RECOMMENDATION ITU-R F.1104

REQUIREMENTS FOR POINT-TO-MULTIPOINT RADIO SYSTEMS USED IN THE LOCAL GRADE PORTION OF AN ISDN CONNECTION

(Question ITU-R 125/9)

(1994)

The ITU Radiocommunication Assembly,

considering

a) that studies on the ISDN have been carried out and Recommendations have been developed by the ITU-T;

b) that point-to-multipoint systems have advantages for rapid construction and expansion of the ISDN because of their ease of installation and portability, even if the number of subscribers is small;

c) that point-to-multipoint systems may operate in frequency bands where radio-frequency channel arrangements have been recommended by the ITU-R for point-to-point systems and will have to share with such services;

d) that further study is required on the processing, protocols and procedures required for the various ISDN channels between the exchange and terminal equipment through the point-to-multipoint systems;

e) that, in particular, further study is required on the assignment and activation/deactivation of radio channels using techniques such as demand assignment and multiple-access,

recommends

1. that the performance and availability objectives for point-to-multipoint radio systems used in the local grade portion of the ISDN should be in accordance with Recommendation ITU-R F.697;

2. that for guidance on appropriate modulation techniques and applicable frequency bands for point-to-multipoint radio systems for data transmissions in urban areas, including ISDN data bit rates, reference should be made to Annex 3 of Recommendation ITU-R F.755;

3. that for guidance on channel assignment and the use of point-to-multipoint radio systems as digital data concentrators in rural areas, reference should be made to Annex 1 of Recommendation ITU-R F.756;

4. that guidance on the use of point-to-multipoint radio systems in the local grade portion of an ISDN connection, may be obtained from Annex 1;

5. that guidance on methods for circuit activation/deactivation of radio channels using demand assignment, multiple access point-to-multipoint protocols and on the ISDN channel processing required, may be obtained from Annex 2.

ANNEX 1

Configuration of point-to-multipoint systems used in the local grade portion of an ISDN connection

1. Introduction

This Annex describes a typical basic access ISDN connection infrastructure and the general principles of the use of point-to-multipoint systems for this connection.

2. Local grade portion of an ISDN connection

An ISDN basic access comprises:

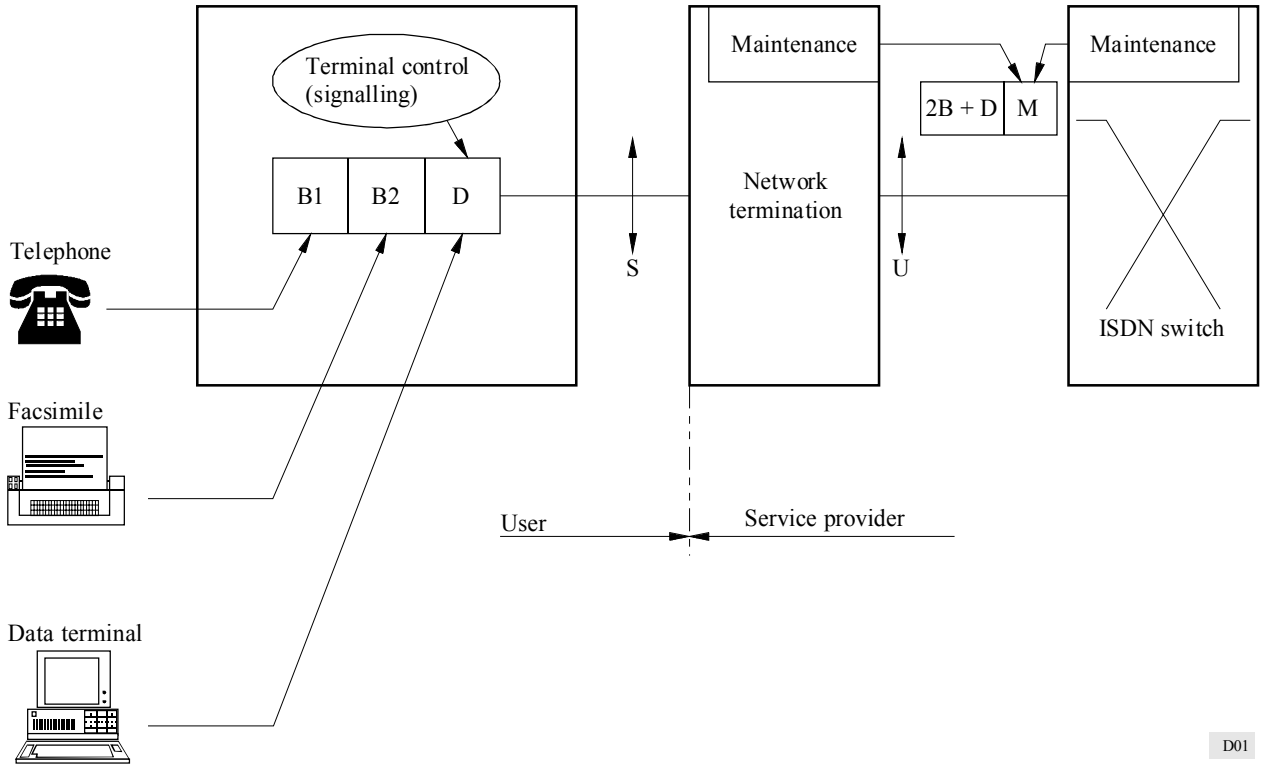
– two 64-kbit/s B-channels for carrying information in circuit mode and packet mode,

– one 16-kbit/s D-channel for carrying signalling and packet-mode data.

An ISDN basic rate may therefore be represented as in Fig. 1:

FIGURE 1

ISDN basic access configuration



Clearly, the B signals are readily transmissible in the 64 kbit/s time-slots of a point-to-multipoint transmission system.

On the other hand, the information contained in the D-channel requires channels with appropriate bit rates.

3. Position of point-to-multipoint systems in the network

Point-to-multipoint systems are used in the access portion of the service provider network. In the case of the ISDN, this means that point-to-multipoint systems are inserted at the U reference point interface. Some applications, such as connection of private subscribers to ISDN PABXs are performed at the S reference point interface.

With the S interface, radio equipment can be designed to connect with exchanges in such a way as to provide advanced functions such as lost call procedures. These functions are not required in a wired subscriber transmission system. With the S interface, acquisition of information about circuit activation/deactivation is also possible. This implies that a simple “translation” of this information would enable the point-to-multipoint system to use a demand assignment, multiple access technique. On the other hand, the U interface has the advantage that it allows connection to any standard terminal equipment and subscriber transmission line. Nevertheless, the U interface involves a very important maintenance aspect. The parent exchange of the point-to-multipoint transmission system should have a total maintenance overview of the section comprising the U interface, the network digital terminal (NT) and the S interface connecting the subscriber.

4. ISDN applications – System capacity

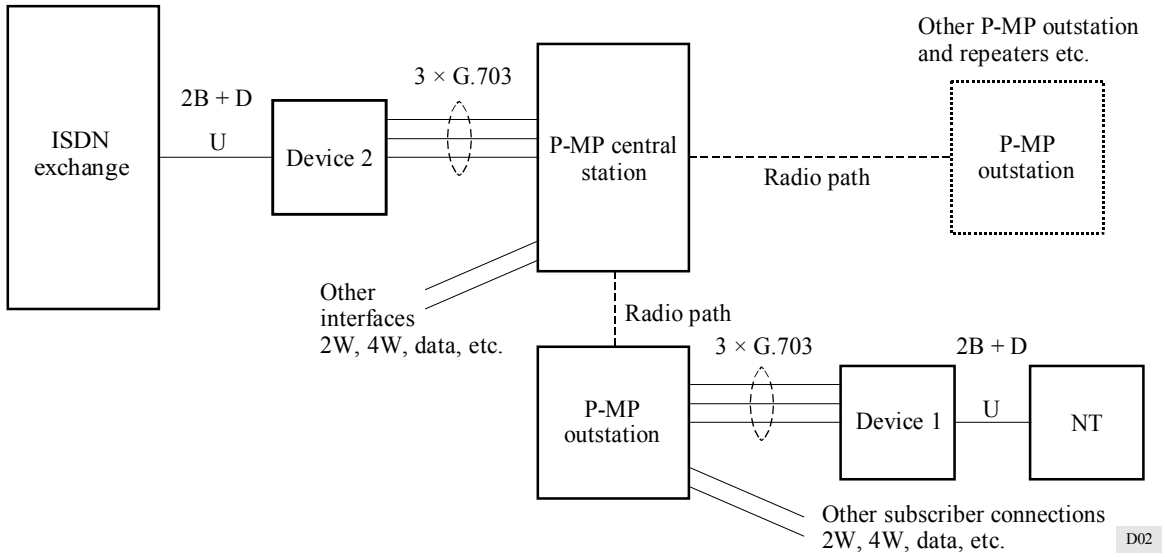
4.1 Applications

During the ISDN introduction phase or for the implementation of a few ISDN basic access subscribers in a point-to-multipoint network, two solutions can be foreseen:

4.1.1 Using three ITU-T Recommendation G.703 64 kbit/s circuits, the ISDN subscriber loop connection using a P-MP system is shown in Fig. 2.

FIGURE 2

A single ISDN 2B + D connection to an ISDN switch



For devices 1 and 2 see Note 1 at the end of § 4.1.1.

At the subscriber end the connection is a U interface into an NT, at the standard ISDN 2B + D basic access 160 kbit/s (2B1Q line encoding) rate.

Device 1 (see Note 1) connects to the U interface of the NT and converts the signal to three ITU-T G.703 co-directional 64 kbit/s signals. Each of two of these ITU-T G.703 signals handles one of the B-channels, while the third handles the D-channel plus synchronization and maintenance data information, which enables the integrity of the 2B + D signal to be maintained through the P-MP system. Since 64 kbit/s ITU-T G.703 co-directional interfaces are generally available on P-MP systems, three such interfaces can readily be used to carry the three 64 kbit/s signals to the central station (C/S). At the C/S the reverse process occurs and the three 64 kbit/s signals are converted in device 2 (see Note 1) to a U interface again – an exact replica of that from the NT. This U interface is then connected to the ISDN switch in the usual way, providing access to the ISDN itself.

The P-MP system can, of course, carry many different types of traffic (2W voice, 4W, data, etc.) simultaneously with ISDN services. A number of ISDN 2B + D signals may be carried through the P-MP system from various locations into the ISDN providing interconnectivity between each other and the ISDN as a whole.

This method offers a relatively straightforward way of adding ISDN circuits to an existing P-MP system without any down time. A number of ISDN circuits may be implemented economically on new systems which may be useful in the provision of ISDN services.

Note 1 – Devices 1 and 2 may be included in the P-MP system or physically separate.

4.1.2 Another solution uses only two and a half circuits (i.e. two ITU-T Recommendation G.703 64 kbit/s circuits, plus one 32 kbit/s circuit) for the transmission of the basic rate (2B + D). This solution permits the carrying of the D-channel somewhat more efficiently, whilst retaining many of the features of solution 4.1.1.

4.2 Effect on the system capacity

Demand assignment of circuits is preferred when more efficient use of the frequency spectrum is desired. For example, if fixed assignment is used, a radio system which has 30 circuits capacity could only accommodate 10 (for solution 4.1.1) to 12 (for solution 4.1.2) subscribers, providing them with 2B + D basic interface service. In contrast, use of demand assignment of 2B + D circuits provides a traffic capacity of 5.9 E with a lost call rate of 1%. Consequently a system with the same transmission capacity could accommodate about 60 subscribers with 0.1 E call rate.

Similarly, 20 channels of B + D could be provided when most subscribers use only one B-channel. In this case, the radio system can provide a traffic capacity of 12.0 E for 120 subscribers. Consequently, demand assignment and individual channel assignment are preferable from the viewpoint of frequency band utilization.

While demand assignment procedures are relatively straightforward to implement for the connection at the S reference point (as mentioned in § 3), such procedures are more complex for the connection at the U reference point.

ANNEX 2

Examples of methods for demand assignment, multiple access of ISDN links on a point-to-multipoint system

1. Introduction

This Annex describes two possible methods for the assignment on demand of ISDN circuits on a point-to-multipoint system.

2. First method: P-MP system seen as an ISDN repeater

This method consists of considering the point-to-multipoint system as an ISDN repeater: this architecture requires the allocation of a half time-slot (one time-slot: 64 kbit/s, half a time-slot: 32 kbit/s) per declared ISDN subscriber in order to transmit transparently the D-channel and maintenance to the ISDN terminal (16 kbit/s are used for the D-channel and 16 kbit/s for the maintenance channel). The B-channels are allocated dynamically according to subscriber needs by decoding of the 1, 2 and 3 layers of the ISDN protocol and detailed analysis of the resultant signalling.

In such a case, the interfaces between the ISDN switch and central station can either be individual U type or multiplex type ($12 \times (2B + D)$ at 2.048 Mbit/s).

2.1 Advantages

– The point-to-multipoint system preserves its role as a repeater and has a clear status which is provided for in the present ISDN Recommendations.

– The D-channel protocol is passed transparently between the ISDN switch and the subscriber (resources are always available).

– Maintenance signalling is passed transparently to the subscriber-side U interface at the remote station so that the switching exchange can control the NT on the subscriber's premises and permanently supervise transmission quality.

2.2 Disadvantages

– A half time-slot is permanently occupied for each declared ISDN subscriber, which means that the number of ISDN subscribers per system is limited.

3. Second method: P-MP system seen as an ISDN concentrator

3.1 General description

With this architecture, the TDMA point-to-multipoint transmission system dynamically allocates the ISDN B-channels according to demand and concentrates the D-channels.

The data flow over the D-channels is sporadic and it is more efficient to concentrate all the ISDN subscriber signalling channels in one $n \times 64$ kbit/s signalling link than to provide a 16 kbit/s channel for each ISDN subscriber.

This method therefore enables the number of subscribers to be optimized in terms of the system resources available. However, this architecture raises the issue of the place of the point-to-multipoint transmission in the network; the very important aspect of maintenance at the U interface becomes more complex to manage and time delays which occur in the system may also give rise to difficulties. The point-to-multipoint TDMA system itself may have to send maintenance tests over the U interfaces at the remote station and supervise their transmission quality. Subject to these limitations the use of basic or primary rate interfaces between the central station of the point-to-multipoint system and the ISDN switch is possible.

3.2 Transmission of signalling data and the D packet between the central station and remote stations

The first solution is to pass the signalling information plus the D packet data over the same signalling link (which will be a multiple of 64 kbit/s).

The second solution involves a separation on transmission of the signalling part in the D-channel from the packet part in the same D-channel.

3.2.1 Single signalling plus D packet channel

Since signalling between the ISDN automatic switching exchange and the central station is transmitted over point-to-point links, there is no collision due to random access. That is not the case in a point-to-multipoint system between remote stations and the central station, because the remote stations transmit over the signalling channel in random access. If the number of collisions rises excessively in the signalling channel, communication over that channel loses much of its efficiency. This means that the dimensioning of the internal signalling channel is important.

Two methods may be applied, one static and the other dynamic.

3.2.1.1 Static dimensioning of the internal signalling channel

Under this dimensioning mode, the network operator allocates a fixed number of time-slots to the signalling link, depending on the total number of ISDN subscribers served by the point-to-multipoint transmission system and the number of ISDN subscribers who have taken out a D packet subscription.

3.2.1.2 Dynamic dimensioning of the internal signalling channel

In this case, according to the number of collisions occurring in the remote station-to-central station direction within the signalling link and the transmission delay incurred, the software establishes new time-slots or releases surplus ones. Similarly, in the central station-to-remote station direction, the software adapts the number of signalling link time-slots according to the length of the transmission queue.

Note 1 – Data recovery is a complex matter whichever method is used, since information which may be transiting in different time-slots must be properly re-ordered.

3.2.2 Signalling and D packets carried independently

The approach for this architecture is different. The principle is to separate the signalling in the D-channel from the D packet and to transmit each of them independently.

Although more complex to manage, this method should permit full optimization of the time-slots used for transmitting the information contained in the different D-channels of all ISDN subscribers.

3.2.2.1 Signalling

ISDN signalling will travel over a signalling link at $n \times 64$ kbit/s. Such a signalling link will have random access in the remote station-to-central station direction. It will be dimensioned either dynamically or statically, as indicated in § 3.2.1.

3.2.2.2 The D packet

D packets will travel over a sub-rate link. Initial signalling information is passed over the random-access signalling link in order to establish the sub-rates.

With this method, X.25 level 3 management is conducted to monitor the line and determine the X.25 "D packet" communication requirements (X.25 call set up/release, necessary bit rate, etc.).

4. Summary

The second architecture, which confers on the point-to-multipoint TDMA transmission system a genuine ISDN concentrating role, is the most efficient in terms of resource occupancy. However, the notion of an ISDN concentrator is not yet defined in the Recommendations on the local grade portion of the ISDN connection.

The solution of a P-MP system as a repeater at the U interface level providing D-channel and maintenance channel transparency may be well suited to the current network architecture where both ISDN and non-ISDN circuits may be present.