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

Digital sections and digital line system – Optical fibre
submarine cable systems

Forward error correction for submarine systems

ITU-T Recommendation G.975

(Formerly CCITT Recommendation)

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Forward error correction for submarine systems

Summary

The present Recommendation is primarily concerned with the implementation of a Forward Error Correction (FEC) function in the multigigabit-per-second optical fibre submarine cable systems. The applications being addressed in this Recommendation are both optically amplified repeatered systems and repeaterless optical systems (described in ITU-T G.973 [3]). The use of this FEC function in submarine terminal transmission equipment is not mandatory.

Source

ITU-T Recommendation G.975 was revised by ITU-T Study Group 15 (1997-2000) and approved under the World Telecommunication Standardization Assembly (Montreal, 27 September – 6 October 2000).

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.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.975

Forward error correction for submarine systems

1 Scope

The present Recommendation is primarily concerned with the implementation of a Forward Error Correction (FEC) function in the multigigabit-per-second optical fibre submarine cable systems. The applications being addressed in this Recommendation are both optically amplified repeated systems and repeaterless optical systems (ITU-T G.973 [3]). The use of this FEC function in submarine terminal transmission equipments (TTEs) should not be considered as mandatory.

It is not the intention of this Recommendation to pursue the transverse compatibility of the system. Therefore the selection of the FEC frame structures described in this Recommendation is a matter of joint engineering.

The transmission data rates under consideration in this Recommendation are 2.5 Gbit/s STM-16 (ITU-T G.707 [1]) and integer multiples of 2.5 Gbit/s (interleaved STM-16 tributaries).

Clause 5 presents the main features of the FEC function implemented in the submarine systems, and in particular the error monitoring facility.

Clause 6 provides the definition of the forward error correction algorithm to be used, which is a Reed-Solomon code, and gives guidelines for the implementation of this algorithm in the submarine Terminal Transmission Equipments (TTEs).

Clause 7 is dedicated to the measurement of the performance of this Reed-Solomon code and the expected gain on the optical transmission power budget.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- [1] ITU-T G.707 (1996), *Network node interface for the synchronous digital hierarchy (SDH)*.
- [2] ITU-T G.972 (1997), *Definition of terms relevant to optical fibre submarine cable systems*.
- [3] ITU-T G.973 (1996), *Characteristics of repeaterless optical fibre submarine cable systems*.

3 Terms and definitions

This Recommendation uses the following terms defined in other Recommendations:

- Synchronous Digital Hierarchy (SDH): See ITU-T G.707 [1].
- Synchronous Transport Module (STM): See ITU-T G.707 [1].
- Optical fibre submarine cable system: See ITU-T G.972 [2].
- Terminal Transmission Equipment (TTE): See ITU-T G.972 [2].
- Optical power budget: See ITU-T G.972 [2].
- Service channel: See ITU-T G.972 [2].

- Order wire channel: See ITU-T G.972 [2].
- Line error ratio: See ITU-T G.972 [2].
- Forward Error Correction (FEC): See ITU-T G.972 [2].
- FEC frame: See ITU-T G.972 [2].
- FEC encoder: See ITU-T G.972 [2].
- FEC decoder: See ITU-T G.972 [2].

4 Abbreviations

This Recommendation uses the following abbreviations:

BER	Bit Error Ratio
EDFA	Erbium-Doped Fibre Amplifier
FEC	Forward Error Correction
GF	Galois Field
RS	Reed-Solomon

5 FEC features

5.1 General principles of the FEC function

The FEC function defined in this Recommendation works on the STM-16 basis. When M (M integer different from 0) STM-16 signals are interleaved to achieve $M \times 2.5$ Gbit/s transmission data rates, the encoding is performed before the interleaving of the M STM-16 tributaries and the decoding is performed after the de-interleaving of the optical line signal.

The FEC function essentially comprises:

- a FEC encoder in the transmit Terminal Transmission Equipment (TTE) that accepts information bits and adds computed redundant symbols, producing encoded data at a higher bit rate;
- a FEC decoder in the receive Terminal Transmission Equipment (TTE) that performs the error correction while extracting the redundancy to regenerate the data that was encoded by the FEC encoder.

Figure 1 outlines the fact that the encoding and decoding procedures are performed at the Terminal Transmission Equipment (TTE) level only, on electrical signals, and benefit the overall optical fibre submarine cable system, which comprises the optical fibre and possibly optical modules such as optical amplifiers using EDFA technology.