST is an acronym for *fast access to subscriber terminals* and the letter *G* stands for the ITU-T G series of recommendations. G.FAST, the latest specification set for copper-based broadband access delivery, is a digital subscriber line (DSL) standard developed by ITU and coordinated with the Broadband Forum. G.FAST is defined to support gigabit rates over short copper lines (< 100 meter) and has been developed to provide higher speeds by using frequencies up to 106MHz in the initial stage and 212 MHz in the future in combination with vectoring in a Fiber to the Distribution Point (FTTdp) scenario.

G.FAST Specification

G.FAST is built upon VDLS2 and is the next step between FTTN (Fiber To The Node) and fiber FTTH (Fiber To The Home) internet services. G.FAST requires fiber to be pulled closer to consumers but avoids the cost of doing fiber runs to each individual home (i.e. ADSL) or services that are served from a DSLAM that is located about a mile from customers (i.e. VDSL). Instead, G.FAST serves customers from an FTTdp that is a maximum of 300 meters away from customers.

Unlike VDSL2 which currently works on the 17 MHz or 30 MHz frequency bands, G.FAST will work on the 106 and 212 MHz frequency bands providing a significant increase in bandwidth. This spectrum overlaps with some FM broadcast services and other radio services, therefore spectrum resources in the fixed communication sector should be appropriately planned to prevent conflicts with frequency bands already in use or planned to be used in the future. The ITU-T G.9700 recommendation (G.FAST-psd) specifies the technical requirements for 106 MHz and 212 MHz profiles in order to limit interference caused by G.FAST to these radio services.

Similar to VDSL2, G.FAST performance is affected by crosstalk interference. To neutralize this, both use a vectoring technology. It works by continuously analyzing the noise conditions on copper lines, and then creates a new, anti-noise signal to cancel it out. Without the use of vectoring, speeds offered by G.FAST would drop from over 1Gbps to 200Mbps as is illustrated in the following figure [1]:



G.FAST simulation results over 100-meter lines

The impact of crosstalk on G.FAST is much more severe than on VDSL2 therefore G.FAST must use a more advanced vectoring technology to cancel crosstalk between lines. Recommendation ITU-T G.9701 specifies all necessary functionality to support far-end crosstalk cancellation between multiple pairs of copper wires.

Benefits

- G.FAST technology uses TDD (time division duplex) so different timeslots are used for upstream and downstream transmission facilitating hardware implementation and flexible downstream/upstream ratio definition;
- G.FAST is designed to be a customer installed technology therefore customers will be able to plug in their modems to the standard phone jack to receive service bringing as consequence significant cost savings to customers;
- G.FAST technology is capable of gigabit access speeds over existing copper lines; and
- It may economical enough that operators may be willing to upgrade their existing networks while moving to eventually implement Fiber to the Home connections.

Applications

- Next-generation IPTV service at well over 100 Mb/s;
- Access to small and medium business sites at well over 100 Mb/s;
- Backhaul for very small wireless cell sites, including HetNet;
- Backhaul for WiFi hot spots.

Co-existence with ADSL2 and the various VDSL2 profiles requires:

- Interoperability with VDSL2;
- Coexistence with xDSL:
  Start frequency: 2.2, 8.5, 17.664, and 30 MHz;
- Service rate performance targets:
  500-1000 Mb/s for FTTB deployments @<100m, straight loops
  500 Mb/s at 100m

200 Mb/s at 200m
150 Mb/s at 250m;

- Mandatory support for vectoring: Far-end crosstalk (FEXT) cancellation;
- Control of downstream/upstream asymmetry ratio:
  Mandatory: 90/10 to 50/50
  Optional: from 50/50 to 10/90;
- Duplexing method: TDD (time division duplex);
- Forward Error Correction (FEC): Trellis code + Reed Solomon of VDSL2 (G.993.2) with the retransmission block (DTU) interleaving defined in G.998.4.

Looking ahead

G.FAST is a natural evolution of VDSL2 and can rely on VDSL2 vectoring to serve their customers in a cost-effective way. The ITU G.FAST standard approval milestone has been achieved and it is expected that vendors will begin work on standards-based commercial products.

References

1. Recommendation ITU-T G.9700 (2014), Fast access to subscriber terminals (FAST) – Power spectral density specification.
2. Recommendation ITU-T G.994.1 (2012), Handshake procedures for digital subscriber line transceivers.
3. G.FAST: Moving Copper Access into the Gigabit Era; Huawei, 2014-02-13
4. G.FAST Delivers Gigabit Broadband Speeds To Customers Over Copper (FTTdp); PC Perspective, 2014-02-13
5. G.FAST for FTTdp; Joint ITU/IEEE Workshop on Ethernet - Emerging Applications and Technologies; Geneva, Switzerland, 22 September 2012