

RECOMMENDATION ITU-R M.1167

**FRAMEWORK FOR THE SATELLITE COMPONENT OF FUTURE
PUBLIC LAND MOBILE TELECOMMUNICATION
SYSTEMS (FPLMTS)**

(Question ITU-R 39/8)

(1995)

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1 Introduction

Future Public Land Mobile Telecommunications Systems (FPLMTS) are third generation mobile systems which are scheduled to start service around the year 2000 subject to market considerations. They will provide access, by means of one or more radio links, to a wide range of telecommunication services supported by the fixed telecommunication networks (e.g. PSTN/ISDN), and to other services which are specific to mobile users.

A range of mobile terminal types is encompassed, linking to terrestrial or satellite based networks, and the terminals may be designed for mobile or fixed use.

Key features of FPLMTS are:

- high degree of commonality of design worldwide;
- compatibility of services within FPLMTS and with the fixed networks;
- high quality;
- use of a small pocket-terminal with worldwide roaming capability.

FPLMTS are defined by a set of interdependent ITU Recommendations of which this one is a member.

The integrated terrestrial and satellite components of FPLMTS are complementary in terms of service provision. Together they cover the wide range of user densities, service types, and available service sets which comprise FPLMTS. Each component has particular advantages and constraints.

The terrestrial component provides, economically, high quality telecommunication services typically to areas of high to very high user densities. The satellite component provides users with quality telecommunication services primarily on a virtually global coverage basis, and is most economic outside those areas covered by the terrestrial component. Additionally to providing this global coverage, the satellite component may, in more densely populated areas, precede and encourage later coverage by the terrestrial component.

2 Scope

Recommendation ITU-R M.818 sets the overall requirements of the satellite component of FPLMTS. Recommendation ITU-R M.1035 describes the framework of the radio interfaces of FPLMTS taking particular account of the terrestrial component.

This Recommendation together with Recommendation ITU-R M.1035 describes the technical and operational capabilities and features of the satellite component, particularly where they are distinct from those of the terrestrial component. It forms the framework for further development of the satellite component of the integrated overall systems of FPLMTS.

In particular, the Recommendation comments on the aspects of integration with the terrestrial component, operational considerations, network interfaces and radio interfaces.

2.1 Purpose

This Recommendation builds upon Recommendation ITU-R M.818 in particular, to provide input material firstly to the derived Recommendations on radio interface selection procedures for satellite system and subsequently to the key choices and specifications of FPLMTS satellite component, as well as the guidelines for satellite system design.

3 Structure of the Recommendation

This framework Recommendation sets out a number of considerations in the form of outline discussions which are grouped together into sections on: distinct features of the satellite component (§ 6); integrated satellite and terrestrial components (§ 7); standardization/commonality of interfaces associated with the satellite component (§ 8); and services supported by the satellite component of FPLMTS (§ 9). The considerations form a part of the overall Recommendation and the specific Recommendations, shown in bold and italics, follow the discussions within the relevant section.

4 Related documents

Recommendations ITU-R M.818, ITU-R M.819, ITU-R M.1035, ITU-R M.1036 and ITU-R M.1078

5 Abbreviations

CDMA: code division multiple access

DTMF: dual tone multi frequency

e.i.r.p.: equivalent isotropic radiated power

FDMA: frequency division multiple access

FSS: fixed-satellite service

GSO: geostationary orbit

HEO: highly inclined elliptical orbit

IN: intelligent network

ISL: inter-satellite link

LEO: low-Earth orbit

LES: land earth station

MEO: medium Earth orbit

MES: mobile earth station (See Note 1)

MS: mobile station (See Note 1)

MSS: mobile-satellite service

PES: personal earth station (See Note 1)

PS: personal station (See Note 1)

SP: satellite pager

TDMA: time division multiple access

UPT: universal personal telecommunication

NOTE 1 – It should be noted that in this Recommendation the expressions (mobile) station and (mobile) terminal are equivalent.

6 Distinct features of the satellite component of FPLMTS

6.1 Key features of the satellite component of FPLMTS

- The geographical coverage of any one satellite is likely to be much larger than that of any cluster of terrestrial base stations.
- Coverage is likely to be by means of a number of spot beams from any one satellite – each spot beam is likely to be larger than any terrestrial cell.
- Coverage by satellite can be regional, multiregional or global.
- Potential orbit constellations will fall into a number of categories, such as GSO, LEO, MEO, HEO; each with its own particular properties (e.g. propagation delay, Doppler shift etc.) and FPLMTS design implications.
- Technical and/or economic considerations may constrain the distribution and the number LES (forming gateways to the fixed networks) which can be accommodated in a satellite system.
- The Radio Regulations provision No. 746A identifies frequencies on a worldwide basis for FPLMTS of which some frequencies are additionally identified for the satellite part of the system. It should be noted that it may be desirable to dedicate the use of this band to the satellite component rather than share with the terrestrial component.
- The terrestrial and satellite components of FPLMTS should be optimized taking the existence of the other component into account.
- The LESs will connect to the satellites using feeder links which operate in frequency bands outside those identified for mobile satellite and FPLMTS operation. The feeder link frequencies may be used by other satellite systems and terrestrial systems, and appropriate sharing criteria need to be observed.

- ISLs if used, will operate outside the FPLMTS band.
- When using the satellite component in indoor locations, it may be necessary to enhance performance by suitable orientation and location of the antenna.
- It is assumed that there will be more than one satellite system possibly utilizing different satellite constellations in operation and that they will be in competition. However, even with only one satellite system in operation, multiple service providers can provide competition in service provision to users.

6.2 Coverage and handover

For the terrestrial component of FPLMTS, geographical coverage is provided from base stations which communicate over relatively limited ranges giving service to users within that range; the coverage area thus formed is termed a cell. To achieve continuity of coverage a number of contiguous cells are provided and, for users in motion, the system automatically transfers calls in progress from one cell to another. This transfer involves functionality in both the mobile and in the base station together with its infrastructure. The transfer process is termed handover.

In the satellite component, continuity of coverage is provided by the contiguous footprints of (spot) beams from one or more satellites in a constellation. For non-geostationary satellites, these footprints will be in motion, and continuity of calls in progress, whether for mobile or stationary users, is achieved by handover between beams; again involving functionality in the mobile and in the satellite component.

The importance of handover depends upon the expected rate of handover occurrence. In a terrestrial network the rate of handover is mainly influenced by the rate at which a terminal crosses cell boundaries. However, handover due to user movement rarely happens in a satellite network since the size of a satellite cell (beam) is usually very wide compared with the moving range of a terminal during a call. In a non-geostationary satellite constellation, the satellite beams, or cells, will be in motion, necessitating a handover mechanism between beams and between satellites in order to achieve call continuity. Therefore, handover requirements may depend upon the choice of satellite constellation as well as satellite cell sizes.

Handover involving the satellite component of FPLMTS may be initiated based on prediction of the satellite movements, estimates of signal strength or quality of service parameters (bit error ratio, delay, etc.), traffic conditions or user requests. This needs to be taken into account when designing the handover mechanisms and protocols for FPLMTS.

It should be noted that such handovers in the satellite component due to satellite movement may be performed locally between the terminal and the LES through appropriate air interface protocols, and using dedicated connections between LESs (or ISL connections between satellites), if required. Thus such handovers can be performed solely within the mobility management of the FPLMTS satellite networks.

Six scenarios for handover involving the satellite component have been identified as indicated below:

- a) on the same satellite, maintain the same feeder link, handover the service link;
- b) on the same satellite, handover the feeder link, maintain the same service link;
- c) on the same satellite, handover the feeder link, and handover the service link (combination of cases a) and b));
- d) handover from satellite to satellite, handover feeder link, handover service link (satellite handover-trunk handover);
- e) handover from the satellite component to terrestrial component (intercomponent handover);
- f) handover from the terrestrial component to the satellite component (intercomponent handover).

For users of equipment which is able to access both the terrestrial and satellite components, there may be a perceived need to maintain continuity of calls in progress as the user crosses the boundary between the components (i.e. intercomponent handover). Such handovers are expected to be relatively rare and the actual implementation will be for the network operators to determine. Nonetheless, technical capability of the process involved should be further considered.

Spectrum availability or the economics of the satellite component may limit the number of FPLMTS satellite systems. If each FPLMTS satellite network provides virtually global coverage, there is no technical reason to provide handover between FPLMTS satellite networks.