RECOMMENDATION ITU-R M.1822

Framework for services supported by IMT

(2007)

TABLE OF CONTENTS

1 Introduction

International Mobile Telecommunications-Advanced (IMT-Advanced) systems are mobile systems that include the new capabilities of IMT that go beyond those of IMT-2000. Such systems provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

IMT-Advanced systems support low to high mobility applications and a wide range of data rates in accordance with user and service demands in multiple user environments. IMT-Advanced also has capabilities for high-quality multimedia applications within a wide range of services and platforms providing a significant improvement in performance and quality of service.

The key features of IMT-Advanced are:

– a high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications in a cost efficient manner;

– compatibility of services within IMT and with fixed networks;

– capability of interworking with other radio access systems;

– high-quality mobile services;

– user equipment suitable for worldwide use;

– user-friendly applications, services and equipment;

– worldwide roaming capability;

– enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility were established as targets for research)[1].

These features enable IMT-Advanced to address evolving user needs.

The capabilities of IMT-Advanced systems are being continuously enhanced in line with user trends and technology developments.

The framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000 are described in Recommendation ITU-R M.1645. Furthermore, based on Recommendation ITU-R M.1645, ITU-R had developed IMT-Advanced related documents such as Reports ITU-R M.2072 and ITU-R M.2074.

IMT-Advanced is expected to be a platform that could provide novel services, which are either a profound improvement of present ones or a revolution that leads to applications that might change people's lives. Therefore, one of the most important tasks is to provide a framework for the high-level requirements for services to be delivered by IMT from end-user's point of view and illuminate the requirements from other perspectives on this basis.

2 Scope

This Recommendation addresses the high-level requirements for telecommunication services and applications to be supported by IMT, including the future development of IMT-2000 and IMT-Advanced. It includes service parameters and service classifications of IMT. This Recommendation also includes examples of telecommunication services that may be supported by IMT.

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1 Data rates sourced from Recommendation ITU-R M.1645.

3 Related ITU documents

List of related ITU-R Recommendations and Reports:

1 Recommendation ITU-R M.816-1 – Framework for services supported on International Mobile Telecommunications-2000 (IMT-2000).

2 Recommendation ITU-R M.1645 – Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000.

3 Report ITU-R M.2072 – World mobile telecommunication market forecast.

4 Report ITU-R M.2074 – Radio aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000.

5 Recommendation ITU-R M.1079-2 – Performance and quality of service requirements for International Mobile Telecommunications-2000 (IMT-2000) access networks.

List of related ITU-T Recommendations:

1 ITU-T Recommendation Q.1702 – Long-term vision of network aspects for systems beyond IMT-2000.

2 ITU-T Recommendation Q.1703 – Service and network capabilities framework of network aspects for systems beyond IMT-2000.

3 ITU-T Recommendation Y.2001 – General overview of NGN.

4 ITU-T Recommendation Y.2011 – General principles and general reference model for Next Generation Networks.

4 List of definitions, acronyms and abbreviations

4.1 Definitions

None.

4.2 Acronyms and abbreviations

ID: Identification

IMAP: Internet message access protocol

IMT: International Mobile Telecommunications

IP: Internet protocol

IT: Information technologies

ITS: Intelligent transport systems

LAN: Local area network

MMS: Multimedia messaging service

MOS: Mean opinion score

PDA: Personal digital assistants

POP: Post office protocol

PSAP: Public safety answering point

PTT: Push-to-talk

QoS: Quality of service

RX: Receive

SMS: Short messaging service

TX: Transmit

URL: Uniform resource locator

VoIP: Voice over IP

5 Considerations

The ITU-R Radiocommunication Assembly,

considering

a) the possible involvement of several types of networks;

b) the increasing technical developments and opportunities;

c) the need of many users for services which are not bounded by geography or operators;

d) the necessity of priority services (e.g. emergency calls shall be supported as higher priority than other commercial services);

e) that the services supported by IMT will be operated in an environment which requires recognition of the following factors:

e-1) *Low cost*: Users want diverse, affordable, and convenient mobile services. Such demands will be realized by development of technology that will reduce the cost per packet.

e-2) *High data rate*: Services such as video phone, streaming, and video-on-demand, which are currently available via wired networks will be required to be supported via wireless networks with higher broadband capacity with anytime, anywhere availability.

e-3) *Convergence*: The rapid development of information technology (IT), including the Internet, has resulted in the aggregation and convergence of various networks and digital devices. In addition to the aggregation of data and voice, the integration of wired and wireless communications is ongoing.

e-4) *Personalization*: As society becomes diversified, user-customized, personalized services will need to be provided in lieu of the existing standardized services.

e-5) *Wide range of terminals*: A wide range of terminals is desired for future mobile services. Some users may need an affordable voice-centric terminal while other users would prefer a versatile mobile phone that could provide not only traditional functions like telephony, but also utilities such as a digital camera, music and movie player, map guidance, e-Wallet, etc. For connecting to the electric, electronic, and mechanical machine surrounding user, short-range communication devices could be merged to the terminals.

e-6) *Multiple profile*: Services should support multiple profiles in various environments. For example, voice telephony may support many different quality levels. In some cases, a voice call has a typical data rate of 12.2 kbit/s, while in other cases, a voice call may have a data rate of 40 kbit/s. From a user's viewpoint, voice telephony is one single service, but may support multiple profiles in multiple environments.

e-7) *Multi-application support*: Users will simultaneously use several services. One example is that a user could make a phone call while continuing to walk under the guidance of a real-time map downloaded to the same device.

e-8) *Environment awareness*: The services will support an environment-awareness function. This means that the services can automatically adapt to different environments. Users will not need to change the settings of the application manually. Environment information can be acquired, understood and handled by the services themselves;

f) that the following technology trends are contributing to the development of new and novel services for wireless applications:

f-1) *Personal networking*: Connecting different electronic devices within a person's immediate surroundings to facilitate real-time communication of data (e.g. multimedia, file transfer, connection to Internet).

f-2) *Home networking*: Connecting the different electronic devices and appliances in a household by way of a local area network (LAN) to allow for real-time communication of data (e.g. multimedia, remote control, connection to Internet, file transfer).

f-3) *Intelligent transportation and vehicular networking*: Broad range of diverse technologies applied to transportation to make systems safer, more efficient, more reliable and more environmentally friendly.

f-4) *Virtual communities*: A virtual or online community is a group of people who primarily or initially communicate or interact via the Internet.

f-5) *Context awareness*: It is expected that the integration and convergence of information technology, telecommunications, and content will result in new service delivery dynamics and a new paradigm in telecommunications where value-added services, such as those which are location dependent, will provide significant benefits to both the end users and the service providers;

g) that the list of examples in Annex 1 may be supported by IMT systems.

6 Recommendation

The ITU Radiocommunication Assembly,

recommends

1 that the following high-level requirements should be used for the telecommunication services and applications to be supported by IMT, taking into account that the requirements may be different from one service offering to another.

Seamless connectivity

Seamless handover to support user mobility was stated as a requirement for IMT-2000. It remains a requirement for IMT-Advanced. In addition, IMT-Advanced should support seamless handover to at least one of the IMT-2000 family members. Requirements of various seamless services are shown in ITU-T Recommendations Q.1703, Y.2001 and Y.2011. It is necessary to take into consideration the factors shown below.

Mobility management

– As described in Recommendation ITU-R M.1645, IMT is needed to continue service under nomadic, slow and high mobility conditions without conscious cooperation of the users.

Interoperability

– When users are in multimodal service with IMT and other services, the users should not need to be aware of the type of system.

Constant connection

– Some of the applications, such as network-camera and monitoring, constantly transmit data. These types of applications require constant connection services.

Application scalability

– For continuous service, IMT is required to maintain services despite changes of condition by adapting the data rate and/or the error tolerance of the application.

Security

Some applications, such as voice over IP and video telephony need to authenticate the user with the telephone number, and other applications (such as secure m-Commerce) require the assurance of data integrity. IMT is required to support high security services to prevent security breaches such as eavesdropping and spoofing. Useful information concerning security is described in several Recommendations such as ITU-T Recommendations H.235 and Q.1703.

Prioritization

In the Report ITU-R M.2072, applications with urgency, such as emergency/disaster/disaster prediction, are described. Such applications require higher priority than other applications. IMT needs to support prioritization of access to network resources.

Location

Many location-based services need to acquire the information on the user's position. An important aspect of this capability is the ability to protect the privacy information of the user.

Broadcast/multicast

Broadcast applications, broadcasting programmes and IP broadcast high definition TV and video are described in Report ITU-R M.2072. There are also multicast applications for specified users, such as collaborative working (application sharing), other than broadcasting services for the general public. Efficient support for point-to-multipoint transmission is required because broadcast and multicast services are expected to be an important part of an operator's service offering in the future.

Presence

Presence allows a set of users to be informed about the availability, willingness and means of communication of the other users in a group.

Usability

The mobile services for IMT should be easy and convenient to use for users when they want to access desired services. The usability may include the following two aspects:

Voice recognition

– Natural languages are more flexible interaction methods making IMT easier to use. So voice recognition will be a promising feature for future mobile applications.

User-friendly human-to-machine interface

– Good user experience plays a crucial role in the acceptance and usability of services. Since many advanced features and services will be provided in IMT systems, it is very important to enable a user-friendly human-to-machine interface.

Support for a wide range of services

A wide range of services are currently delivered by IMT-2000 to mobile users. Many of the service examples in Annex 1 are offered. IMT is required to have the ability to offer a wide range of telecommunication services. While a specific set of services is not required, the service parameters and service classifications in Annex 2, Sections A2.1 and A2.2 respectively, should be used to ensure that a wide range of telecommunication services to mobile users can be provided by IMT.

Annex 1

Examples

This list provides a wide range of telecommunication service offerings that will increase as new applications are developed based on the advancement of technology.

Messaging

Messaging services (e.g. SMS, MMS and e-mail) exchange messages between user terminals.

Video messaging service is comparable to voicemail with a video accompanying the voice message.

Voice telephony

Voice communication involving two or more parties that includes features such as call waiting, conference calling, voicemail, message waiting indication, caller ID and calling name ID. VoIP is a form of voice telephony service, which is described in ITU-T Recommendation H.323.

Push-to-talk/Push-to-X

Push-to-talk is a two-way communication service allowing one participant at a time to speak, and is not meant to be a replacement for normal voice telephony calls. Its design should allow for instant access, simplicity, a quick exchange of information between users and the efficient use of network resources. The basic functionality described above can also be enhanced to support a whole series of push-to-X services. Examples are push-to-view, which allows users to share images during a PTT call, push-to-find, where location information is transferred, or push-to-show.

High-quality video telephony

High-quality video telephony is full-duplex, real-time audiovisual communication between or among end users. It may be provided as a complement of traditional voice telephony service. Visual telephone systems, multimedia conversational services, and video telephony services over IP networks are described in ITU-T Recommendations H.100, F.703 and F.724, respectively.

Video conference

Video conference is full-duplex, real-time audiovisual communication between or among end users. Conventional video conference system is described in ITU-T Recommendation H.140. Video conference system over IP networks is mentioned in ITU-T Recommendations F.702 and F.733.

Internet browsing

Internet browsing is accessing Internet pages to get information. It mainly involves communication between user equipment and an information server/content provider.

Interactive gaming

Interactive gaming services mainly involve data transferred between multiple users that are connected to a server, or directly between the equipment of multiple users. Real-time communication with low delay and low jitter may be required for interactive gaming.

File transfer/download

File transfer/download is the act of transferring a file electronically from one network element to another.

Multimedia

Multimedia is media that uses multiple forms of information content and information processing (e.g. text, audio, graphics, animation, video, interactivity) to inform or entertain the audience (user). Multimedia communication is an essential element of various application services described in this section which are to be supported by IMT. The framework of multimedia services is described in ITU-T Recommendations F.700, F.701 and F.741.

e-Education

e-Education is a term generally used to refer to computer-enhanced education, although it is often extended to include the use of mobile technologies.

Consultation

Mobile consultation can provide the user with desired data collection and storing automatically, and remote consultation services in real time with mobility. For example, e-Health services, such as health care/health check, remote diagnostics, medication information and medical data provision, may benefit from the use of mobile technologies.

Remote collaboration

Remote collaboration is sharing of files and documents in real time to advance/deliver a project. It mainly involves data transferred between multiple users that are connected to a server or directly between the equipment of one user.

This includes facilities for a virtual office that is a personal online office, where the data and files can be shared in real time. The data transferred among multiple users, or among the equipment of one user, can be done in real time.

Mobile commerce

Mobile commerce is buying and selling of goods and services through wireless handheld devices, such as cellular telephone and personal digital assistants (PDAs). It mainly involves data transferred between user equipment and financial servers connected with secured databases. This service also enables the real-time sharing and management of information on products, inventory, availability, etc. This service requires a high level of reliability.

Mobile broadcasting/multicasting

Mobile broadcasting is one to many transmission of multimedia content (e.g. text, audio and video) over the mobile networks. This includes mobile instant and interactive content/TV is the ability to interact with an audio/video programme by exchanging multimedia information.

Machine-to-machine

Machine-to-machine communication is a type of service which exchanges data without human interaction, such as remote sensor, remote bio-monitoring and personal environment service. This service may transfer a small size of data traffic in a large number of sessions.

Remote sensor

– Instrument recording a measurement and transmitting it over a distance

Remote bio-monitoring

– The act of monitoring someone's vital signs or other key physical elements from a distance using intelligent processing elements connected by a network

Personal environment service

– The electric, electronic, and mechanical machine surrounding users can be automatically configured according to the pre-defined and/or self-growing user preference.

ITS-enabled services

Services enabled by ITS utilize the combination of computers, communications, positioning and automation technologies to improve the safety, management and efficiency of terrestrial transportation systems. For example, vehicles in ITS can communicate between each other automatically, and vehicles can communicate with the other traffic systems, such as toll-gates and traffic lights.

Emergency calling

Emergency calling routes emergency calls from subscribers and non-subscribers to the appropriate public safety answering points (e.g. police, fire and ambulance), and automatically delivers the caller's phone number and location coordinates to facilitate the emergency call handling procedures. Depending on the circumstances, emergency calls will also use multimedia, such as SMS, MMS or one-way video call, in addition to a two-way voice or video call. Device characteristics also need to be sent to the PSAPs to determine capabilities for remote access while insuring privacy issues are managed.

Public alerting

Public alerting enables emergency management officers to quickly notify all residents and emergency response teams, within a defined area of hazardous situations, such as chemical spills, power outages, weather warnings and other potential life-threatening events. Location, device screen characteristics and a feedback mechanism may be required as an enhanced public alerting service.

Number portability

Number portability provides the ability for customers to keep their telephone number when changing telephone service providers.

Priority service

Priority service provides qualified users with priority access to radio resources and network resources to help increase call completion rates, especially during periods of congestion or emergency.

Lawful intercept

Lawful intercept provides network operators, access providers and service providers with the legal and technical ability to provide the specific communication content and related information of selected users to law enforcement agencies. Lawful intercept is based upon national or regional laws or technical regulations.

Location-based services

Location-based services, which depend on the present location of a user, enable users to find other people, vehicles, resources, services or machines.

Annex 2

Service parameters and classification of services

1 Telecommunication service parameters

The principle in service definition is user-centric. In a communication system, users play a sender and/or receiver's role. Application traffic is generated in the sender side, and passed through a communication system, and recovered in the receiver side. Service definition is the description method of the whole process, from one end to another.

1.1 Quality

1.1.1 Transmission level

Generally, one service has both uplink and downlink traffic. So a complete description of parameters of transmission level quality shall include both uplink and downlink. Of course, for a single-direction service, the other direction can be left empty.

To simplify the description of transmission level quality, several important parameters are identified and listed below:

Information loss

– Information loss is not limited to the effects of bit errors or packet loss during transmission, but also includes the effects of any degradation introduced by media coding for more efficient transmission (e.g. the use of low bit-rate speech codecs for voice).

Throughput

– The throughput can be evaluated at several levels for mobile communication systems. User throughput is defined as the amount of data per time unit per user, and sector throughput is defined as the total amount of data per sector of the base station. They can also be classified into throughput of layer level such as physical layer, data link layer, network layer, application layer, and so on. Higher layer throughput is delivered by reducing the lower layer overhead. For example, network layer throughput is the amount of correctly received information bits at IP packet layer per time unit delivered to a network entity reduced with the lower layer overhead (e.g. guardbands, guard times, preambles, pilots, headers and control signalling).

Burstiness

– Burstiness is an attribution to characterize data traffic. IMT provides sufficient capacity to handle bursty traffic. The burstiness can be estimated by a numerical factor. For example, the ratio of the peak bit rate to the average bit rate can be used for this estimation, where the peak bit rate is the maximum data rate observed during the session and the average bit rate is the average determined during a session.

Delay/jitter

– Delay has many components, including transmission delay, queuing and schedule delay, media delay, device processing delay and error control caused delay. For example, the transmission delay can be evaluated as the one-way transit time between a packet being available at the IP layer in either the user terminal or the base station and the availability of this packet at IP layer in the base station/user terminal after its transmission over the air interface.

– IMT provides real-time and non-real-time services respectively. Real-time services require low delay and jitter.

Useful information concerning these parameters is described in several Recommendations such as Recommendation ITU-R M.1079-2, ITU-T Recommendations G.1010, Y.1541 and P.1010.

1.1.2 Connection level

Latency (session establishment)

IMT support appropriate quality of connection when end users request session establishment. Latency is a parameter to consider in the quality of connection.

1.1.3 Application level

Voice MOS

Voice quality in IMT is expected to satisfy Recommendation ITU-R M.1079-2.

1.2 Degree of asymmetry

Applications which IMT supports may have various degrees of asymmetry. Report ITU-R M.2072 describes not only download dominant applications such as e-newspaper, but also upload dominant applications such as observation (network-camera) and upload file transfer. Also, the degree of other applications such as high-quality video telephony, mobile broadcasting, and video conference depends on their requirements.

1.3 Degree of mobility

IMT services may be provided under the various mobile circumstances (mobile/nomadic) which are described in Recommendation ITU-R M.1645.

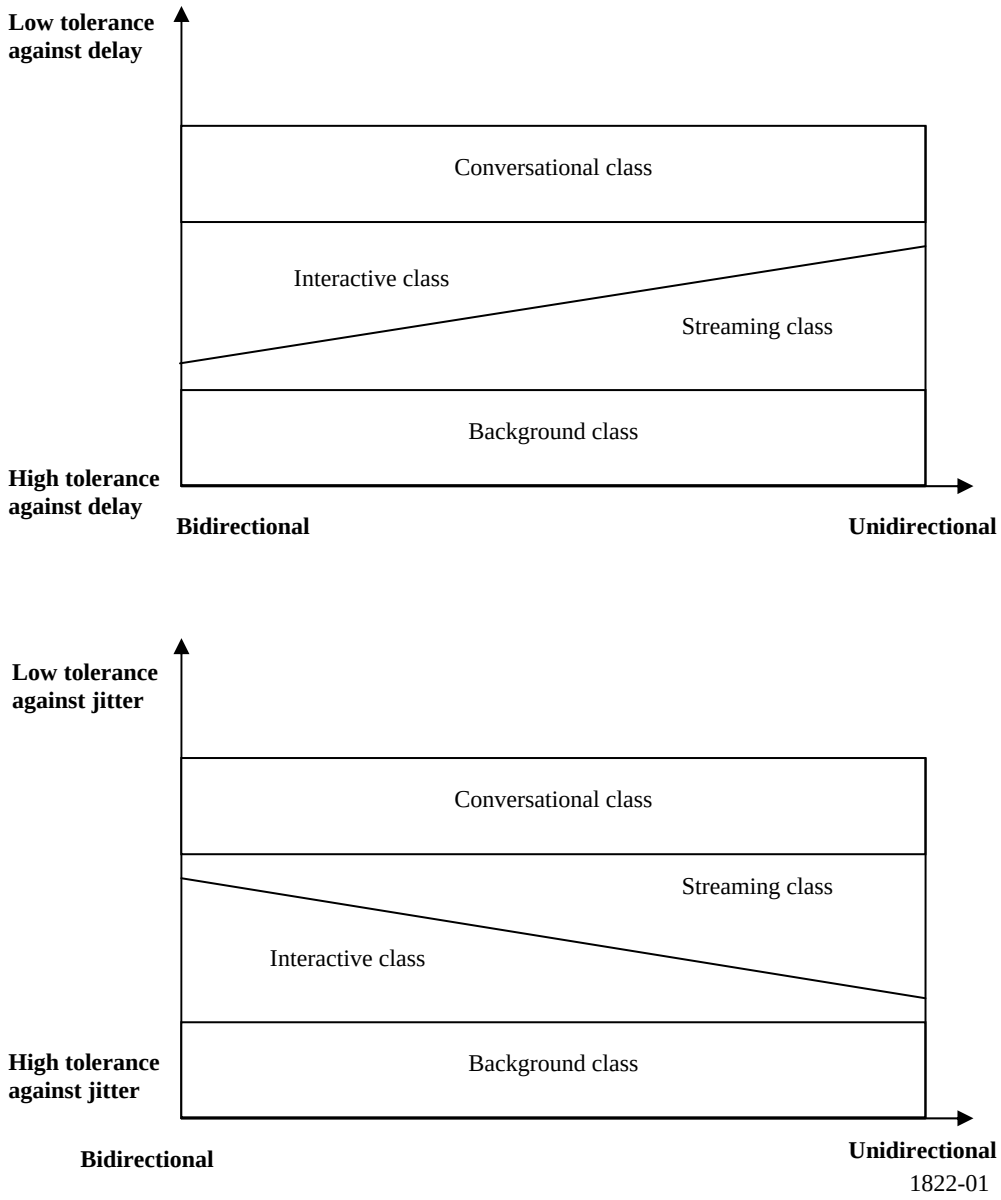
2 Classification of services

2.1 User experience classes

User-experience classes are classified according to two criteria, which are bidirectionality and tolerance against delay and jitter. For example, conversational class has characteristics of minimal delay and jitter regardless directionality. In this aspect, the diagram below explains the relative position of each class along these two dimensions.

FIGURE 1

General concept of user experience classes



2.2 Detailed description of service classes

Generally, end users are indifferent towards quality-related issues that are not visible to them. The quality-related issues that can be observed by a user are specific to the considered service application. For example, a web browsing user perceives quality of service (QoS) mainly in terms of the time it takes until a webpage is fully displayed after clicking on a hyperlink or entering a URL. Technically this duration results from a complex interaction of factors like throughput, packet delay, and residual bit error ratio. On the other hand the quality of a voice call mainly depends on only the residual bit error ratio.

Translating service application requirements into requirements that are directly related to data transport through a wireless network commonly leads to considering a limited number of QoS attributes, such as data throughput, packet delay and/or delay variations (often referred to as delay jitter), bit/packet error rate and other similar aspects.

This motivates the introduction of service classes that group together services that are similar in terms of their requirements towards a network. The service classification makes use of the existing QoS classes specified in Recommendation ITU-R M.1079-2. Since classification of the services listed in Annex 1 based on user experience class only still leaves considerably different services in each user experience class, within each QoS class services that are similar in terms of required QoS are combined into service classes. In Table 1 the different services from the service examples are mapped onto service classes. In the conversational user experience class there are three service classes. The basic conversational service class comprises basic services that are dominated by voice communication characteristics. The rich conversational service class consists of services that mainly provide synchronous communication enhanced by additional media such as video, collaborative document viewing, etc. Conversational low delay class comprises real-time services that have very strict delay and delay jitter requirements.

In the interactive user experience class two service classes are distinguished. Interactive services that permit relatively high delay which usually follow a request-response pattern (e.g. web browsing, database query, etc.). In such cases, response times in the order of a few seconds are permitted. Interactive services requiring significantly lower delay are remote server access (e.g. IMAP) or remote collaboration.

In the streaming user experience class there are two service classes. The differentiating factor between those two classes is the live or non-live nature of the content transmitted. In case of live content, buffering possibilities are very limited, which makes the service very delay-sensitive. In the case of non-live (i.e. pre-recorded) content, playout buffers at the receiver side provide a high robustness against delay and delay jitter.

The background class only contains delay-insensitive services, so that there is no need for further differentiation.

TABLE 1

Service classification

User experience class	Service class	Example services
Conversational	Basic conversational	Voice telephony (including VoIP), Emergency calling, Push-to-talk.
	Rich conversational	Video conference, High-quality video telephony, Remote collaboration, e-Education (e.g. video call to teacher), Consultation (e.g. video interaction with doctor), Mobile commerce.
	Conversational low delay	Interactive gaming, Consultation, Priority service.

TABLE 1 (*end*)

User experience class	Service class	Example services
Interactive	Interactive high delay	e-Education (e.g. data search) Consultation (e.g. data search) Internet browsing, Mobile commerce, Location-based services, ITS-enabled services.
	Interactive low delay	Emergency calling, e-mail (IMAP server access), Remote collaboration (e.g. desktop sharing), Public alerting (e.g. with feedback), Messaging (instant messaging), Mobile broadcasting/multicasting (mobile interactive personalized TV), Interactive gaming.
Streaming	Streaming live	Emergency calling, Public alerting, e-Education (e.g. remote lecture), Consultation (e.g. remote monitoring), Machine-to-machine (e.g. observation), Mobile broadcasting/multicasting, Multimedia.
	Streaming non-live	Mobile broadcasting/multicasting, e-Education (e.g. education movies), Multimedia, Mobile commerce, Remote collaboration.
Background	Background	Messaging, Video messaging, Public alerting, e-mail (transfer RX/TX, e.g. POP), Machine-to-machine, File transfer/download, e-Education (file download/upload), Consultation (file download/upload), Internet browsing, Location-based service.

Higher, enriched services exist that are difficult to capture by only one service profile, they use multiple service profiles, but are perceived by the end user as one service. These services include, for example, e-Education (e.g. conversational class for interaction and interactive for accessing learning material), consultation (e.g. conversational class for interaction and streaming for monitoring), location-based service (e.g. interactive class for accessing information and navigation aspect).

Furthermore, there are some services that are system functions including priority service, lawful intercept, and number portability.