International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.998.2
Amendment 1
(12/2006)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Access networks

Ethernet-based multi-pair bonding

Amendment 1

ITU-T Recommendation G.998.2 (2005) – Amendment 1

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ITU-T Recommendation G.998.2

Ethernet-based multi-pair bonding

Amendment 1

Summary

This amendment to ITU-T Rec. G.998.2 addresses differential delay for aggregation of ADSL2plus links and of VDSL2 links.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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ITU-T Recommendation G.998.2

Ethernet-based multi-pair bonding

Amendment 1

Insert new clause 6.2.3:

6.2.3 Exceptions to clause 61.2.2.5

IEEE 802.3-2005 clause 61.2.2.5 requires the receiving PCS to be able to handle a maxDifferentialDelay of 15 000-bit times between the slowest link (i.e., link with the lowest net data rate) and the fastest link (i.e., link with the highest net data rate) in an N-pair bonding group. This allows to operate at a slowest link fragment size value (max. 512 octets) and at a fastest link speed value (max. 400/(N+3) Mbit/s) and at a speed ratio value (fastest to slowest net data rate ratio, max. 4:1), all close to their maximum allowed values, with the transmitting PCS assuring that:

$$(8 * \text{slowest\_link\_fragment\_size}) * (\text{speed\_ratio}) \leq 15\ 000$$

and in case the transceiver jitter does not significantly contribute to the differential delay to be handled by the receiving PCS. A low transceiver jitter is particularly achieved by G.992.1 (SHDSL) transceivers.

However, in the case of ADSL2plus and VDSL2, transceiver jitter is caused e.g., by buffering inside the transmitting or receiving transceiver (number of octets jitter), by symbol rate (1 symbol jitter = 250 µs), by sync symbols (1 symbol jitter = 250 µs), and by FEC (K_{FEC} octets jitter). Transceiver jitter is further increased by differences over the transceivers in the bonding group in interleaving delay (number of µs jitter) and processing time (number of µs jitter).

While ITU-T Recs G.992.3/5 and G.993.2 provide means to reduce the interleaving delay difference over the links in the bonding group down to some low value depending on granularity, these Recommendations do not define transceiver jitter bounds. The remaining transceiver jitter can be estimated as an additional differential delay (in bit times) at the receiving PCS up to about:

$$(K_{FEC} * 8/\text{slowest\_link\_net\_data\_rate} + 500\ \mu s) * \text{fastest\_link\_net\_data\_rate}$$

depending on whether or not the transceiver jitter is reduced by the receiving transceiver.

If such differential delay is input to a receiving PCS capable of handling only 15 000-bit times of differential delay, then the net data rate of each link in the bonding group is limited between 0 and 25 Mbit/s, depending on the transmitting PCS's choice of maximum or minimum fragment size and speed ratio respectively. To avoid such limitations on the net data rate of ADSL2plus or VDSL2 links, the receiving PCS should be able to handle the additional differential delay introduced by the transceiver jitter.

NOTE – For example, to support the full 100 Mbit/s aggregate net data rate for a 2-pair bonding group at a 4:1 speed ratio, the receiving PCS may need to be able to handle a total differential delay of approximately 65 000-bit times, in case the receiving transceiver does not reduce the transceiver jitter.

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