RECOMMENDATION ITU-R M.1311

FRAMEWORK FOR MODULARITY AND RADIO COMMONALITY WITHIN IMT-2000

(1997)

CONTENTS

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. public switched telephone network/integrated services digital network (PSTN/ISDN)), and to other services which are specific to mobile users.

A range of mobile terminal types is encompassed, linked 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 service quality,

– worldwide roaming, and

– use of a small pocket terminal worldwide.

This Recommendation forms part of the process of specifying the radio interface(s) of IMT-2000. IMT-2000 is defined by a set of interdependent ITU Recommendations of which this Recommendation is a member.

1.1 Emerging trends

One of the most challenging aspects of designing future wireless telecommunications systems is accurately anticipating what the future market and technological drivers will be. This is made even more difficult by the rapid advances in technology over the last few years and the increasingly sophisticated demands of the end-user. For example, in the next few years wireless networks will likely need to support high-speed data, image, and/or multimedia in addition to pure voice traffic in order to meet customer demands. Even voice will be coded differently and at different rates for various services and applications. This will create the need for an infrastructure that can support end-user connections with differing technical systems requirements. As a result of all the factors, the design of any future wireless network must be as flexible as possible. Clearly, a common, flexible infrastructure is needed that can interface with multiple radio interface technologies on the one hand and multiple fixed network technologies on the other.

At the time IMT-2000 are introduced, narrow-band voice networks will still predominate in the fixed network, but advanced broadband networks will be a critical component as well. In these broadband networks, asynchronous transfer mode (ATM) technology will likely be the switching and transmission technology of choice due to the provision of a common, flexible platform from which many different types of communications (voice, data, image, video, high-quality sound and multimedia) can be served.

In addition, there is a worldwide move towards standards which are substantially technology-independent, to maximize their potential application to a number of different environments.

A number of emerging trends are having a significant impact upon the design of telecommunications networks and current indications are that this process will accelerate in the future. Work in other standards bodies, particularly regarding broadband technologies, and other major advances in technology, are contributing to this situation. Of particular consequence to network design are:

– the separation of applications from networks,

– the convergence of telecommunications and information technology,

– the convergence of fixed, mobile and private network capabilities,

– the emerging importance of personal communications,

– new advanced distributed processing concepts available for service control,

– the increasing use of ATM and transmission control protocol/Internet protocol (TCP/IP) for the transport of all types of information,

– the need for substantially “seamless” evolution from one telecommunications technology/standard to a later one, or for evolution within the standard.

1.2 Objectives of IMT-2000 that impact on modularity

Important design objectives for IMT-2000 are to minimize the number of radio interfaces, to maximize the commonality between them and to be able to flexibly adapt different services onto these radio interface(s). These design objectives should be met in order to minimize costs and to ease service and network deployment.

A number of objectives have been established which place requirements upon IMT-2000 system design and the design of networks implementing IMT-2000. The key aspects for the purpose of this Recommendation are:

– to facilitate evolution to IMT-2000 from existing fixed and mobile systems;

– to provide a common platform/framework for the support of various categories of services;

– to be adaptable to the service providers' and network operators' need to differentiate their service offerings;

– to facilitate the deployment of the system in a manner consistent with the individual needs of service providers and network operators.

Each of these objectives could have a significant impact upon IMT-2000 system, network and protocol design.

In short, two major goals to be achieved for the transport mechanisms are: independence from the transmission technology and support of a wide and changing range of services.

A modularized functional and physical architecture needs to satisfy the following requirements:

– future evolution,

– interworking between a variety of access technologies/standards, core transport and core control standards/networks,

– technology-independence of telecommunications standards,

– service differentiation options for operators and/or service providers,

– standards which provide scope, within a generic framework, for proprietary enhancements to meet specific needs,

– support for a variety of radio environments,

– backwards compatibility.

1.3 Rationale

IMT-2000 will serve different radio environments leading potentially to different radio interface technology choices. In order to minimize the investments in the core network (CN), it is thought that the ability to connect different radio transmission modules to the same CN equipment, e.g. a switch, should be investigated. Moreover, it has been recognized that IMT-2000 shall be “future proof”, that is IMT-2000 shall have the ability to evolve by replacing modules and keeping others. Such a design will also facilitate the evolution of mobile systems that are currently in service or will be introduced prior to IMT-2000 (referred to as “pre-IMT-2000” systems) to third generation ones. One way to achieve such a goal is, again, to have radio transmission modules clearly separated from the CN.

Such similar goals have been pursued in the field of the fixed network and led to the development of ATM standards. Therefore it is proposed to adopt a similar approach for the radio interface of IMT-2000. Taking a similar approach means using a layered approach leading to a clear independence of the transport mechanism from the services on one side and from the transmission technology on the other side.

2 Scope

This Recommendation is primarily based on the principles, requirements and framework of the IMT-2000 radio interface(s), as outlined in IMT-2000 Recommendations ITU-R M.687, ITU-R M.819, ITU-R M.1034 and ITU-R M.1035. This Recommendation identifies and describes the modularity and radio commonality principles which should be adopted in the development of the radio-related aspects of IMT-2000.

This includes:

– the modularity concept and its rationale,

– the functional modules in the radio access network (RAN),

– the groupings of functions in the RAN.

The purpose of the Recommendation is to facilitate the development of a modular framework which can be used as a basis for specific architectures, enabling these to be combined in various ways to meet operators' needs.

3 Related documents

– Recommendation ITU-R M.687:	International Mobile Telecommunications-2000 (IMT-2000).
– Recommendation ITU-R M.816:	Framework for services supported on IMT-2000.
– Recommendation ITU-R M.817:	International Mobile Telecommunications-2000 (IMT-2000) Network Architectures.
– Recommendation ITU-R M.818:	Satellite operations within IMT-2000.
– Recommendation ITU-R M.819:	IMT-2000 for Developing Countries.
– Recommendation ITU-R M.1034:	Requirements for the Radio Interface(s) for IMT-2000.
– Recommendation ITU-R M.1035:	Framework for the Radio Interface(s) and Radio Subsystem Functionality for IMT-2000.
– Recommendation ITU-R M.1036:	Spectrum Considerations for Implementation of IMT-2000 in the Bands 1 885-2 025 MHz and 2 110-2 200 MHz.
– Recommendation ITU-R M.1167:	Framework for the Satellite Component of IMT-2000.
– Recommendation ITU-R M.1224:	Vocabulary of Terms for IMT-2000.
– Recommendation ITU-R M.1225:	Guidelines for Evaluation of Radio Transmission Technologies for IMT-2000.
– ITU-T Recommendation Q.931:	Digital subscriber signalling system No. 1 (DSS 1) – ISDN user-network interface layer 3 specification for basic call control.
– ITU-T Recommendation Q.2931:	Broadband integrated services digital network (B-ISDN) – Digital Subscriber Signalling System No. 2 (DSS 2) – User-Network Interface (UNI) layer 3 specification for basic call/connection control.

4 Terminology

This paragraph defines terminology relevant to this Recommendation which is not included in Recommendation ITU-R M.1224.

4.1 Terms and definitions

Adaptation functionality (AF)

A set of functions which allows the provision of CN services transparently through the RAN between the mobile terminal and the corresponding CN.

Interworking function (IWF)

Mechanism which masks the differences in physical, link and network technologies by converting or mapping states and protocols into consistent network and user services (see Recommendation ITU-R M.1224).

Mobile terminal other functionality (MTF)

The set of functions which, together with the MT-RTT, form a mobile terminal.

Radio access network (RAN)

A network which provides the connectivity between the mobile terminal and the CN and typically consists of a network of base stations and associated controllers.

Radio bearer common functionality (RBCF)

A common adaptation functionality situated between the RAN interface and the RTAFs. RBCF adapts respective RTT/RTAF combinations onto the RAN interface. RBCF principally contains radio technology independent functions.

Radio transmission adaptation functionality (RTAF)

A functionality which provides the necessary functions to adapt a specific RTT with the RBCF. In contrast to the RBCF, the RTAF is radio transmission technology dependent and RTAFs adapt different RTTs to the RBCF.

Radio transmission specific functionality (RTSF)

A functionality which is explicitly radio technology and radio operating environment dependent. In the RAN, the RTSF includes all the functions related to RAN-RTT and RTAF.

4.2 Acronyms and abbreviations

AF: Adaptation functionality

CN: Core network

DSS 2: Digital subscriber signalling system 2

IWF: Interworking function

MPEG 4: Moving picture expert group 4

MTF: Mobile terminal other functionality

RAN: Radio access network

RBCF: Radio bearer common functionality

RTAF: Radio transmission adaptation functionality

RTSF: Radio transmission specific functionality

RTT: Radio transmission technology

TCP/IP: Transmission control protocol/Internet protocol

5 Recommendations

The ITU Radiocommunication Assembly recommends that the framework for modularity and radio commonality presented in the following should be adopted for IMT-2000.

6 Approach to modularity

The recommended approach to modularity is based on the separation of transport, access, control and management functionalities within systems. A system is defined as being a regularly interacting or interdependent group of items forming a unified, whole technology (see Recommendation ITU-R M.1224).

Systems should be decomposed into a number of subsystems, each consisting of resources and functionality wholly controlled by that subsystem. Subsystem boundaries should be clearly delineated and specified, with each subsystem providing its own specific capabilities to one or more other subsystems and able to use the capabilities of other subsystems.

Subsystems can be enhanced to provide additional capabilities without affecting any other subsystem. Individual subsystem enhancements can be implemented and deployed in any order, to facilitate system upgrading and network operation and evolution. Here, the network is defined as a set of nodes and links that provides connections between two or more defined points to facilitate telecommunication between them (see Recommendation ITU-R M.1224).

Similarly, entirely new subsystems can be added to take care of evolving needs without adversely affecting the other subsystems.

The interfaces between the different sub-networks need to be clearly defined and delineated, so that it is possible to introduce or enhance a new sub-network without causing problems in another network. Ideally the interfaces between the different sub-networks should be radio-technology independent, such that any suitable technology can be used.

The modular subsystem or network approach facilitates system and network evolution. Each module (subsystem or network) should be plug-compatible, in the sense that each network can substitute replacement modules without impacting other modules (in the same network or in different networks).

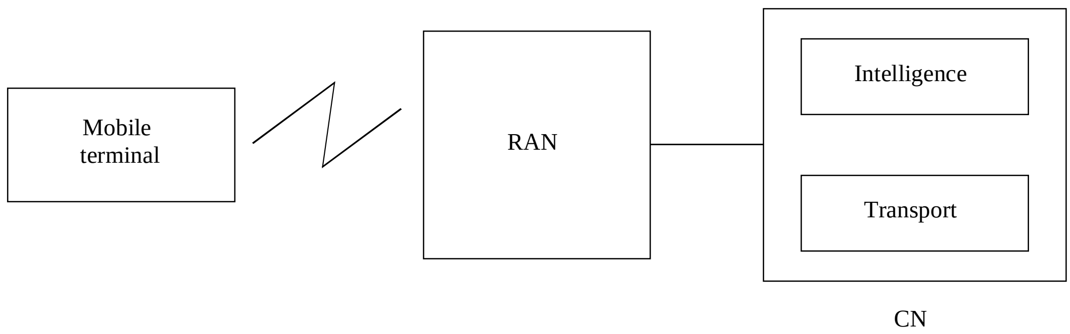
A clear distinction between radio transmission modules and the CN can be attained by designing a transport mechanism on the radio access side independent from the radio technology used (frame size, multiple access, modulation, etc.). From the network side, the transport mechanism defines bearer capabilities independent of the radio technology. These bearer capabilities are also used by the higher layers of the mobile station. They are interpreted by the radio-dependent functions in order to establish the required radio resources.

From a modularity aspect, IMT-2000 can be considered to have two main elements: the RAN and the CN (see Note 1), plus the mobile terminal as shown in Fig. 1.

NOTE 1 – Other terms for CN are backbone network and network subsystem.

FIGURE 1

High-level IMT-2000 system model



The RAN:
- provides the connectivity between the mobile terminals and the CN,
- typically consists of a network of base stations and associated controllers.

The CN consists of *transport and intelligence.*

The transport:
- provides transport of both user traffic and signalling traffic, including switching;
- provides universal and reliable connectivity;
- moves traffic through the network, but the routing control is in the intelligence outside the transport network.

The intelligence:
- includes functions related to service logic and service control which are outside of the transport network;
- may be distributed across network elements;
- offers and receives services through a controlled set of well-defined interfaces;
- includes mobility management functions.

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Adaptation functions may be implemented between dissimilar access and CNs. Also, not shown in Fig. 1, are the service management functions that include service creation, service provision, customer control capabilities, and support for the administration, coordination and control of operational support systems.

The flexibility offered by ATM, TCP/IP and other emerging transport techniques offers good support for the concept of modularity and should be considered when formulating the functional elements of the modularized architecture (see Annex 1).

7 RAN modelling

The principles, requirements and framework for the IMT-2000 radio interface(s) are outlined in Recommendations ITU-R M.687, ITU-R M.1034 and ITU-R M.1035. These Recommendations indicate that IMT-2000 must have the capability to support more than one radio interface if necessary. The need to interface to multiple CNs has also been identified.

Since the technologies for wireless networks, including IMT-2000, are evolving, it is important to have the flexibility to easily reconfigure the access network by plugging in different radio modules. To facilitate this evolution of systems, functional grouping referred to as RBCF is introduced, which facilitates commonality between different radio access technologies and allows an interface that decouples the access network from the CN(s).

The RBCF is a set of common functionalities which are independent of the RTT. In essence, it covers a generic role with respect to the radio transmission specific functions.

Such a commonality concept requires that specific radio adaptation functions are implemented in the RAN in order to ensure the compatibility between different RTTs and the RBCF. Subsections below describe the basic IMT-2000 model based on the above rationale and how this model can encompass pre-IMT-2000 systems aiming at a convergent perspective for mobile communications.

7.1 Basic IMT-2000 model

Figure 2 illustrates the basic system model for IMT-2000 showing potential for multiple IMT-2000 RTTs, pre-IMT-2000 RTTs, and pre-IMT-2000 CNs. Consistent with the high-level system model shown in Fig. 1, the RAN and the CN are identified including their basic components, in Fig. 2.

– The RBCF would be used to adapt between the relatively error-free high bandwidth CN(s) and the more error-prone band-limited RTTs serving the various IMT-2000 operating environments. It should be designed to meet the appropriate service quality objectives. This potentially leads to a uniform RAN interface which is independent of the radio access technology, the radio operating environment or the services provided.

– The RTAF provides the necessary functions to adapt to a specific RTT using the RBCF. In contrast to the RBCF, the RTAF is RTT dependent.

– The RTT segment consists of two parts and embodies the radio transmission functionalities, on both the mobile terminal (MT-RTT) and the RAN (RAN-RTT).

– In the RAN, the set of functions provided by RAN-RTT and the RTAF form the RTSF of RAN. In the mobile terminal the set of functions not included in the RTT segment, referred to as MTF, embodies all of the mobile terminal functions relevant to procedures that are provided by mobile terminal transparently with respect to the RTT.

– On the CN side, the IMT-2000 CN conforms with the above RAN interface without any adaptation, as IMT-2000 is developed consistently.

This model supports:

– different radio access technologies within the IMT-2000 RAN;

– connectivity of different CNs to the IMT-2000 RAN.

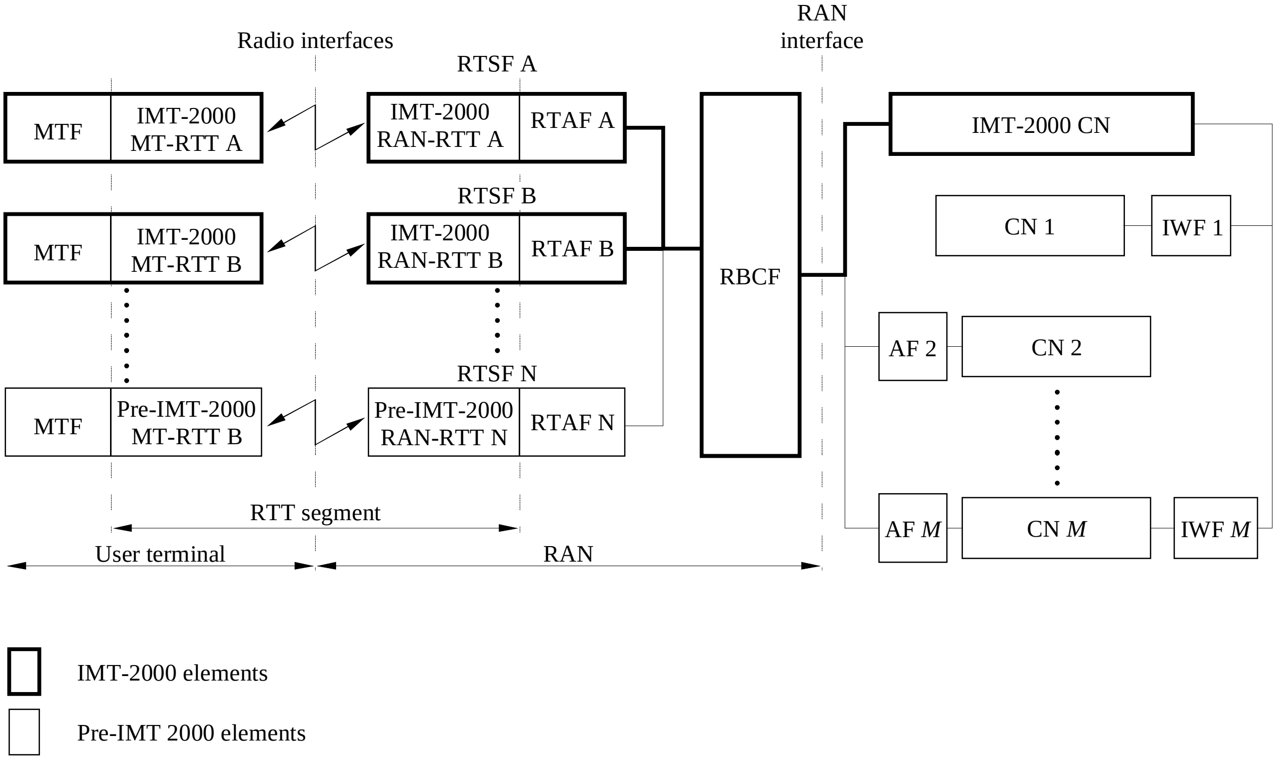
This approach will not only enable the specification of the RAN interface to begin prior to adoption of specific radio access technologies, but will provide scope for future evolution within the IMT-2000 standard.

In addition, this approach provides convergence between different evolution paths to IMT-2000 on both the radio and the CN side.

The IMT-2000 radio interface(s) and the RAN interface are to be standardized in ITU.

FIGURE 2

Basic IMT-2000 system model plus pre-IMT 2000 systems



AF: adaptation functionality
CN: core network
IWF: interworking
MTF: mobile terminal other functionality
RAN: radio access network
RBCF: radio bearer common functionality
RTAF: radio transmission adaptation functionality
RTSF: radio transmission specific functionality
RTT: radio transmission technology

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7.2 Pre-IMT-2000 systems

The following sections refer to the areas not shown in bold in Fig. 2.

7.2.1 Evolving towards IMT-2000 capabilities

Pre-IMT-2000 CNs which wish to evolve towards IMT-2000 capabilities can be supported by the use of an appropriate AF (see Note 1) to connect to the IMT-2000 RAN. Similarly pre-IMT-2000 RANs which wish to evolve towards IMT-2000 capabilities can be supported by the use of an appropriate RAN-RTT/RTAF (see Note 1).

NOTE 1 – Outside of scope of this Recommendation.

7.2.2 Adaptation functionality with IMT-2000 networks

AF supplies a means to allow CN services transparently through the RAN between the mobile terminal and the corresponding CN.

7.2.3 Interworking with IMT-2000 networks

IWF provides connection and roaming capabilities between different CNs. Pre-IMT-2000 CNs which wish to interwork with IMT-2000 networks can be supported by the use of an appropriate IWF (see Note 1, § 7.2.1).

7.3 Satellite aspects

Recommendation ITU-R M.1167 indicates that the terrestrial and satellite components of IMT-2000 may need to be considered independent of each other for operational resources. This may have an impact on some commonality aspects. Various scenarios of satellite operation are described in Recommendation ITU-R M.1167, § 8, which may help clarify these issues.

8 Commonality in packet access mechanisms

Packet access is a major feature for IMT-2000. Benefits include efficient use of the radio resources. The support of packet access from the beginning of the definition of IMT-2000 enables IMT-2000 to provide some commonality in the system management.

– Resources management ought to be provided independently from connection management. This principle allows a common connection management scheme for all radio access techniques, both in circuit and in packet access modes.

– Similarly, it would be useful to define some commonality in the radio resource management. It is desirable to provide the upper part of the MAC layer independently from the RTT. Nevertheless, it is difficult to define an efficient radio resource management completely independent from the transmission scheme. This section analyses the impact of packet access on IMT-2000 radio interface and points out some constraints that should be taken into account to provide some commonality in the radio resource management.

With a packet access mode, capacity is allocated on demand. To avoid wasting capacity, radio resources used to transfer information are released during breaks in traffic source activity. Nevertheless, in connection-oriented packet access mode, a logical connection is maintained possibly through the use of a permanent control channel, to avoid repeating some call establishment information. For example, timing advance and power control information are exchanged on that logical channel.

A packet access mode needs a particular radio resources reservation mechanism. The radio resource cannot be only allocated at the beginning of the call. Radio resources reservations may occur during the call. The protocol and the associated physical resources must allow such a dynamic allocation.

Packet access protocols have some influences on logical channel structure. A connection-oriented packet access protocol needs a permanent control channel used to keep control of each mobile that has set up a connection, even when no traffic is being carried. Moreover, specialized packet access common control channels may be necessary.

Packet access mode needs to have a more frequent exchange of signalling information than circuit access mode. Indeed low level signalling is often exchanged for radio resources requests and allocations. It is necessary to reserve some bandwidth for signalling channel on the downlink frame for resource allocations and fast paging. In the same way, bandwidth is reserved on the uplink frame for resource requests and fast paging acknowledgements.

9 Identification of common functions in RBCF

This paragraph indicates how to identify the IMT-2000 radio related functions and parameters that can be made common across multiple radio operating environments. The technical requirements and the rationale for commonality to apply are also stated. These functions and parameters are derived considering different aspects such as:

– provision for a common signalling in the radio subsystem,

– common logical channel structure,

– mechanisms to adapt CODECs to different radio environment,

– rules to set the radio-related parameters (e.g. bandwidth).

9.1 Guidelines for assessing whether a function can be made common

When identifying common functions it may seem attractive to identify a common set of criteria, or common sets of criteria, against which the functions can be tested for commonality. Recommendation ITU-R M.687 identifies a number of system objectives and Recommendation ITU-R M.1034 identifies a number of requirements applicable to the radio interface(s) of IMT-2000.

Nevertheless, if a strict approach were adopted to identify the common radio independent functions, the set of radio technology independent network elements would probably be very limited, because the radio characteristics also affect higher levels of the network infrastructure. In this case, all advantages tied to the realization of a generic RBCF in IMT-2000 would be lost. Accordingly, a more flexible approach has been adopted where the following types of common functions have been identified:

Type 1 function: This is common in the sense that it performs the same actions on the same objects independently of the radio transmission technique. Such a function could be ciphering algorithms.

Type 2 function: This can be defined in the same way for all RTTs, even if only a subset of its elementary tasks is used for each RTT. This type of function may require that additional internal tasks are introduced in order to characterize the function for each radio technique.

9.2 Common functions in RBCF

According to the criteria reported in § 9.1, the common functionalities to be assigned to RBCF have been identified. They have been grouped into three categories, namely radio transport, radio resources management and mobility related functions. Call control and location management functions have not been mentioned as candidates for RBCF since they usually belong to the CN.

Each of the common functions embodies, in general, both transport and control roles; however, since this is a high-level description, no distinction is made between the two roles. Some of the common functions may not only be needed in the RBCF, but also in other points of the network(s). The handover function, for instance, is usually performed both on radio side (RBCF) and on the CN side (exchange).

9.2.1 Radio transport functions

9.2.1.1 Error detection and correction

This functionality detects and corrects frames that have been subject to transmission errors, using both forward and backward correction scheme; error detection and correction commonalities refer to the same service.

9.2.1.2 Frames structure adaptation

This functionality allows for achieving common frames structures in the interface between radio access and CN. Moreover, it allows the development of source CODECs and radio access technologies independently of each other.

9.2.1.3 Multiplexing and demultiplexing

This functionality allows the use of a single channel for different information streams; it applies to both different calls and different connections within a single call (multimedia services) (see Annex 2).

9.2.1.4 Source coding

This functionality enables generic CODECs to be used with different RTTs.

9.2.1.5 Encryption and decryption

This functionality protects data against non-authorized parties; it enables generic encryption algorithms to be used with different RTTs.

9.2.2 Radio resources management functions

9.2.2.1 Bearer capacity set up and release

This functionality generates set-up and release requests to the RTT for a given transport capability.

9.2.2.2 Flexible resource allocation

This functionality controls the radio resource allocation during a call; it applies in a variable bit rate context to both packet and circuit access modes.

9.2.2.3 Multibearer capability

This functionality enables the segmentation of a single data stream into multiple radio bearers and the reverse re-assembly function.

9.2.2.4 Admission control

This functionality is responsible for accepting or denying a connection, based on the system conditions and the available resources.

9.2.2.5 Quality control

This functionality monitors the actual QoS associated with a connection and triggers the necessary actions to fulfill the QoS requirements.

9.2.3 Mobility-related functions

9.2.3.1 Handover

This functionality controls and performs the bridging and switching functions to ensure, in a seamless way, the connection continuity.

9.2.3.2 Macrodiversity

This functionality controls and performs the combining of information streams generated by a single source but conveyed via several parallel physical channels; in the opposite transmission direction it replicates the information stream onto multiple physical channels towards a single recipient.

9.2.3.3 Paging execution

This functionality accomplishes the paging command by sending the appropriate messages towards the mobile stations through a given number of base stations. It applies to both paging procedures for incoming calls and specific paging services.

10 Summary and conclusions

This Recommendation identifies the following requirements for the IMT-2000 design:

a) adoption of a modularized functional and physical architecture for the RAN of IMT-2000;

b) separation of transport, access, control and management functionalities;

c) minimization of the number of radio interfaces and maximization of the commonality between them;

d) distinct separation of radio access functionalities from the core network;

e) use of common functions allowing for compatibility of different radio transmission technologies;

f) use of transport mechanisms which are essentially independent from services, to enable support of a wide and changing range of services;

g) the option to separate source and channel coding where necessary, in order to support multiplexed multimedia applications (see Annex 2);

h) provision of a transparent radio bearer capability, in order to support multiplexed multimedia applications, with separation of radio bearer and connection (see Annex 2);

i) support of several parallel connections for a single call, in order to support different types of services (see Annex 2);

j) consideration of broadband functional architectures when formulating the functional elements of the modularized architecture;

k) consideration of ATM, TCP/IP and other emerging trends in transport techniques when formulating the functional elements of the modularized architecture (see Annex 1);

l) consideration of emerging distributed processing techniques when formulating the functional elements of the modularized architecture;

m) consideration of packet access mechanisms when defining the commonality functions in the RAN;

n) standardization of a RAN interface within the ITU in addition to the IMT-2000 radio interface(s).

Such a generic, modular architectural framework for telecommunications networks will:

– provide a common framework for progressing standards within and between various areas of expertise, exploiting synergy among the various groups involved and avoiding replication;

– enable cost-effective implementation of standards, each operator or manufacturer being able to choose what to implement, and when, without incurring problems when missing or additional functionality is added later.

ANNEX 1

ATM service modes of operation

Two different approaches can be defined for the radio interfaces between the mobile terminal and base subsystem using non-transparent and transparent ATM service models. In the non-transparent service approach, ATM cells are not carried over the radio interface. In this case a specific ATM adaptation layer is used in the base subsystem so that an optimum radio interface protocol can be used to utilize the radio resources. In the transparent ATM service approach, the radio interface contains ATM layering structure. This approach provides maximum ATM compatibility.

Two examples of service models are described below.

1 Non-transparent service model

The architecture of the non-transparent ATM service model radio system interworks with ATM without any modifications to the radio system or ATM signalling. This approach has the least impact on the radio system and ATM infrastructures. The ATM user network interface (UNI) terminates at the base subsystem.

The base subsystem is connected to a mobility enhanced ATM access switch in the fixed network segment. This ATM switch can be considered to be an ordinary switch with extra functionalities to handle mobile-specific functions. The switch cooperates with database systems to provide mobility support to wireless users. Note that if the base subsystem provides an ATM UNI interface, the ATM gateway can be eliminated.

In the non-transparent ATM service model, ATM is used as the backbone network instead of providing end users with ATM features directly. This may be desirable because the transmission of an ATM cell requires large overhead and the end-to-end ATM QoS is more difficult to maintain in a noisy radio environment.

2 Transparent service model

In the network architecture of the transparent ATM service model the ATM cell is carried over the radio interface (the ATM cell format which is carried over the radio link may be compressed so that the overhead can be reduced and to maintain required QoS over the noisy radio access environment). It is different from the non-transparent mode in that mobility management signalling is included as part of ATM signalling. All signalling messages, ATM and mobility management, are handled by the base subsystem and mobile enhanced ATM switch. In the transparent ATM service model, the ATM UNI may still be terminated at the ATM gateway.

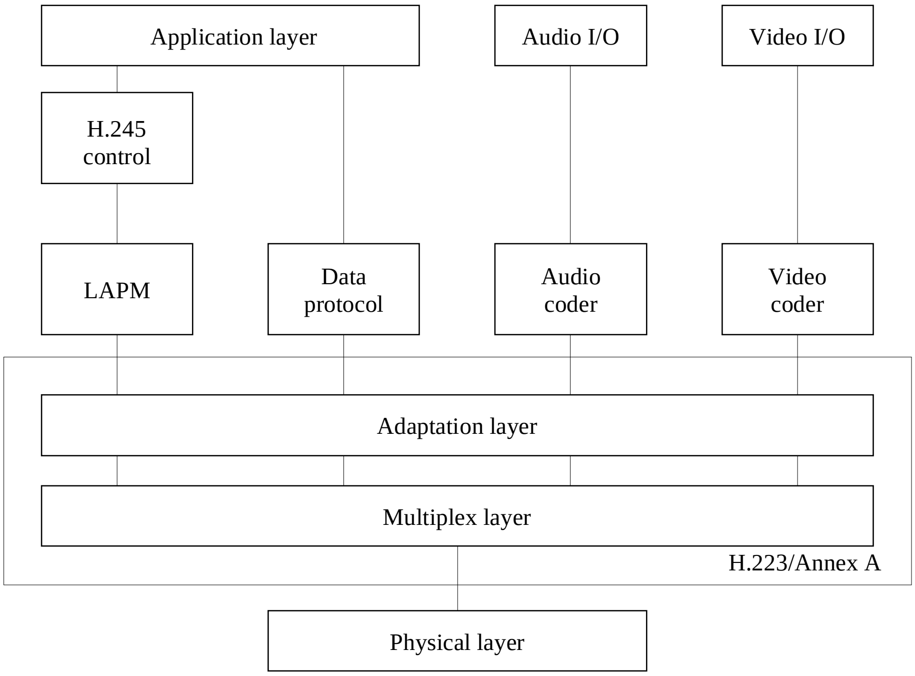
ANNEX 2

Mobile multimedia services

Figure 3 below, which is based on the proposed Annex A of ITU-T Recommendation H.223 (Multiplexing Protocol for Low Bit-rate Mobile Multimedia Communication) provides valuable insight into the significantly different multiplexed world of mobile multimedia. This robust ITU-T multiplexer together with appropriate audio and video coders, such as G.723, G.729, H.263 and MPEG 4, are being developed specifically for wireless applications. In the future, the **negotiated radio bearer will likely be under the control of the users application** which will expect to be able to **renegotiate bandwidth on demand during a session**. In addition to the obvious implications that this will have on radio resource control, the reuse of common functionality and the multiplexing of different types of traffic will necessitate that future RTTs be viewed essentially as bit carriers.

FIGURE 3

Protocol stack for ITU-T Recommendation H.223/Annex A (based on H.223)



LAPM: link access procedure for modems

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It will no longer be necessary to combine source and radio channel coding unless a single service bearer, e.g. speech only, is negotiated between the mobile terminal and the network. While this separation of source and radio channel coding may appear to be non-optimum it will facilitate the reuse of common functionality in multiple radio operating environments and allow delivery of future multimedia services about which we have no knowledge today.

An alternative approach would consist of delivering a limited number of information streams that could be supported by several radio bearers having different QoS requirements. For instance, speech could be supported by a low delay radio bearer while data file transfer would be supported by a high delay radio bearer. This approach would optimize the use of radio resources while maintaining good QoS for each type of service.