RECOMMENDATION ITU-R M.1168

FRAMEWORK OF INTERNATIONAL MOBILE TELECOMMUNICATIONS-2000 (IMT-2000) MANAGEMENT

(Question ITU-R 39/8)

(1995)

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1   Introduction

International Mobile Telecommunications-2000 (IMT-2000) 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 and/or satellite-based networks, and the terminals may be designed for mobile or fixed use.

Key features of IMT-2000 are:

–   high degree of commonality of design worldwide;

–   compatibility of services within IMT-2000 and with the fixed networks;

–   high quality;

–   use of a small pocket-terminal with worldwide roaming capability.

IMT-2000 are defined by a set of interdependent ITU Recommendations of which this one is a member.

This Recommendation forms part of the requirements for specifying the radio interfaces of IMT-2000. IMT-2000 will operate in the worldwide bands identified by Radio Regulations Provision No. 746A (1 885-2 025 MHz and 2 110-2 200 MHz, with the satellite component limited to 1 980-2 010 MHz and 2 170-2 200 MHz).

The subject matter of IMT-2000 is complex and its representation in the form of a Recommendation is evolving. To maintain the pace of progress on the subject it is necessary to produce a sequence of Recommendations on a variety of aspects. The Recommendations strive to avoid apparent conflicts between themselves. Nevertheless, future Recommendations, or revisions, will be used to resolve any discrepancies.

IMT-2000 management is considered as providing the various functions necessary for planning, provisioning, installation, operation, maintenance, administration and customer services. To provide such functions, a service-specific network which permits the exchange and processing of management information between IMT-2000 equipment and/or operations systems is needed. This network could be established based on the TMN concept. TMN has been studied in the ITU Telecommunication Standardization Sector (ITU-T) which has developed the philosophy and concept of TMN and made some TMN relevant Recommendations [1]. The basic concept behind TMN is to provide an organized architecture to achieve the interconnection between various types of operation systems and telecommunications equipment for the exchange of management information using an agreed architecture with standardized interfaces.

2   Scope

The purpose of this Recommendation is to present the conceptual and methodological framework for the definition of the management of IMT-2000.

The methodology described in ITU-T Recommendation M.3020 [2] is used to define management requirements, management services, management functions, information models, and management protocols related to the management of IMT-2000.

This framework is the initial Recommendation on IMT-2000 management and identifies objectives for IMT-2000 management, and provides guidelines for the specification of Recommendations on IMT-2000 management, particularly a TMN management service on IMT-2000. Other Recommendations on IMT-2000 management will be produced by ITU in the near future.

3   Structure of the Recommendation

Section 4 of this Recommendation, provides a list of related documents. In § 5, a list of definitions commonly used throughout this Recommendation is given. Section 6 states the considerations that have been taken into account in the creation of this Recommendation. Section 7 identifies objectives for IMT-2000 management standardization, general requirements for IMT-2000 management, and provides principles for the specification of IMT-2000 management Recommendations, particularly the TMN management service on IMT-2000. Annex 1 discusses the application of TMN concept to IMT-2000 management. Annex 2 records details which should be used to produce the future Recommen-dations on IMT-2000 management.

4   Related documents

The following ITU-R and ITU-T Recommendations are related to this Recommendation:

[1]   ITU-T Recommendation M.3010 – Principle for a Telecommunications Management Network (TMN)

[2]   ITU-T Recommendation M.3020 – TMN Interface Specification Methodology

[3]   Recommendation ITU-R M.817 – International Mobile Telecommunications-2000 (IMT-2000). *Network Architectures*

[4]   Recommendation ITU-R M.818 – Satellite Operation within International Mobile Telecommunications-2000 (IMT-2000)

[5]   ITU-T Recommendation M.3200 – TMN Management Services: Overview

[6]   ITU-T Recommendation M.3100 – Generic Network Information Model

[7]   ITU-T Recommendation M.3400 – TMN Application Functions

[8]   Recommendation ITU-R M.687 – International Mobile Telecommunications-2000 (IMT-2000)

[9]   Recommendation ITU-R M.816 – Framework for Services Supported on International Mobile Telecommunications-2000 (IMT-2000)

[10]   Recommendation ITU-R M.1078 – security Principles for International Mobile Telecommunications-2000 (IMT-2000)

[11]   Recommendation ITU-R M.1034 – Requirements for the Radio Interface(s) for International Mobile Telecommunications-2000 (IMT-2000)

[12]   Recommendation ITU-R M.1035 – Framework for the Radio Interface(s) and Radio Subsystem Functionality for International Mobile Telecommunications-2000 (IMT-2000)

[13]   Recommendation ITU-R M.1079 – Speech and Voiceband Data Performance Requirements for International Mobile Telecommunications-2000 (IMT-2000).

5   Definitions

The following abbreviations are used in this Recommendation:

B-ISDN: broadband aspects of ISDN

BS: base station

CCCH: common control channel

GDMO: guidelines to define managed objects

GOS: grade of service

IN: intelligent network

ISDN: integrated services digital network

MF: mediation function (see [1])

MS: mobile station

MSC: mobile service switching centre

NEF: network element function (see [1])

O&M: operation and maintenance

OS: operation system (see [1])

OSF: operation system function (see [1])

OSI: open system interconnection (see ITU-T Recommendation X.200)

PLMN: public land mobile network

PSTN: public switched telephone network

QAF: Q adapter function (see [1])

QoS: quality of service

RBC: radio bearer control

RFTR: radio frequency transmission and receiving

RRC: radio resource control

SCEF: service creation environment function

TMN: telecommunications management network (see [1])

UPT: universal personal telecommunication

WSF: work station function (see [1])

Definitions will be developed in the future Recommendation on IMT-2000 terminology. (See also ITU-T Recommendation Q.1001.)

6 Considerations

The ITU Radiocommunication Assembly,

considering

a) that system management is related to activities which control, monitor and record the use of telecommunication resources, and which enable the evaluation of the performance of these resources;

b) the importance to ensure the integrity, the configuration flexibility and the resource status monitoring of IMT-2000, in order to provide telecommunication services to users with a certain level of quality;

c) the importance to provide an open architecture for IMT-2000 which will permit the easy introduction of technology advancements, as well as different applications;

d) that the mobility will be unrestricted in terms of location within the radio coverage area;

e) that IMT-2000 will support UPT;

f) that management capabilities can vary in complexity from a very simple connection between an OS and a single piece of telecommunications equipment to a complex network interconnecting many different types of OSs and telecommunications equipment;

g) that IMT-2000 management may extend beyond the traditional operations and maintenance activities of a stand-alone network;

h) that there is a need to support global terminal mobility among public mobile telecommunication networks in different countries or the same country;

j) that exchange of appropriate management information among IMT-2000 operators is necessary;

k) that an effective and accurate exchange of management information among operators implies the needs to satisfy organizational, security, functional, naming, and communications requirements;

l) that the inter-operation between IMT-2000 and a wide range of existing or future partner networks and services (e.g. other mobile networks, ISDN/B-ISDN, PSTN, UPT) must be addressed;

m) the need to allow the cost effective introduction and implementation of IMT-2000;

n) the existing work and results from other standards organizations on system management;

o) the need for IMT-2000 management Recommendations;

p) the importance of using management techniques for IMT-2000 which are consistent with those used in other systems;

q) the importance of an evolutionary approach towards IMT-2000,

recommends

1   to specify IMT-2000 management according to the framework given in § 7.

7   Recommendations

7.1   Recommendations for IMT-2000 management standardization

7.1.1   Objectives

IMT-2000 management should be defined in compliance with the following objectives:

7.1.1.1   To provide a management architecture, in order to support a multi-vendor IMT-2000 environment.

7.1.1.2   To define management information to be exchanged across standardized interfaces in terms of OSI model.

7.1.1.3   To support the capability of controlling IMT-2000 itself as far as possible.

7.1.1.4   To address the management and assessment of system performance and operation through the use of measurements, etc.

NOTE 1 – This would enable an IMT-2000 operator to make comparisons with its service quality criteria and objectives.

7.1.1.5   To improve service assistance and interaction with customers.

7.1.1.6   To address a flexible billing and accounting administration, so as to support charging across IMT-2000 and non-IMT-2000 systems.

7.1.1.7   To support the capability of geographical dispersion of control functions.

7.1.1.8   To provide common methods for the provisioning of IMT-2000 services by IMT-2000 management.

7.1.1.9   To provide the capability to report events and reaction in a common way, in order to enable remote control and to simplify maintenance interventions.

7.1.1.10   To minimize the complexity of IMT-2000 management.

7.1.1.11   To minimize the load caused by management traffic when the telecommunications network is used to carry it.

7.1.1.12   To define methods and control to be employed to effect as quick as possible set up and changes to the system.

NOTE 2 – This would enable a safe, continuing extension and enhancement of offered IMT-2000 services.

7.1.1.13   To enable the support and control of a growing number of resources. This would allow the system to start from a small and simple configuration and to grow as needed both in size and complexity.

7.1.1.14   To support the system to be configured for the condition of not only a high traffic area but also a low traffic area, e.g. rural remote area.

7.1.1.15   To allow for enough flexibility in the configuration of the system such that particular IMT-2000 operator requirements concerning the availability of IMT-2000 services may be met.

7.1.1.16   To address the convergence of IMT-2000 management for the operation of terrestrial and satellite components of IMT-2000.

7.1.1.17   To allow also the management of IMT-2000 radio-connected "infrastructure" (e.g. mobile base stations).

7.1.1.18   To address interworking between IMT-2000 operators, whether public or private, covering overlapping or adjacent areas.

NOTE 3 – This will allow IMT-2000 services provision by more than one operator in any area of coverage, and a continuity of service between IMT-2000 environments.

7.1.1.19 To specify standards to support the exchange of necessary and/or desirable management information between IMT-2000 operators, whether public or private.

NOTE 4 – This would support inter-operators roaming from mobile users.

7.1.1.20 To reuse the existing relevant standardization work on management of PLMN, IN, ISDN/B-ISDN, etc. already carried out by other standardization bodies.

7.1.1.21 To address IMT-2000 interworking with a wide range of existing or future partner networks and services such as other mobile networks, ISDN, B-ISDN, PSTN, UPT.

7.1.1.22 To support and control the management of the security aspects in IMT-2000 such as cryptographic key administration and access control management.

7.1.1.23 To take account of existing and developing mobile telecommunication networks and systems that may wish to evolve towards IMT-2000.

7.1.2   General requirements for IMT-2000 management

The objectives for IMT-2000 management must now be analysed from different viewpoints (e.g. service quality aspects, management functional areas) to identify general requirements for IMT-2000 management.

NOTE 1 – IMT-2000 operator refers to an IMT-2000 network operator or an IMT-2000 service provider or to both of them, according to how the responsibility is shared between the network operator and the service provider.

NOTE 2 – A direct assignment of O&M functions and activities to functional blocks is not possible before the definition of network architecture. This statement is at the moment valid for all network components of IMT-2000.

7.1.2.1   Service quality

IMT-2000 operators should be able to select criteria for the evaluation of the IMT-2000 service quality. The following requirements, from an operator's perspective, have been identified:

–   to recognize the kind of service and related service quality;

–   to monitor the service quality;

–   to be able to recognize the different kinds of terminal;

–   to support handover between networks while maintaining the appropriate quality;

–   to support the demand of users to communicate in every network with the appropriate service quality;

–   to support the functionality to indicate degraded service quality to the user/terminal;

–   to cooperate on service quality issues with other network management systems.

7.1.2.2   Service and business areas

This section provides the general IMT-2000 management requirements, from an IMT-2000 operator point of view, for the following aspects:

–   subscriber and user administration;

–   charging and billing (e.g. collection of charges from subscribers);

–   inter-operator accounting (e.g. collection of charges from other operators);

–   service management.

7.1.2.2.1   Subscriber and user administration

IMT-2000 management should include the management functions associated with the administration of data (possibly distributed over several databases), related to the provision of IMT-2000 services to subscribers and users. The use of a unique user identification and of a unique equipment identification needs to be foreseen.

Every user is associated with a subscription. Every subscription is associated with a service provider.

7.1.2.2.2   Charging and billing

In IMT-2000 there will exist different possibilities to charge for calls:

a)   *Normal case*

In this case usage records are created by the network operators. These usage records will be collected by the appropriate service providers for billing.

b)   *Hot billing after the call* (credit card callings)

In this case the network operator bills the credit card agency for the call after collection of all relevant usage records.

c)   *Hot billing during the call* (prepaid cards or cash)

In this case the network operator deducts units from the prepayment while the call is in progress.

IMT-2000 management should provide the means to apply proper charging according to cases a) to c).

Usage records are transferred to the service provider of the involved users.

Originating, transit and terminating IMT-2000 operators should be able to do usage metering.

Usage metering of network resources for the purpose of billing shall be the responsibility of the network operator.

IMT-2000 management should enable IMT-2000 operators to register certain kinds of handovers, in order to be able to charge differently depending on handover cases (e.g. terrestrial/satellite).

IMT-2000 management should enable IMT-2000 operators to charge for the usage of location management procedures.

In order to enable different charging techniques during the call (e.g. directly to the user), IMT-2000 management should provide mechanisms to manage the exchange of charging information, e.g. when a handover is invoked.

7.1.2.2.3   Inter-operator accounting

Inter-operator accounting should be verifiable. This implies that when traffic over a given connection or link between two IMT-2000 operators is to be charged, usage metering needs to be done on both sides: outgoing (Operator A) and incoming traffic (Operator B).

The service provider will be able to collect usage records relating to use of resources from all involved network operators.

Inter-operator accounting should result in an exchange of usage metering information based on the actual route.

Usage metering of signalling traffic (out of call procedures: e.g. interrogation, location updates) for the purpose of inter-operator accounting might be needed.

7.1.2.2.4   Service management

IMT-2000 management should allow the use of IMT-2000 for the purpose of providing its services to fixed users.

IMT-2000 management should support the use of IMT-2000 for the purpose of providing its services to fixed users, as well as to mobile users.

IMT-2000 management should allow service management even in the case of shared infrastructure.

IMT-2000 management should support IMT-2000 operation (interworking) with a wide range of existing or future partner networks and services (e.g. other mobile networks, ISDN/B-ISDN, PSTN, UPT). This should allow the desired services to be offered in a cost-effective way.

7.1.2.3   Security management area

This section provides the general IMT-2000 management requirements for the following aspects:

–   management of IMT-2000 specific security mechanisms and algorithms,

–   key management,

–   encryption management,

–   authentication management,

–   access control management,

–   service barring list management,

–   security audit management,

–   management of subscriber related credential information,

–   information exchange regarding security management.

NOTE 1 – Security management standardization is concerned with the management functions allowing IMT-2000 operators to perform administration of the security features of the network (e.g. handling of security alarms).

NOTE 2 – Security management standardization is not concerned with the definition of security features (e.g. cryptographic key generation and distribution).

7.1.2.4   Performance monitoring area

This section provides the general IMT-2000 management requirements for the following aspects:

–   performance data generation and collection (e.g. for QoS/GOS analysis),

–   traffic measurements,

–   subscriber activity tracing.

IMT-2000 management should support the use of measurements from, e.g. handover, user registration, location updating and paging, for performance and planning purposes.

The measurement data produced by the network could be used for:

–   traffic measurements (e.g. successful/unsuccessful handovers per a group of base stations per hour);

–   evaluation of current network configuration (e.g. ratio of handover attempts and successful handovers per cell). The measurement results can be further processed in the network planning and reconfiguration part of TMN;

–   evaluation of possible fault situations around the IMT-2000 network (e.g. number of successful and failed handovers per source/target cell).

7.1.2.5   System configuration area

This section provides the general IMT-2000 management requirements for the following aspects:

–   spectrum management,

–   system extension (e.g. introduction of a new network element or function),

–   system reduction (e.g. removal of a network element or function),

–   system modification (e.g. change of an existing network element or function),

–   interworking with other systems.

IMT-2000 management should support:

–   the flexibility to manage a wide range of cell types;

–   reconfiguration of assigned frequency blocks (spectrum management) in response to changing traffic, service requirements or spectrum allocation, allowing efficient and economical use of the radio spectrum;

–   provision of access to IMT-2000 dependent on the mobile terminal type or location;

–   provision of access to IMT-2000 for fixed users;

–   reconfiguration of the system without disrupting the normal provision of services;

–   the management of the relevant configuration information used by IMT-2000 specific radio interface protocols, e.g. cell identities;

– the control of handover configuration, e.g. by allowing the selection of the handover algorithm, the selection of the candidate cells for handover for each cell individually, the configuration of the handover function, and the management of handover mechanisms characteristics;

– operators' ability to initiate maintenance activities (e.g. to clear a cell by forced handovers or no admittance of new calls);

– the management of IMT-2000 mobile network elements configuration (e.g. mobile base stations).

7.1.2.6 Maintenance area

Operators need to maintain the system (telecommunication equipment) in a state where the quality of offered services to the subscriber is acceptable. Maintenance includes techniques that aim to minimize the loss of service caused by a failure.

This section provides the general IMT-2000 management requirements for the following aspects:

– pro-active maintenance (e.g. routine maintenance activities, transmission relevant failure information to manufacturers);

– detection/localization/isolation of failure (e.g. monitoring, analysis of operating trends, analysis of customer complaints);

– reactive maintenance (e.g. repair and restore the network functions).

NOTE 1 – It could be expected that most faults in terminals have no impact to the network, meaning they do not disturb the network. In this case fault detection and repair is not a concern of the network operator. On the other hand there may be faults in terminals which do disturb the network. In this case it is necessary for the network operator to have the capability to deal with these problems. This subject is for further study.

7.1.2.6.1 Pro-active maintenance

The main purpose of pro-active maintenance is to minimize failure occurrences. For example, the following mechanisms can be used:

– self tests, may be used to ensure correct functioning prior to operation;

– test loops, may be used to ensure correct communication prior to operation;

– a maintenance friendly design of the equipment, so that normal maintenance activities can easily be performed by the maintenance staff;

– provision of redundant units of equipment (these units may be on hot or cold standby, depending on requirements): such units should be proved for all important units necessary to maintain the operation;

– arrangement of equipment of the network in such a way that, in case of a failure, the active part of the network can be switched to an equivalent circuit;

– establishment of a database of failure for forecasting purpose.

7.1.2.6.2 Detection/localization/isolation of failures

Detection and localization mechanisms are necessary to recover from system failures. Isolation mechanisms are necessary to minimize the impact of these failures.

If a failure occurs, this can have different effects on services depending where the fault occurs. Understanding the severity of the fault is necessary to determine the required speed of repair. For example, the following mechanisms may be used for detection, localization and isolation:

– failures have to be able to be reported in alarm messages, with information facilitating the localization and severity assessment;

– generation of alarms if IMT-2000 performance, e.g. handover performance, is below a pre-defined threshold;

– detection and evaluation of discrepancies between two hot standby units;

– recording and evaluation of call characteristics (e.g. statistical surveys of calls to avoid or to detect faults);

– analysis of user complaints;

–   the ability to perform regular and automatic testing, and test functions or facilities which can be activated on site;

–   facilities to check status information of all units;

–   analysis of operating trends to detect or describe failures using history databases;

–   performance of alarm correction, e.g. using an expert system.

7.1.2.6.3   Reactive maintenance

Once the detection, localization and isolation of the failure has been accomplished, the faulty unit (software or hardware) must be repaired or replaced.

In order to support effective maintenance, IMT-2000 management should provide the following information:

–   equipment/system status,

–   load levels,

–   trouble conditions,

–   activated network management control.

When existing, the redundant units must overtake the operation.

In order to verify the repair, it is useful for the maintenance staff to have access to the management network to initiate tests.

In case of replacement, the consistency between software and hardware versions must be verifiable.

7.2   Principles and guidelines for the specification of IMT-2000 management Recommendations

7.2.1   General

The target of IMT-2000 management is to offer a variety of functions such as planning, installation, provisioning, operation, maintenance, administration and customer services under a multi-vendor and multi-operator environment. The concept of TMN, which has been studied by ITU-T, is most beneficial for providing these functions. IMT-2000 should apply the TMN concept to its network management.

Hereafter are provided principles and guidelines for the specification of the IMT-2000 management, particularly the IMT-2000 specific TMN management service. These IMT-2000 management Recommendations should finally reflect the IMT-2000 management objectives and requirements, as defined in this framework Recommendation. In order to assist in achieving this goal, the scope of each planned IMT-2000 management Recommendation is clarified hereafter.

7.2.2   TMN management service for IMT-2000

This Recommendation should follow the new template given in [2] for the definition of a TMN management service. This includes the provision of: a management service description, management goals, a management context description, roles, resources, TMN management functions, management scenarios, and the architecture.

This Recommendation should take into account the need for the following IMT-2000 specific management activities:

–   IMT-2000 subscriber, mobile equipment and service data administration,

–   IMT-2000 charging and accounting management,

–   IMT-2000 security management,

–   IMT-2000 performance management,

–   IMT-2000 configuration management and administration,

–   maintenance of IMT-2000 infrastructure.

The exchange of management information between IMT-2000 operators (service providers or network operators) should be addressed, when relevant, for each of these management activities.

7.2.3   TMN management function sets

ITU-T Recommendation M.3400 [7] will contain the specification of both generic and specialized functionality related to TMN management functions and needed for all telecommunications activities.

ITU-T Recommendation M.3400 will provide the specification of the TMN management function sets to be used for IMT-2000 management, according to the specification of the IMT-2000 TMN management service Recommendation. The description for TMN management function sets will follow the new template given in [2]. This includes the provision of: management requirements, a functional model, summary description of each TMN management function, and detailed description of the management information.

7.2.4   IMT-2000 management information

This Recommendation should provide the definition of IMT-2000 management information which will be exchanged across standardized interfaces, according to the specifications of the Recommendation "TMN Management Service for IMT-2000".

This management information should be used to manage IMT-2000, as required and specified in the relevant TMN management function sets. The IMT-2000 management information should be described using the object-oriented paradigm in the ISO/ITU-T GDMO formal style (see ITU-T Recommendation X.722). Related work from other standard groups will be reused whenever possible and discussed within the context of IMT-2000 management.

ANNEX 1

Application of TMN concepts for IMT-2000 network management

1.1   Field of application

The following are examples of the networks, the major types of equipment, and telecommunications systems, that compose IMT-2000 and may be managed by the TMN:

–   TMN:

  –   TMN related equipment realizing TMN function blocks such as OSF, MF, QAF, WSF, and the management part of NEF (operation systems and their peripherals, etc.);

  –   TMN related equipment realizing data communication function used for information exchange between TMN function blocks;

–   mobile stations:

  –   user terminal equipment associated with mobile termination,

  –   mobile termination,

  –   user terminal equipment associated with mobile termination,

  –   pocket-sized station,

  –   portable station,

  –   vehicle-mounted station;

–   mobile stations for fixed applications;

–   base stations:

  –   fixed base stations,

  –   mobile base stations (secondary base stations mounted in vehicles, etc.);

–   other network equipment.

In addition, a TMN may be used to manage distributed entities and services offered by growing of the items in the above list.

All the equipment or grouping of equipment described above, except for TMN-related equipment realizing OSF, MF, WSF and QAF, are referred to as network elements belonging to the telecommunications environment.

1.2 General presentation of TMN

A TMN is intended to support the management requirements of an IMT-2000 operator to plan, provision, install, maintain, operate and administer telecommunications and services.

The basic concept behind a TMN is to provide an organized architecture to achieve the interconnection between various types of OSs and the interconnection between OS and network elements for the exchange of management information using an agreed architecture with standardized interfaces including protocols and messages.

Within the context of TMN, IMT-2000 management refers to a set of capabilities to allow for the exchange and processing of management information to assist IMT-2000 operators in conducting their business efficiently. OSI systems management (ITU-T Recommendations X.700-series) services and protocols represent a subset of the management capabilities that can be provided by the TMN and that may be required by an IMT-2000 provider. A telecommunication service in this context consists of a range of capabilities provided to customers.

Multiple TMNs pertaining to an IMT-2000 operator or a single TMN across IMT-2000 operators may exist.

1.3 TMN functional reference model

Figure 1 shows TMN functional reference model by illustrating an example of each pair of functions that can be associated by a reference point [1]. Figure 1 also illustrates the typical flow of information between function blocks in a hierarchical arrangement.

FIGURE 1
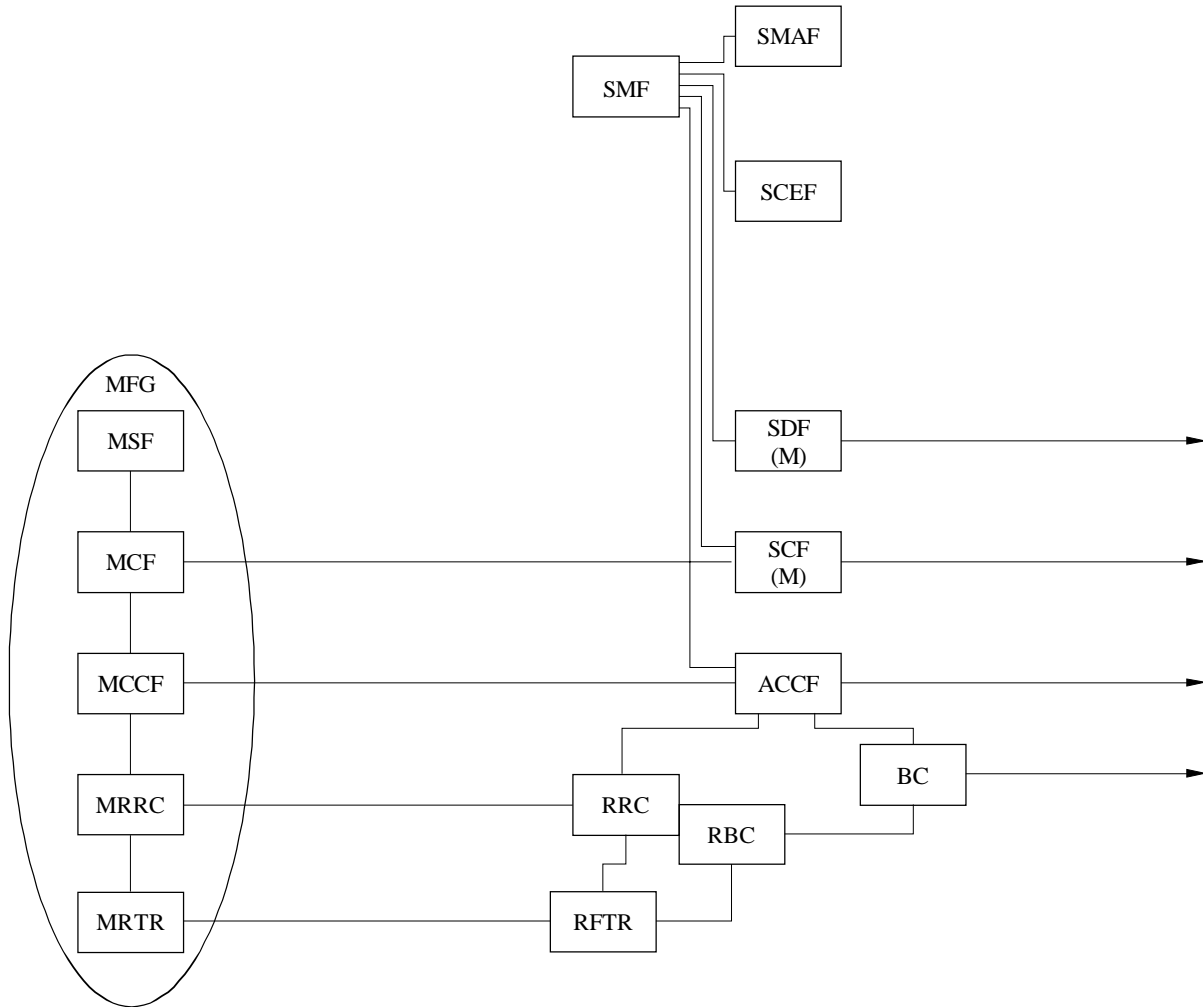
TMN functional reference model
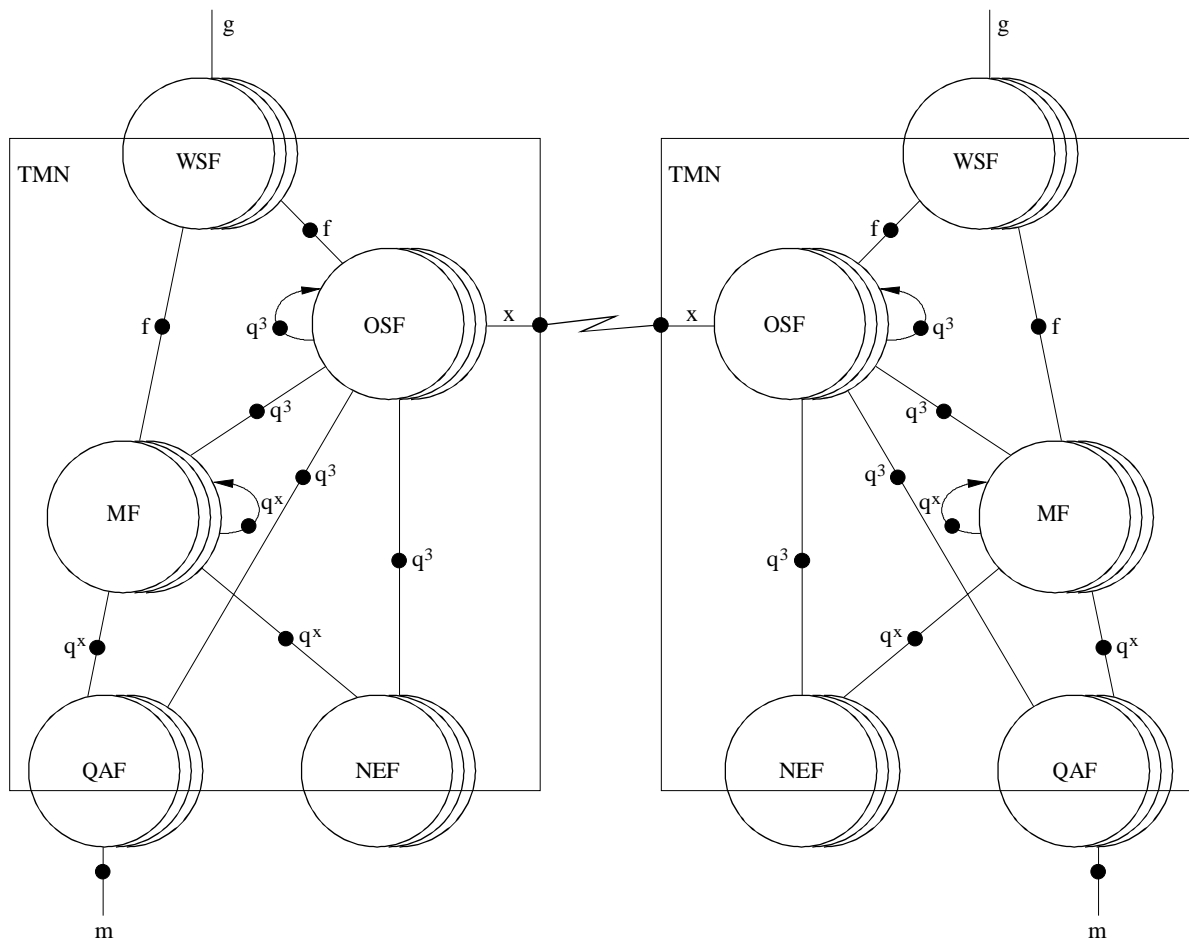
Note 1 - The allocation of functional entities to the TMN reference model including mapping of SCEF may be subject to changes in the future.

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1.4 IN management concepts for IMT-2000

Figure 2 shows the basic functional model for IMT-2000 defined in [3].

FIGURE 2

Basic functional model for IMT-2000

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                                    ┌────────┐
                                    │  SMAF  │
                        ┌────────┐  └────────┘
                        │  SMF   │
                        └────────┘  ┌────────┐
                                    │  SCEF  │
                                    └────────┘


                                    ┌────────┐
      ╭─────────────╮               │  SDF   │──────────────►
      │ MFG         │               │  (M)   │
      │  ┌────────┐ │               └────────┘
      │  │  MSF   │ │
      │  └────────┘ │               ┌────────┐
      │             │               │  SCF   │──────────────►
      │  ┌────────┐ │               │  (M)   │
      │  │  MCF   │─┼───────────────└────────┘
      │  └────────┘ │
      │             │               ┌────────┐
      │  ┌────────┐ │               │  ACCF  │──────────────►
      │  │  MCCF  │─┼───────────────└────────┘
      │  └────────┘ │                   │      ┌──────┐
      │             │                   │      │  BC  │──────►
      │  ┌────────┐ │       ┌──────┐    │      └──────┘
      │  │  MRRC  │─┼───────│ RRC  │────┘
      │  └────────┘ │       └──────┘ ┌──────┐
      │             │           │    │ RBC  │
      │  ┌────────┐ │       ┌──────┐ └──────┘
      │  │  MRTR  │─┼───────│ RFTR │
      │  └────────┘ │       └──────┘
      ╰─────────────╯
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Functions related to service management
    SMF: service management function
    SMAF: service management access function
    SCEF: service creation environment function
Functions related to service logic and service control
    SDF: service data function
    SCF: service control function
    MSF: mobile storage function
    MCF: mobile control function
Functions related to access, call and bearer control
   ACCF: access and call control function
    BC: bearer control
    RRC: radio resource control
    RBC: radio bearer control
    RFTR: radio frequency transmission and reception
    MCCF: mobile call control function
    MRRC: mobile radio resource control
    MRTR: mobile radio transmission and reception
    MFG: mobile functions group

Note 1- This basic functional model for IMT-2000 is recommended in [3]. But, the possibility to modify this model is under discussion in Telecommunication Standardization Study Group 11.

1.5 TMN/IN integration

An example of TMN reference model for IMT-2000 is shown in Fig. 3 representing mobile station (MS) and BS/MSC as separate NEFs. This figure also involves IMT-2000 basic functions shown in Fig. 2. Further study on network management interface between NEF (MS) and OSF should be carried out taking radio interface specific requirements and constraints into account.

FIGURE 3

An example of TMN reference model for IMT-2000 with basic functions
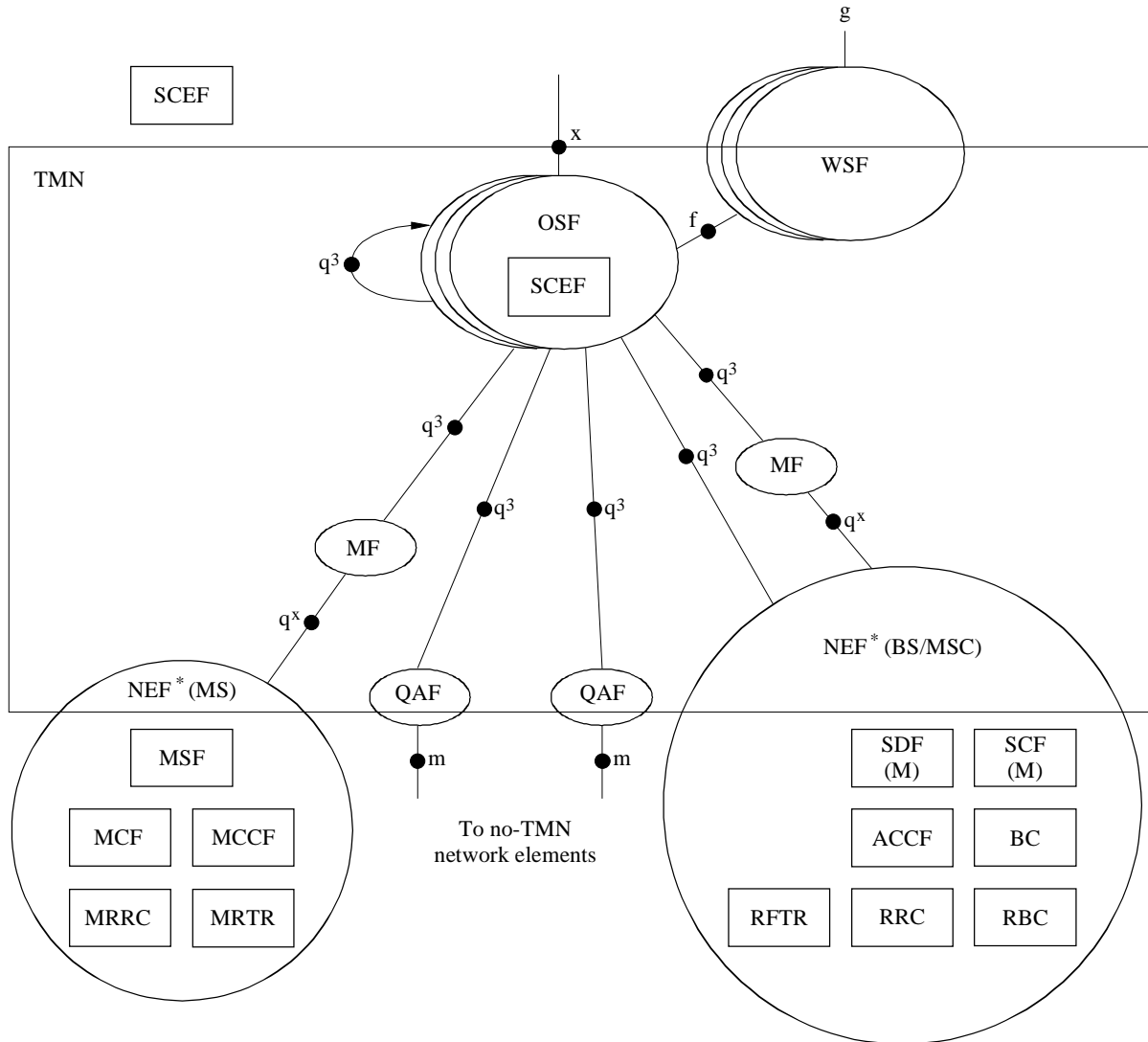
* For simplification, all IMT-2000 network functions at each of the two nodes are shown as one TMN NEF. However, for management purposes they can be viewed as a number of NEFs each containing one or more IMT-2000 network functions.

Note 1 - The allocation of functional entities to the TMN reference model including mapping of SCEF may be subject to changes in the future.

1.6 TMN interface specification methodology

ITU-T Recommendation M.3020 defines a sequence of tasks which should be followed to specify functional and protocol aspects of TMN interfaces, and their management information models. This methodology is recommended for the specification of the management of IMT-2000.

Task 1 – Describe TMN management services from the users perspective

It consists in identifying each area of management activity which is to be supported by the TMN in the form of a list of TMN management services. For each TMN management service, the TMN management goals and examples of benefits which users obtain from these goals must be identified.

Task 2 – Describe TMN management context

It consists in developing the TMN management context, by listing management roles, resources and TMN management functions (or function set/group) associated with a given TMN management service. Their relationships must also be specified, where possible in the form of scenarios.

Task 3 – Object modelling

To identify object classes needed to support each TMN management function.

Task 4 – Consolidation

For each TMN management function, check if it is supported by one or more object classes and vice versa. This task forms part of an iterative process to define the management information model.

IMT-2000 management will be based on the principles and functional architecture described in [1]. Therefore, according to the methodology defined in [2] and described above, the following tasks need to be performed:

– Description of the IMT-2000 specific TMN management service (using the template given in [2]).

– Description of IMT-2000 specific TMN management functions (using the template given in [2]).

– Specification of an IMT-2000 management information model described using the object oriented paradigm in the ISO/ITU-T GDMO formal style.

IMT-2000 management will wherever possible use already existing TMN management services, TMN management functions and managed object definitions.

ANNEX 2

Baseline information on IMT-2000 management

2.1 General

In addition to the same management services as studied by ITU-T with regard to fixed telecommunication network management, IMT-2000 management has to provide specific management services dealing with the unique characteristics of IMT-2000, such as radio resources utilization and mobility of terminal equipment.

This Annex identifies IMT-2000-specific management services.

2.2 IMT-2000-specific network management services

The following is the list of TMN management services imported from Annex A of [5].

1) Customer administration

2) Routing and digit analysis administration

3) Traffic measurement and analysis administration

4) Tariff and charging administration

5) Management of the security of TMN

6) Traffic management

7) Management of customer access

8) Management of transport networks

9) Switching management

10)   Management of equipment in customer premises

11)   System installation administration

12)   Quality of service and network performance administration

13)   Management of the customer controlled service

14)   Common channel signalling system management

15)   Management of intelligent networks

16)   Restoration and recovery

17)   Materials management

18)   Staff work scheduling

19)   Management of the TMN

The following IMT-2000 management services may give rise to extensions to the above-mentioned management services which will be prepared for fixed telecommunication network or may be newly defined as IMT-2000-specific management services:

1)   radio resource related management service,

2)   MS mobility related management service,

3)   charging and accounting management service,

4)   user and user terminal equipment management service,

5)   security management service.

Figure 4 shows an example of IMT-2000 management services classification in consideration of management services described in [5] which can be commonly used in fixed and IMT-2000 network.

FIGURE 4

Example of IMT-2000 management services classification
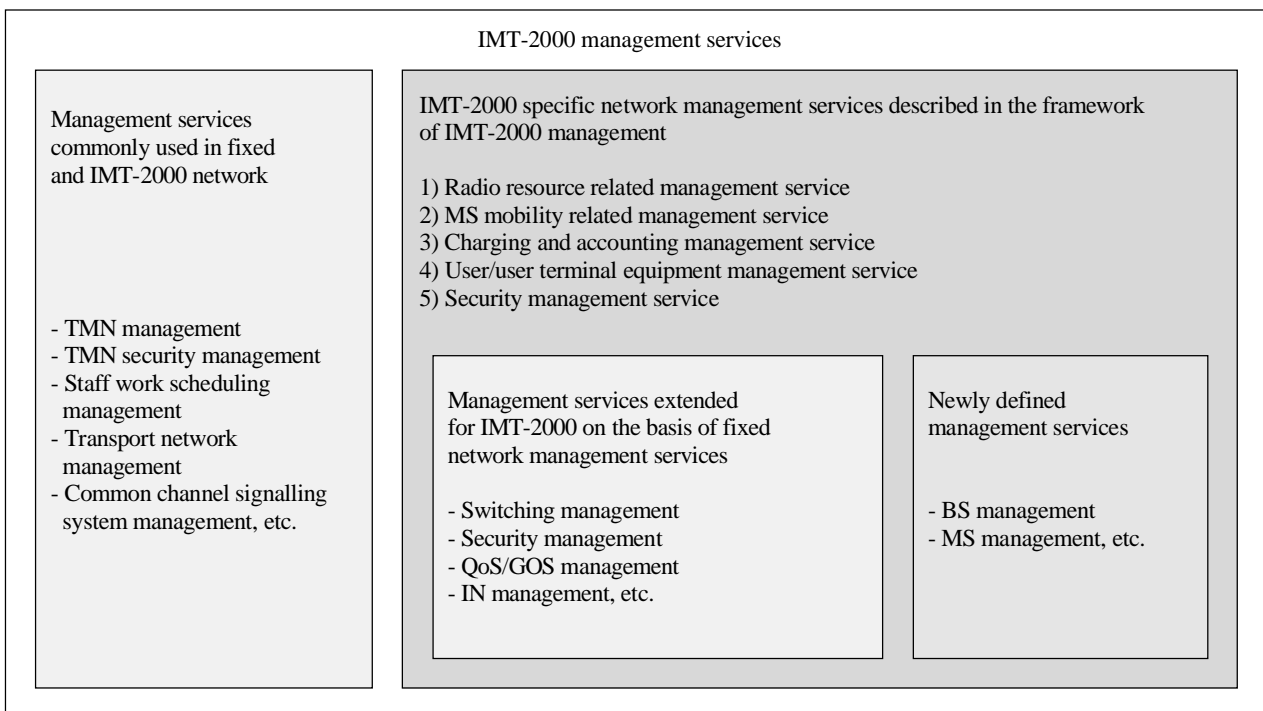
2.2.1 Radio resource related management service

Radio resource related management service is most significant and has a great influence on performance, configuration and fault management of IMT-2000. The related management activities include:

– MSC management,

– fixed/transportable/mobile BS management,

– home/roaming MS management,

– satellite radio resource management,

– management of radio channel quality between MS and BS,

– management of traffic load in each cell,

– management of point-to-multipoint connections in radio common control channel,

– inter-operator information exchange regarding radio resource related management.

2.2.2 MS mobility related management service

MS mobility related management service has to deal with the management activities included below:

– handover performance management,

– location/paging area management,

– mobility pattern measurement,

– MSC management with regard to MS mobility,

– fixed/transportable/mobile BS management with regard to MS mobility,

– home/roaming MS management with regard to MS mobility,

– inter-operator information exchange regarding MS mobility related management.

2.2.3 Charging and accounting management service

Charging and accounting management service has to deal with the management activities included below:

– charging for mobile public pay telephones,

– charging based on diversified accounting parameters,

– inter-administration accounting,

– charging notification,

– inter-operator information exchange regarding charging and accounting management.

2.2.4 User and user terminal equipment management service

User and user terminal equipment management service has to deal with the management activities included below:

– management of user identity,

– management of subscriber and its subscription,

– management of user terminal equipment attached to mobile termination,

– management of complaints from both home and roaming users,

– inter-operator information exchange regarding user and user terminal equipment management.

2.2.5 Security management service

Security management is the control and distribution of security relevant information to various users and systems for user protection and for protecting the nodes of IMT-2000. It is used for reporting on security relevant events, which affect subscriber and network protection.

Secure communication is generally achieved by the generation, exchange and processing of security information according to the procedures of the specific security mechanism employed.

A security policy is a set of rules which constrains one or more sets of security relevant activities of one or more sets of elements. The security policy defines the rules for each security service. Its specification must include the definition of the set of activities and the elements to which the policy applies in the network management.

A security domain is a set of elements under a given security policy administered by a single authority for some specific security relevant activity. The definition of security domains should be used as a means of dividing security related management entities of the network management into sections where a local security policy is applied. Local management of the domain also simplifies management and enforcement of the security policy.

2.3   IMT-2000 specific management service descriptions

NOTE 1 – Some of the following descriptions may be part of or closely related to IMT-2000 radio functions covered in other IMT-2000 Recommendations.

2.3.1   Radio resource related management service descriptions

The following descriptions are specific to the radio resource related management services of IMT-2000:

2.3.1.1   Management of MSC

Management of the MSC should be done through management interfaces between the MSC and the operation system.

Configuration, fault and performance management of IMT-2000 specific network elements (e.g. digital exchange with mobile call and bearer control functions, real time database system such as location register, network elements realizing IN functional entities such as RRC, RBC and so on) and the signalling system installed in the MSC should be done.

Configuration, fault and performance management of software/data used in the MSC should be done. Software/data modification and data collection via management interfaces should be supported.

In-service and out-of-service test function of the MSC, in accordance with complex signalling protocol in call control (i.e. mobile originated and mobile terminated call control), should be provided. Test equipment with MS functionality, which can be controlled by the operation system, may be required.

2.3.1.2   Management of fixed/transportable/mobile BS

Management of fixed/transportable/mobile BS should be done through radio or wired management interfaces between the BS and operation system.

Fixed/transportable/mobile BS identity, BS location, cell configuration (shape, size, structure type (single or multi layered)) and its effective coverage should be managed. Physical and logical channels over the radio interface assigned to BS may be managed in order to support RRC function.

Configuration, fault and performance management regarding IMT-2000 specific network elements (e.g. radio transceiver, base station controller, network elements realizing IN functional entities such as RFTR and so on) installed in the BS should be done.

Detection, analysis and restoration of radio module faults occurring in the radio transceiver should be done. A fail safe mechanism to prevent the transmission of abnormal power which would result in interference is required.

Configuration, fault and performance management of software/data used in the BS should be done. Software/data modification and data collection via radio or wired management interfaces should be supported.

Detection, analysis and restoration of faults due to radio interference generated inside and outside the system should be done. For example, broadcasting channel fault in a particular cell occurs by abnormally and illegally generated co-channel interference.

In-service and out-of-service test function of the BS in accordance with complex signalling protocol for call control (i.e. mobile originated and mobile terminated call control) should be provided. Test equipment with MS functionality, which can be controlled by the operation system, may be required.

2.3.1.3 Management of satellite component

Management of satellite(s) link should be performed through the radio management interface between satellites and earth station.

Configuration, fault and performance management regarding IMT-2000 satellite component specific network elements should be done.

Configuration, fault and performance management regarding software/data in the satellite component should be done. Software/data change and data collection via radio management interfaces should be done.

Detection, analysis and restoration of radio module faults occurring in the satellite component should be done. A fail safe mechanism to prevent the transmission of abnormal power which would result in interference is required.

2.3.1.4 Management of home/roaming MS

Management of home/roaming MS should be done through the radio management interface between the MS and the BS.

Mobile termination identity should be managed according to type of MS (e.g. hand portable/vehicle mounted) and the radio interface specific parameters such as the value of maximum transmission power and location registration information.

Detection, analysis and restoration of radio module faults occurring in the MS should be done. A fail safe mechanism to prevent the transmission of abnormal power that would result in interference is required.

It is necessary to detect, analyse and restore faults occurring in the IMT-2000-specific protocol adapter between the MS and user terminal equipment.

Configuration, fault, and performance management of software/data in the MS should be done. Software/data modification and data collection via radio management interfaces should be done.

In-service and out-of-service test function of the MS in accordance with complex signalling protocols in call control (i.e. mobile originated and mobile terminated call control) should be provided, e.g. in response to user's complaints or the requests of service personnel.

2.3.1.5 Management of radio channel quality between MS and BS

Management that assures radio channel quality between MS and BS should be done. It should be noted that required radio channel quality generally depends on the provided service.

In-service measurement and radio channel quality should be determined by using a method specific to the radio channel evaluated. In-service measurements are to be done in both uplink and downlink. Radio channel quality depends mainly on the co-channel interference which is the function of the traffic carried in a specific cell and cells reusing the same radio channel and the transmission power level used for such transmissions. These measurements are useful in forming a policy for adjusting power levels and changing frequency reuse interval or code allocations.

Test-call establishment function should be provided for the measurement of end-to-end QoS/GOS through radio channels.

2.3.1.6 Management of traffic load in each cell

Management of the traffic load in each cell (signalling and user traffic) should be done. The total traffic may be subdivided into, for example, signalling traffic for call set-up (MS originated and MS terminated)/mobility control (handover and location updating), revenue-earning traffic (speech and data), and so on. Traffic load management makes it possible to change cell allocation/splitting or allocate new traffic channels so as to increase cell capacity.

Access traffic control is needed to avoid access traffic congestion in a particular cell.

Access traffic control is required to allow only specialized MS for maintenance purposes and so on, or no MS to access a particular BS which is under construction or testing or malfunction.

2.3.1.7   Management of point-to-multipoint connections in radio common control channel (CCCH)

Management of point-to-multipoint connections in the radio CCCH should be done. Monitoring and representation methods of signal traffic in point-to-multipoint connections should be determined.

Signal traffic control is required to avoid signal traffic congestion in any point-to-multipoint connection in the radio CCCH.

2.3.1.8   Inter-operator information exchange regarding radio resource related management

Inter-operator information exchange regarding radio resource related management should be done through the management interface between operation systems. Home network operator or mobile terminal manager wishes to be informed of faulty test results of his MS detected in visited network.

2.3.2   MS mobility related management service description

The following descriptions are specific to the MS mobility related management service of IMT-2000:

2.3.2.1   Handover performance management

Handover performance evaluation as a function of the handover frequency which is related to handover control overhead, handover failure rate and handover parameters may be necessary. This evaluation makes it possible to change handover parameters, handover procedures and cell allocation/splitting so as to optimize system performance. Monitoring and representation methods of handover frequency and handover failure rate should be determined.

2.3.2.2   Location/paging area management

Performance evaluation with regard to location updating signal traffic and paging signal traffic may be done. Such evaluation makes it possible to change the location/paging area allocation so as to optimize the total load of location updating and paging control.

2.3.2.3   Mobility pattern measurement

Mobility pattern measurements may be done. This type of information can be used to assign radio resources to a cell on a fixed or a dynamic basis. Mobility pattern measurement can be done by tracing handovers. The measurement could be in the form of Erlangs per route, at least for major routes (this is similar to measuring vehicular traffic on roads and highways). It would also be useful to know the average distance travelled during a call.

2.3.2.4   MSC management with regard to MS mobility

Configuration, fault and performance management of facilities for mobility control (e.g. location registration, handover and so on) installed in the MSC should be done.

In-service and out-of-service test function of the MSC in accordance with complex signalling protocol in mobility control (e.g. location registration, handover and so on) should be provided. Test equipment with MS functionality, which can be controlled by the operation system, may be required.

2.3.2.5   Fixed/transportable/mobile BS management with regard to MS mobility

Configuration, fault and performance management of facilities for mobility control (e.g. location registration, handover and so on) installed in the BS should be done.

In-service and out-of-service test function of the BS in accordance with complex signalling protocol in mobility control (e.g. location registration, handover and so on) should be provided. Test equipment with MS functionality, which can be controlled by the operation system, may be required.

2.3.2.6   Home/roaming MS management with regard to MS mobility

In-service and out-of-service test function of the MS in accordance with complex signalling protocol in mobility control (e.g. location registration, handover and so on) should be provided, e.g. in response to user's complaints or the requests of service personnel.

2.3.2.7   Inter-operator information exchange regarding MS mobility related management

Inter-operator information exchange regarding MS mobility related management should be done through the management interface between operation systems.

Home network operator or mobile terminal manager wishes to be informed of faulty test results of his MS during roaming.

2.3.3   Charging and accounting management service descriptions

The following descriptions are specific to the charging and accounting management service of IMT-2000:

2.3.3.1   Charging for mobile public pay telephones

Charging for mobile public pay telephones should be supported. Mobile public pay telephones with charging function (e.g. coin box) may perform accounting and charging management by themselves because of the limited capacity of the radio management interface.

2.3.3.2   Charging based on the diversified accounting parameters

In the definition of the total amount of charges associated with a call, it should be possible to take into account the following parameters:

–   duration of the call,

–   distance (between the locations of the called and calling parties),

–   type of information and information volume,

–   performance actually achieved in the connection,

–   service features and attributes,

–   types of bearer service used,

–   types of teleservices provided,

–   supplementary services invoked (including user-to-user information), UPT service, IN service and value added service,

–   communication configuration (point-to-point, point-to-multipoint),

–   time of usage,

–   type of subnetworks involved (e.g. access environment),

–   operator networks involved,

–   medium used,

–   signalling.

Not all parameters are subject to IMT-2000 Recommendations.

2.3.3.3   Inter-administration accounting

Due to the possibility of roaming, accounting of one call in IMT-2000 may involve several administrations, one home operator and one or more visited operators. A home operator is the administration with which a subscriber has a subscription for IMT-2000 services. A visited IMT-2000 operator is any administration except the home IMT-2000 operator in the domain of which the users are allowed to use IMT-2000 services. Therefore, there is a need for an inter-administration accounting process additionally to the subscriber accounting process. Looking at the functionality of the inter-administration accounting process, it may consist of a usage metering, charging, and billing part.

The inter-administration accounting process is based on the usage metering for the subscriber accounting process, so there is no separate usage metering process for inter-administration accounting.

For inter-administration charging, the collection sub-process of the subscriber accounting process could be used. Accounting records initiated by users related to another administration (home IMT-2000 operator of a user) are collected by this sub-process and sent to the charging process of the other administration. Additionally, a separate part for the tariffing of accounting records to be sent to other administrations is needed.

Inter-administration billing process compiles the tariffed accounting records and takes care of the clearing with other administrations.

2.3.3.4 Charging notification

IMT-2000 should support the capability to notify end-users that they will incur extraordinary charges before those charges are incurred. This notification could occur by designated dial-tones, operator intervention, audio announcements, etc. For example, this allows a calling party to be made aware of a called party roaming outside the "home" network and the need for an additional charge to be incurred if a "calling party pays air time" policy is used by an IMT-2000 provider. Such notification allows the calling party the option of whether to complete the call.

2.3.3.5 Inter-operator information exchange regarding charging and accounting management

Inter-operator information exchange regarding charging and accounting management (e.g. inter-administration accounting) should be done through the management interface between operation systems.

2.3.4 User and user terminal equipment management service descriptions

The following descriptions are specific to the user and user terminal equipment management service of IMT-2000:

2.3.4.1 Management of user identity

Management of user identity including home and roaming user (i.e. user with roaming agreement) should be done.

2.3.4.2 Management of subscriber and its subscription

Management of each subscriber and the subscription related to home and roaming user identity should be done.

2.3.4.3 Management of user terminal equipment attached to mobile termination

Management of user terminal equipment attached to mobile termination should be done. Mobile termination should detect the attachment and detachment of user terminal equipment and report it to BS.

2.3.4.4 Management of complaints from both home and roaming users

Management of complaints from both home and roaming users should be done. All complaints and actions taken in response to them should be logged with the operation system.

2.3.4.5 Inter-operator information exchange regarding user and user terminal equipment management

Inter-operator information exchange regarding user and user terminal equipment management should be done through the management interface between operation systems.

2.3.5 Security management service descriptions

The following descriptions are specific to security management service of IMT-2000:

2.3.5.1 Management of IMT-2000-specific security mechanism

IMT-2000-specific security mechanisms are authentication of user and mobile terminal identity, encryption of the information on the radio interface, and user and terminal identity confidentiality.

Fault management of security mechanisms should be done. Detection function of security mechanism fault (e.g. detection of out-of-synchronization status in encryption, detection of security mechanism related facility's fault) is required. Test function of security mechanism is also required.

2.3.5.2 Key management

A key management is necessary for the use of enhanced authentication mechanisms, integrity mechanisms and encipherment mechanisms. The functions comprising this management are listed below:

– generation,

– distribution,

– storage,

– updating,

– destruction,

– archiving,

of keys.

2.3.5.3 Encryption management

Encryption management is management associated with updating of algorithms during the lifetime of the system.

Cryptographic parameters, e.g. algorithm interaction with the key management should be established.

2.3.5.4 Authentication management

Authentication management is an associated management function with key management and encryption management.

Distribution of descriptive information, password or keys to entities e.g. specified personnel is required to perform authentication.

A protocol between communicating entities and other entities providing authentication services should be used.

2.3.5.5 Access control management

Type of access intended for protection against unauthorized use of data and resources may be:

– passive (read only),

– active (read/write),

– command (execute operation).

Distribution of passwords or the use of a protocol between communicating entities and other entities providing access control services should be provided.

2.3.5.6 Service barring list management

Service barring list management is a managing feature by which the service provider can refuse access to services by a particular user.

Such users are identified based on detection of attempted fraudulent use of services, delinquency in paying bills, and so on.

2.3.5.7 Security audit management

A security audit is an independent review and examination of system records and activities. The purpose of security audit could be:

– to conform compliance with established security policy,

– to assist in the analysis of attacks for detecting security violations.

A security audit trails involves the following stages:

– determination of security related events,

– analysis of record related events,

– generation of security alarms (or other actions),

–   recording of security relating events,

–   audit trails archiving,

–   reporting.

2.3.5.8   Management of subscriber related credential information

Storing, reading, and modification of subscriber information should be possible.

Protection of subscriber credential information should be done.

Tracing of subscribers should be possible.

2.3.5.9   Information exchange regarding security management

The distribution of security relevant information to various users and systems for user protection and for protecting the nodes of IMT-2000 in a single operator or between operators should be done.

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