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SERIES G: DIGITAL NETWORKS

Transmission systems and multiplexing equipment

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**Application of transmultiplexers,  
FDM codecs, data-in-voice (DIV) systems  
and data-over-voice (DOV) systems  
during the transition from an analogue to a  
digital network**

ITU-T G-series Recommendations – Supplement 28

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## NOTES

1 Supplement 28 to the G-series Recommendations was approved in Málaga-Torremolinos (1984) and published in Fascicle III.3 of the *Red Book*. This file is an extract from the *Red Book*. While the presentation and layout of the text might be slightly different from the *Red Book* version, the contents of the file are identical to the *Red Book* version and copyright conditions remain unchanged (see below).

2 In this Supplement, the expression “Administration” is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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APPLICATION OF TRANSMULTIPLEXERS, FDM CODECS, DATA-IN-VOICE (DIV) SYSTEMS  
AND DATA-OVER-VOICE (DOV) SYSTEMS  
DURING THE TRANSITION FROM AN ANALOGUE TO A DIGITAL NETWORK

(Malaga-Torremolinos, 1984)

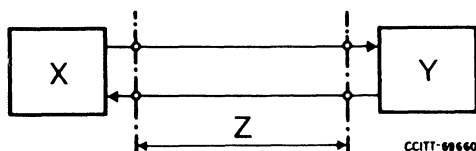
(referred to in Recommendations G.791 to G.795)

1 Introduction

The transition from analogue to digital networks takes place in a number of phases during which interconnection must be carried out between analogue and digital systems. The precise characteristics of the various transitional phases depend on both the peculiarities of the existing analogue network and the introduction scenario chosen, which may vary from one country to another. The purpose of this Supplement is to list the types of equipment which may be used in the transition period and to give some of their typical applications.

2 Interconnection between analogue and digital equipments

Since all telecommunication networks are made up of switching or transmission centres linked to one another by transmission media, the various cases of interconnection may be illustrated schematically by the typical configuration given in Figure 1 where X and Y are the centres to be connected by means of transmission medium Z. The interfaces between the centres and the transmission medium are within the FDM and TDM hierarchies. An interconnection problem arises when X, Y and Z are not all either analogue or digital. Two of the four possible cases involve a single analogue-digital conversion, whereas the two remaining ones involve two conversions (see Table 1).



X, Y switching/transmission centres  
Z transmission medium

FIGURE 1

Typical interconnection configuration

TABLE 1

Interconnection between analogue and digital equipments

| Case | X | Z | Y |
|------|---|---|---|
| 1    | A | A | D |
| 2    | A | D | D |
| 3    | A | D | A |
| 4    | D | A | D |

A: A level in the analogue hierarchy.

N: A level in the digital hierarchy.

In most cases of interconnections shown above, it may be possible, using conventional equipment, to transfer the telephone (and/or other service) channels at the LF level, but this is not covered in this Supplement. There are advantages to be derived from replacing this solution using conventional equipments by the use of equipments recommended in the CCITT for such applications.

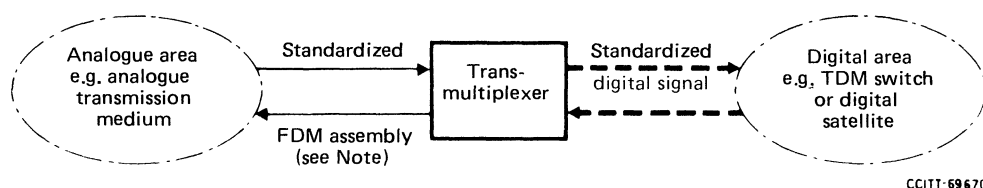
## 2.1 Interconnections involving one analogue-digital conversion

This type of interconnection corresponds to cases 1 and 2 of Table 1. The function performed by equipment providing direct transfer is called transmultiplexing, since frequency-division multiplexed signals are transformed into time-division multiplexed signals, or vice-versa. Interconnection takes place at the level of standardized analogue assemblies and standardized digital signals at a hierarchical bit rate and using a standardized frame structure.

The following CCITT Recommendations are concerned with the characteristics of transmultiplexing equipments:

- Recommendation G.791: General considerations on transmultiplexing equipments
- Recommendation G.792: Characteristics common to all transmultiplexing equipments
- Recommendation G.793: Characteristics of 60-channel transmultiplexing equipments
- Recommendation G.794: Characteristics of 24-channel transmultiplexing equipments.

Typical applications of a transmultiplexer are shown in Figure 2.



Note – Channels within the assembly must be 4 kHz spaced.

FIGURE 2

Typical applications of a transmultiplexer

## 2.2 Interconnections involving two analogue-digital conversions

In case 3 of Table 1, two analogue transmission centres are interconnected by means of a digital transmission medium. In case 4 of Table 1, two digital switching/transmission centres are interconnected by means of an analogue transmission medium. In both cases, one possibility is to use a pair of transmultiplexers, the frame structure (in case 3) and the assembly of analogue channels (in case 4) on the transmission medium conforming to the recommended hierarchical levels. Connections set up in this way are subject to the restrictions peculiar to transmultiplexers (see Recommendation G.791). For cases 3 and 4 applications, other equipments recommended by the CCITT can be used, as follows:

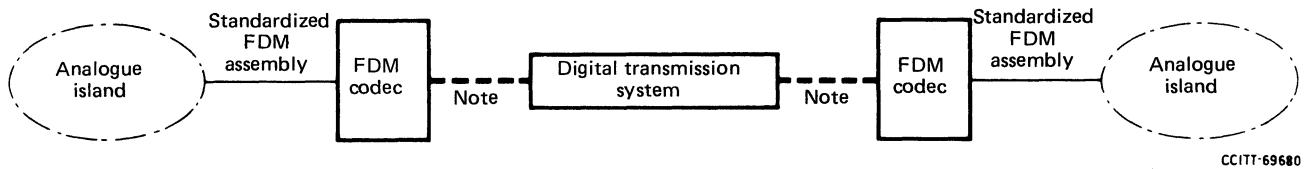
- FDM codecs,
- data-in-voice (DIV) systems,
- data-over-voice (DOV) systems.

One feature of these equipments is that they are used in pairs of the same type. Their characteristics are compatible with those of the digital or analogue paths they use. However, the frame structure for the FDM codecs, and the analogue signal in the DIV and DOV systems may be different in each realization. They simply make use of the available transmitted bit-rate or frequency band, regardless of the type of signal(s) and/or service(s) which is present in the input stream (DIV or DOV) or bandwidth (FDM codecs).

These equipments may be used as follows:

### 2.2.1 Interconnection of analogue centres by means of a digital transmission medium (case 3)

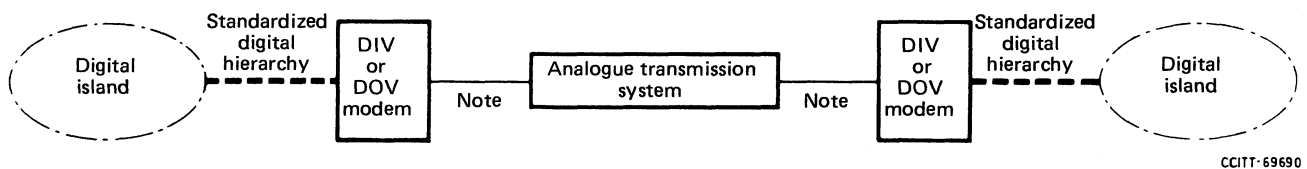
Interconnection may be carried out using a pair of FDM codecs. Their characteristics are described in Recommendation G.795 "Characteristics of codecs for Frequency Division Multiplexed assemblies". Typical application of FDM codecs is shown in Figure 3.



Note – The bit stream has a non standardized frame structure.

FIGURE 3

Typical application of a pair of FDM codecs



Note – For DIV modem the signal is within the band of a standardized FDM assembly. For DOV modem the signal is above the band of a standardized FDM line system.

FIGURE 4

Typical application of a pair of DIV or DOV modems

#### 2.2.2 Interconnection of digital centres by means of an analogue transmission medium (case 4)

There are two cases:

##### a) Transmission in the standard frequency band for FDM channel assemblies:

This is the case of data-in-voice (DIV) systems, which use the frequency band normally assigned to standardized FDM assemblies.

##### b) Transmission in a frequency band above that normally assigned to FDM line systems

This is the case of data-over-voice (DOV) systems, which use a frequency band above that used for transmitting FDM signals. The characteristics of those bands are not in fact described in the Recommendations relating to the corresponding line systems.

The characteristics of DIV and DOV equipments are set out in Recommendation G.941 entitled "Digital line systems provided by FDM transmission bearers".

Typical application of DIV or DOV systems is shown in Figure 4. DIV and DOV systems are mainly used to transmit digital signals, other than digitalized telephone channels, such as synchronous data, or videophone signals.

#### References

- [1] *Interconnection of analogue and digital transmission networks*, Contribution COM XVIII-25, Study Period 1977-1980 (France).
- [2] *Application des transmultiplexers*, Contribution COM XV-67, Study Period 1981-1984 (France).
- [3] *Application of FDM codecs in the network*, Delayed Contribution COM XV-BX, Study Period 1981-1984 (NTT).





