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SERIES E: OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

Network management – International network management

Framework for network management of IMT-2000 networks

ITU-T Recommendation E.418

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ITU-T Recommendation E.418

Framework for network management of IMT-2000 networks

Summary

This Recommendation lays down a framework for supporting and defining the role of network management for IMT-2000 networks. IMT-2000 networks consist of various network elements and telecommunication technologies such as wireless and IP-based services. It is intended to give some guidance to identify data that is needed to check the status/performance of networks, especially IMT-2000 networks.

Network management requires real-time monitoring of current network status and performance and the ability to take prompt action to control the performance and resources of the network when necessary. It should be noted that the complete range of network status and performance parameters are not necessary for the introduction of a network management capability.

Source

ITU-T Recommendation E.418 (2003) was prepared by ITU-T Study Group 2 (2001-2004) and approved under the WTSA Resolution 1 procedure on 2 May 2003.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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1 Scope

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Network management requires real-time monitoring of current network status and performance and the ability to take prompt action to control the performance and resources of the network when necessary. It should be noted that the complete range of network status and performance parameters are not necessary for the introduction of a network management capability.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-T Recommendation E.410 (1998), *International network management – General information*.
- ITU-T Recommendation E.411 (2000), *International network management – Operational guidance*.
- ITU-T Recommendation E.412 (2003), *Network management controls*.
- ITU-T Recommendation E.413 (1988), *International network management – Planning*.
- ITU-T Recommendation E.414 (1988), *International network management – Organization*.
- ITU-T Recommendation E.415 (1991), *International network management guidance for common channel signalling system No. 7*.
- ITU-T Recommendation E.416 (2000), *Network Management principles and function for B-ISDN traffic*.
- ITU-T Recommendation E.417 (2001), *Framework for the traffic management of IP-based networks*.
- ITU-T Recommendation E.771 (1996), *Network grade of service parameters and target values for circuit-switched land mobile services*.
- ITU-T Recommendation E.776 (1996), *Network grade of service parameters for UPT*.
- ITU-T Recommendation I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDNs*.
- ITU-R Recommendation M.1168 (1995), *Framework of International Mobile Telecommunications-2000 (IMT-2000)*.
- ITU-T Recommendation M.3000 (2000), *Overview of TMN Recommendations*.

– ITU-T Recommendation Q.1701 (1999), *Framework for IMT-2000 Networks*.

– ITU-T Recommendation Q.1711 (1999), *Network functional model for IMT-2000*.

– ITU-T Recommendation Q.1741.2 (2002), *IMT 2000 references to release 4 of GSM evolved UMTS core network with UTRAN access network, (clauses 10.3.1 "Telecom Management principles and high level requirements" and 10.3.2 "Telecom Management Architecture")*.

3 Definitions

Network Management definitions are stated within the E.41x series. For the definition of cellular terms reference is made to ITU-T Rec. Q.1001.

IMT-2000 network related definitions are provided in ITU-T Rec. Q.1701.

4 Abbreviations

This Recommendation uses the following abbreviations:

AC Authentication Centre

BS Base Station

CN Core Network

DBMS Database Management System

FA Foreign Agent

GMSC Gateway Mobile Switching Centre

HA Home Agent

HLR Home Location Register

IN Intelligent Network

MAP Mobile Application Part

MSC Mobile Switching Centre

PDSN Packet Data Support Node

RAN Radio Access Network

RNC Radio Network Controller

SCP Service Control Point

UIM User Identity Module

UPT Universal Personal Telecommunication

VLR Visited Location Register

5 Introduction

International Mobile Telecommunications-2000 (IMT-2000) is a family of third generation mobile systems which will provide access to a wide range of telecommunication services, some of which are supported by the fixed telecommunication networks, to other services which are specific to mobile users, and to new and innovative services.

Key features of IMT-2000 are:

– high degree of commonality of design worldwide;
– incorporation of a variety of systems (IMT-2000 Family of Systems concept: ITU-T Rec. Q.1701);
– global roaming;
– high service quality;
– use of IN capabilities.

Extension of network management aspects to IMT-2000 networks requires consideration of IMT-2000 capabilities, including the multiple Quality of Service (QoS) classes, Service Level Agreements (SLAs) and handover procedures that can exist in a wireless-based network. To guarantee QoS in a radio network, radio resource management is needed. It contains handover/power/admission/load control and packet scheduling, etc. To assure a satisfactory level of network performance, a robust and fast network management capability is desired to promptly detect any traffic-related problem in the network and to try to resolve it as quickly as possible.

In this Recommendation, to identify traffic-related problems, some key parameters relating to performance that can affect traffic in IMT-2000 networks are addressed. In order to indicate the status and measure the performance of the network, data will be required which will identity where and when difficulties are occurring in the network, or are likely to occur. Such data will require real-time collection and processing.

Network status and performance parameters from IMT-2000 network elements contain information regarding the following areas:

– traffic performance within the IMT-2000 network;
– resource access measurements;
– Quality of Service;
– resource availability.

6 Traffic management principles and functions for IMT-2000

One major characteristic of IMT-2000 networks is that they contain both packet switching and circuit switching. The combination of packet and circuit switching functionality in the same network node adds complexity to the operations functions that manage the overall network. The network topology of IMT-2000 networks may be adjusted by management controls (e.g., by fine tuning the geographic coverage of adjacent cells, or by adjusting the preference for cell selection for subscribers in the boundary area between such cells) in order to address traffic loading imbalances. Frequent imbalances may need to be detected by management systems, and may be addressed through enhancing the capacity of the radio access network through, e.g., provisioning additional radio resources, cell splitting, etc.

An important issue in Network Management for IMT-2000 networks is that the network topology in mobile networks can frequently change because of roaming and handover, so network management must be able to hold dynamic topology changes e.g., when the cell coverage for specific cells are reduced or expanded from a normal condition when controlling a traffic situation between adjacent cells.

One of the challenges faced in network management for IMT-2000 networks is that there will often be multiple service providers, network provider and content providers. This environment means service providers must be able to share data related to subscriber profiles, billing and security information based on business agreements. When a subscriber roams, some of that subscriber's data is transferred from one network to another, e.g., HLR to VLR, or HA to FA, as part of real-time call

or session handling. Problems in accessing or transferring data in support of roaming need to be detected and addressed by management systems.

Another challenge is that provisioning is complex in mobile networks. Data, with regard to the call set up process, involves a naming scheme of addresses and routes which could be specific for each subscribers service level. This data is maintained in different configuration databases. When a subscriber is roaming within a network or between network operations, the specific routing data with regard to the service level of the subscriber must be transferred between the routing functions. Problems in the data transfer must be detected and handled in order to maintain the service of the network.

The overall process of network management involves the observation of relevant traffic and performance data, suitable analysis of that data, and the resulting implementation of appropriate network management controls. The effectiveness of an implemented set of network management controls is then evaluated, based on new observations of traffic and performance data which are then analyzed and used as a basis to remove, or further modify, if necessary, the current set of network management controls.

In an IMT-2000 network, the traffic of applications and services can be categorized into several classes based on their characteristics. These classes are, e.g:

– Conversational (e.g., voice, video telephony, video games);
– Streaming (e.g., streaming multimedia);
– Interactive (e.g., web browsing, network games);
– Background (e.g., background download of emails).

Therefore, QoS priority is an important factor when managing the traffic in an IMT-2000 network. Relevant status and performance parameters should be provided per class.

7 Network components for IMT-2000 network

The network components and functional subsystems of an IMT-2000 network are described in ITU-T Recs Q.1701 (Framework for IMT-2000 networks) and Q.1711 (Network functional model for IMT-2000) respectively.

8 Network status and performance parameters

In order to identify where and when difficulties are occurring in the network, or are likely to occur, data will be required which indicates the status and measures the performance of the network. Such data will require real-time collection and processing.

The following lists the network status and performance parameters of IMT-2000 network components.

8.1 Base station, radio network controller and mobile switching centre

The status indicators and performance parameters help to identify problems in the QoS.

– **call processing data**; call attempt, failed call attempt, successful call attempt, call completion rate, call drop rate;
– **delay time-control**; voice call set-up delay, video call set-up delay, multimedia call set-up delay;
– **delay time-user**; voice call delay, video call delay, multimedia call delay, web browsing delay;
– **average holding time**;

– **location registration data**; attempted location registration, successful/unsuccessful location registration;
– **channel utilization data**; paging channel utilization, traffic channel utilization, plus utilization of other traffic and control channels specific to the radio access technology;
– **transmission data**; error rate (e.g. bit, frame, cell);
– **node capacity utilization**;
– **handover data**; successful/unsuccessful handover, successful/unsuccessful intra-MSC handover, successful/unsuccessful inter-MSC handover, successful/unsuccessful 2G-3G or 3G-2G handover;
– **bandwidth request**; successful/unsuccessful requests per service class;
– **route statistics**; call attempt, average holding time, completed call, BHCA.

8.2 Home location register and visited location register

The status indicators and performance parameters help to identify problems with the data transfer.

– **DBMS related transaction**; transaction attempts, successful transactions;
– **node capacity utilization**.

8.3 Authentication centre

The status indicators and performance parameters help to identify problems with the data transfer.

– **DBMS related transaction**; transaction attempts, successful transactions;
– **node capacity utilization**.

8.4 Packet data support node and packet data gateway node

The status indicators and performance parameters help to identify problems in the QoS and data transfer.

– **call processing data**; call attempt, failed call attempt, successful call attempt, call drop rate, call priority, number of packets sent/received;
– **HA/FA activity**; number of tunnels established, number of tunnels requested, volume of traffic transferred HA to FA;
– **node capacity utilization**.

9 Network management of an IMT-2000 network

The performance of an IMT-2000 network can be affected by various reasons such as switching performance, circuit congestion, loss of connection to distant network (see ITU-T Rec. E.411), and air interface performance.

Parameters that can help detecting performance problems in the network and the services provided by the network need to be collected through the network management operations system. Based on these performance parameters, network management actions can be made automatically or manually to resolve the problem, depending on the policies of individual operators. It is assumed that most problems will be detected and resolved automatically. However, with respect to some specific problem, network managers should have the ability to access functionality to control the services and the network.

9.1 Base stations

Some parameters mentioned in this Recommendation need to be handled by network managers to control traffic in the air interface (between base stations and mobile nodes). It might occur that in a certain area, a lot of mobile users try to make a call more or less simultaneously which can cause congestion in a certain cell. When detecting this, network managers should be able to apply appropriate network management controls according to the technology and the architecture of the system being controlled. The specific methods for accomplishing this will depend on the technology deployed, but will be aimed at reducing call attempt levels towards the maximum number that can be successfully served. Applied controls may result in some subscribers not being able to obtain service, or having limited service (high unsuccessful calling rates), when demand exceeds capacity, or when the network's resources are allocated to disaster mitigation or emergency response resources. Reducing the frequency of paging can reduce the network traffic. Reducing the transmission power for the cell can give the same result for reducing cell coverage which can reduce the numbers of users entering the cell. Network managers can, through the network management operations system, control traffic load in a cell by controlling the transmission power level or paging frequency, affect the performance of the network.

9.2 Packet networks

In the area of IP-based packet backbone network of an IMT-2000 network, network status and performance data are needed to establish a basis for appropriate network management surveillance and control, and to provide means for evaluating the performance of the network and the effectiveness of applied controls.

The characteristics of packet traffic are different from that of circuit-switched traffic. A large burst of traffic can cause degradation to the performance of the network. In such a case, a coordinated network management policy is required in order to detect disturbances that can affect the customer's services. A situation that may need to be addressed is excessive demand from multiple users at the same time. This relates to the QoS for the packet service instances, the capacity of the network and many other stochastic variables.

Traffic and usage patterns change, but patterns can be determined which provide network managers with a valuable basis for later actions. By observing and monitoring traffic patterns, network managers can manage the packet traffic by adjusting the packet-related performance parameters using network management controls.

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