REPORT 1176*

INTERWORKING BETWEEN THE MOBILE SATELLITE SYSTEMS AND THE TERRESTRIAL NETWORKS FOR DATA TRANSMISSION SERVICES

(Question 89/8)

(1990)

1. Introduction

Question 89/8 addresses the topic of "compatibility for interworking between the mobile-satellite systems and terrestrial networks including ISDN". This Report takes into account the relevant CCITT studies, in considering appropriate technical characteristics for future mobile-satellite systems.

The INMARSAT (International Maritime Satellite Organization), operating the global maritime satellite communication system, will provide several new services in the near future. In addition to this, several national/regional mobile satellite communication systems have been planned in various countries, and are expected to be commercially available in the near future. Some planned mobile satellite communication systems are going to employ advanced digital technologies. The INMARSAT new standards such as Standard-B, C and M, and the INMARSAT aeronautical mobile systems are also being digitalized.

In digital satellite communication systems, data can be directly transmitted through the digital channel, and be connected more efficiently with the terrestrial data network, including at a later stage, through the ISDN.

For the data transmission services, CCITT has been drafting many recommendations which are mainly applicable to the terrestrial data networks. CCITT SG XVIII is studying the integration of the mobile services into the ISDN.

2. CCITT Activities

Besides Recommendations for the telephone and telex services of the INMARSAT Standard-A system, the data transmission services are already specified in the Recommendations X.350 series, which give guidance for the connection of the data channel through the INMARSAT Standard-A voice channel with the terrestrial PSPDN (Packet Switched Data Network).

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* The Director, CCIR, is requested to bring this Report to the attention of the CCITT.

Recommendations for the interface and interworking conditions of the future INMARSAT digital satellite communication systems, such as Standard-B and aeronautical systems, with the terrestrial PSTN/ISDN are also provided as CCITT Q.1100 series.

With regard to the ISDN, CCITT has produced many recommendations, and the general concept of the ISDN-based basic interface (2B+D) has been developed. Question S/XVIII dealing with the integration of mobile services into the ISDN was adopted in 1988. The interworking and interfacing between the mobile system and the ISDN are being studied by CCITT SG XI.

3. Data Transmission

Data transmission in the mobile satellite network is categorized into two cases; one is data transmission through the analogue voice channel by using the voice-band modem, and the other is direct data transmission through the digital channel. However, there will remain a need for voice band data services for some time. In future mobile satellite communication systems, it is expected that digital transmission technologies will be widely employed not only for the effective use of the space segment but also for harmonization with the terrestrial data network.

Figure 1 shows typical data transmission models, which are classified from the viewpoint of the interworking between the satellite systems and the terrestrial networks such as PSTN, PSPDN, CSPDN (Circuit Switched Data Network) and ISDN, taking account of the future evolution of the satellite system and the terrestrial network toward ISDN.

MODEL-1: The data is transmitted through the analogue telephone channel of the mobile satellite system and the PSTN by using a voice-band modem.

MODEL-2: The digital data channel is provided in the mobile satellite system. However, the land earth station does not provide the capability of direct access to public data network, and thus the satellite data channel is connected with the terrestrial data network via PSTN.

MODEL-3: The digital data channel is provided in the mobile satellite system, and the land earth station provides the capability of direct access to public data network. In this case, the complete end-to-end data channel is established.

MODEL-4: The ISDN is assumed to be used as the terrestrial data network. In this case, two scenarios can be envisaged. One scenario is that the mobile satellite systems do not provide any particular ISDN capability. In this case, the Non-ISDN mobile satellite systems must be connected with the terrestrial ISDN by using the conventional Non-ISDN interface condition. The other scenario is that the mobile satellite system does provide ISDN. In this case, the full/partial ISDN services will be provided for mobile users.

4. Signalling Protocols
(To be developed)

Annex I discusses the development of signalling protocols for the Future Public Land/Aeronautical Mobile Telecommunications Systems (FPL/AMTS).

5. Interface Point and Conditions
(To be developed)

6. Channel Quality
(To be developed)

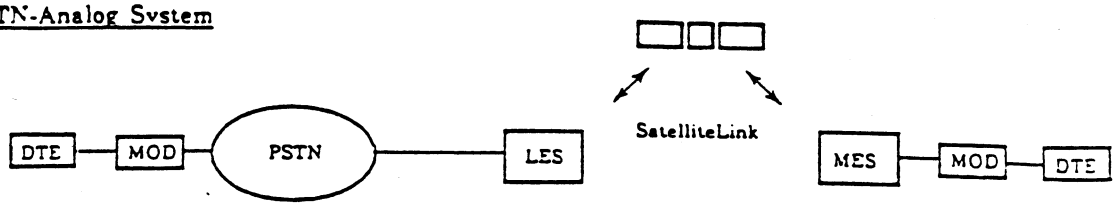
7. Channel Rate
(To be developed)

8. Conclusion

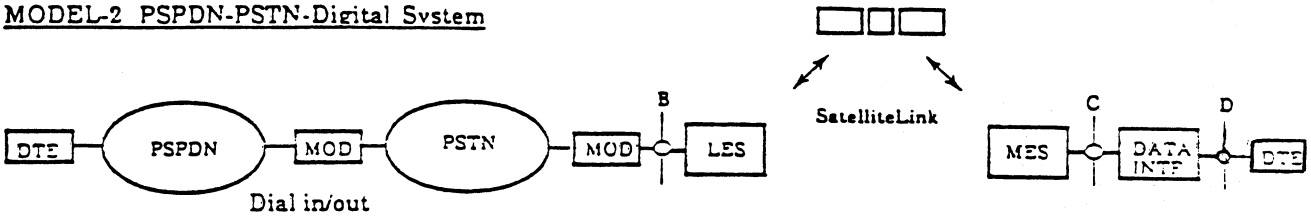
Efficient interworking between mobile satellite systems and terrestrial data networks involves the consideration of various technical parameters. Four models of end-to-end data transmission systems are considered above.

It should be noted that requirements on signal quality and transmission rate may depend on the type of services such as message and facsimile.

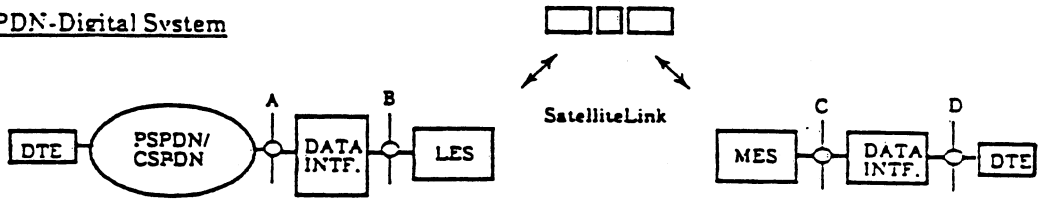
MODEL-1 PSTN-Analog System



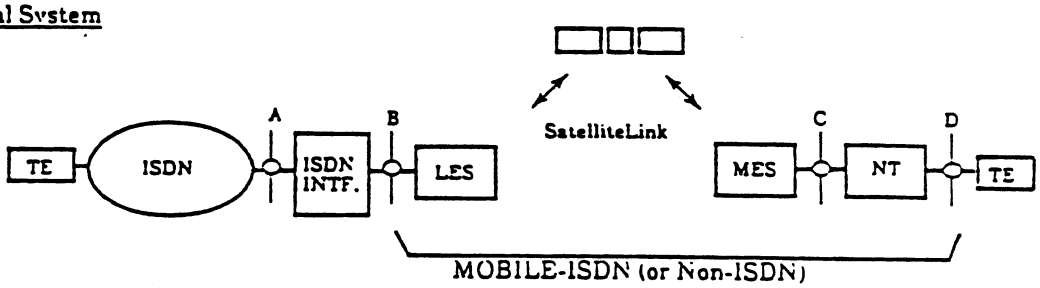
MODEL-2 PSPDN-PSTN-Digital System



MODEL-3 PSPDN/CSPDN-Digital System



MODEL-4 ISDN-Digital System



DTE: Data Terminal
INTF.: Interface
MES: Mobile Earth Station
LES: Land Earth Station
TE: Terminal Equipment for ISDN
NT: Network Termination

*A.B.C and D indicates the possible interface points

Figure 1 Data transmission models for mobile satellite system

ANNEX I

The development of signalling protocols for the future public land/aeronautical mobile telecommunications system (FPL/AMTS)

1. Introduction

The FPL/AMTS will provide a wide range of telecommunications Services. The support fo these services will require the provision of network functions and the definition of signalling protocols for use both over the radio system signalling channels and within the network. This Annex considers the steps involved in identifying the network functions and developing the details of the signalling protocols for these services which are connected to the fixed public networks (telecommunication services).

Digital transmission and signalling systems offer scope for the support of sophisticated and relatively complex Telecommunications Services. The designer of these systems is faced with a multitude of possible solutions to a particular problem, all of which can fulfil the same objective through the use of different protocol structures, message types and information flows. In view of the use of common resources within the fixed network for the support of different types of customer access - for example ISDN, PSTN, CT and FPL/AMTS - it is essential that a common structured "Method" is adopted so that conflicting requirements on the fixed network are avoided.

It is recognized that it is necessary at the outset to define basic reference configurations in order to establish a common understanding of what is precisely meant by the functional groupings such as "network", "terminal" and "radio system". In the case of the FPL/AMTS it may be necessary to define the functions of a Base station/earth station, etc and certainly those of the actual Mobile Station will need to be documented. The reference configuration leads to the definition of reference points which allow a clear demarcation between blocks performing specific functions eg in the Base station/earth station a split between the functions controlling the radio and network resources. Not all "reference points" assume significance as a standardised physical interface. However, clearly that between the mobile station and base station/earth station must!

The definition of an interface is not simply restricted to the "physical" connection. It also needs to include the procedures that need to exist across the interface for controlling functions in the adjacent pieces of equipment. These procedures are usually referred to as protocols and will exist for both controlling the establishment of connections across networks (signalling) and for the secure transfer of information.

The reference configuration provides a means by which the functions of entities and interfaces between them can be related in a clear and unambiguous manner. Procedures are therefore necessary to determine the functional and interface (which includes protocols) requirements based upon the original statement of requirements for the system being developed.

The approach adopted by CCITT [1] is to first define the overall objective in terms of the telecommunications services that are to be offered to the user. These service definitions can be viewed as fulfilling two broad objectives; they are a clear statement of what the customer is to be offered when he subscribes to the service and they also act as the basis for developing a statement of requirements for the functions required in the entities that comprise the system.

The second step is to identify the actual entities (exchanges, databases etc) and Information Flows needed to support these functions. In the case of FPL/AMTS this will include the Mobile Station, the Base station/earth station and the Fixed Network. The objective in defining Information Flows is to ensure that the information is available at the correct time and place so that functions can be executed correctly.

The third and final step is to define protocols that support the defined information flows and enable entities to interact in the desired way. This final step represents considerable detailed study and documentation, representing the procedures that the implementor will use as the basis for the final equipment design.

These three steps have, and are being, effectively used in producing ISDN standards (the "Method")

3 The Progress To Date In CCITT

Studies in CCITT have resulted in a reference configuration [2] being developed for the support of Services on the ISDN. A "Method" [1] has also been developed which details the steps, as outlined above, required to define protocols to support the various telecommunications services. Both customer to network and intermodal protocols (CCITT SS No 7) have been defined for the support of both basic and supplementary services.

The use of the "Method" allows the different aspects of the work to be given to appropriate study groups, each one having a clear understanding of its responsibilities and relationship with the others. In CCITT SGXVIII provides overall guidance regarding Reference Configurations, techniques for Service Description and general Network Aspects. SGII provides technical service description which are then used by:

- SGXVIII and SGII for Network Aspects concerning Numbering, Routing and Interworking;
- SGXI WP5 for definition of Information Flows;
- SGXI WP6 for customer to network signalling;
- SGXI WP2 for Intermodal Signalling (No7).

[This structure is dependent on the new study groups within the next CCITT plenary period]

4 Future FPLMTS Studies

4.1 Reference Configuration

The reference configuration already developed for the ISDN [2] could be used as the basis for the FPLMTS. Clearly additional functions and groupings will be required to reflect

the existence of Base Stations and the special nature of the air interface. The advantages of this approach include:

- the ISDN reference configuration is already well developed and is being used by all international standards bodies developing ISDN associated recommendations;
- the ISDN reference configuration has resulted in interfaces being defined between the "network" and "terminal" equipment. The adoption of the same interface(s) for FPLMTS would enable standard ISDN terminals to be used with the consequential savings of cost etc.

4.2 Service Definitions

Telecommunications services can be divided into two fundamental types which are:

- Basic Services, and
- Supplementary Services.

Basic Services represent the communications abilities offered to the customer using the FPLMTS. A distinction is drawn between Teleservices and Bearer services. Teleservices are those services that rely upon both standardised Terminal and Network functions and include such services as Teletex, Facsimile and Telephony. Bearer services represent a capability offered to the customer to transmit information across the network without referring to the actual application or standardised terminal functions. Bearer services include Data Transmission (64Kbit/s Unrestricted in the ISDN) and 3.1KHz Audio for the transmission of voice band data.

Supplementary Services are services that are used in addition to the basic service. Services such as Call Diversion, Calling Line Identity and Advice of Charge fall into this category.

There has been much detailed study within the ISDN standards fora regarding service definitions. Basic services are perhaps the easiest to consider in view of network and transmission medium restrictions that clearly restrict the possible options. Supplementary services require considerable effort because of their interactive nature and many possible variants on a basic theme.

FPLMTS service definitions should, where possible, be aligned with those of the ISDN in order to avoid conflicting and new requirements being placed upon the network, specifically the intermodal signalling system (CCITT SS No7). In particular, great care should be exercised when defining Supplementary Services as, by their nature, they will interact with other types of user on the network.

FPLMTS Basic Service definitions will have to reflect the environment in which the service is being offered. It may not be practical to offer ISDN like bearer services, however it is essential that consideration is given to the restrictions that will result from adopting "non standard" rates. For example the availability of a 32Kbit/s transparent bearer service at the FPLMTS would be only suitable for calls to other FPLMTS users! The development of service definitions should therefore consider the requirement for communicating with other types of user connected to the network and state what is required when "interworking" with other types of user is encountered. An obvious example where interworking will be required is Telephony where the requirement should be self explanatory! However special consideration may be necessary for emergency services, operator services etc.

4.3 Identification and Allocation of Functions and Information Flows

The service definitions, reference configuration and Information Flows will provide the basis for identifying the functions required within the system and for the development of the signalling protocols. The functions will include radio system management, security including encryption and authentication if required, charging and accounting, interworking etc. In most cases it will be obvious where the particular function should be incorporated into the system ie in the Mobile Station, the Base station/earth station or the fixed network - however it is important to reach a clear understanding at the outset in order to avoid duplication or omissions. Network functions have been identified for the ISDN [3]; the network requirements for FPLMTS should build upon those for the ISDN, identifying additional functions as necessary. The information flows required for FPLMTS should, as far as possible, use those developed for the ISDN. Clearly additional information flows will be needed to reflect specific FPLMTS requirements, however those required in the network for the support of basic and supplementary services should ideally remain unchanged.

4.4 Protocols

The culmination of the above activities should result in a clear statement of requirements for protocols that support signalling and the transfer of data in the FPLMTS.

Signalling protocols will be required for controlling the radio system, for call control via the radio system, and for use in the fixed network. Those required for controlling the radio system will need to be developed specifically for FPLMTS and are expected to require the largest resourse.

The protocols required for call control via the radio system could be readily based upon those developed for the ISDN; considerable effort has been expended in this area, the results being contained in a number of large and detailed recommendations [4]. A different approach in this area could prove to be very costly and time consuming.

The protocols required for the transfer of user data will need to take into account the transmission performance of the Air Interface. Specially designed protocols may be required in view of the possible higher error rates associated with radio systems at the extremes of the coverage area, (particularly relevant for the terrestrial aeronautical service). The use of protocols different from those defined for the ISDN may, however, require interworking functions at the Base station/earth station.

5 Conclusion

The "Method" as indicated in section 2 has been proven in the design of a communication network (ie by CCITT for ISDN) and the development of signalling protocols for the FPLMTS should be progressed according to the same "Method". This will avoid conflicting requirements being placed upon the fixed network and allow the ISDN signalling protocols to be readily developed for use by FPLMTS, saving considerable time and resources. A priority for FPLMTS studies is to consider the concepts of the ISDN reference configuration with a view to producing an appropriate model and to initiate some work on the definitions for services to be provided to FPLMTS users.

References

1. CCITT Recommendation I.130 - Method for the Characterisation of Telecommunications Services Supported by an ISDN and Network Capabilities of an ISDN. To appear in CCITT Blue Book.

2. CCITT Recommendation I.411 - ISDN User-Network Interfaces - Reference Configurations. New text to appear in CCITT Blue Book.

3. CCITT Recommendations

I.310 - Network Functional Principles
I.324 - ISDN Network Architectures
I.325 - Reference Configurations for ISDN Connection Types

All new text, to appear in CCITT Blue Book

4. CCITT Recommendations in Q900 Series - ISDN User-Network Signalling Protocols, Layers 2 and 3.