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SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for IMT-2000

Service and network capabilities framework of network aspects for systems beyond IMT-2000

ITU-T Recommendation Q.1703

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ITU-T Recommendation Q.1703

Service and network capabilities framework of network aspects for systems beyond IMT-2000

Summary

This Recommendation specifies the service and network capability framework for systems beyond IMT-2000, from the network aspects, in order to attend the high level end-user needs delineated in the ITU long-term vision for systems beyond IMT-2000, as specified in ITU-T Recs Q.1701 and Q.1702 and ITU-R Rec. M.1645.

Source

ITU-T Recommendation Q.1703 was approved on 29 May 2004 by ITU-T Special Study Group (SSG) (2001-2004) under the ITU-T Recommendation A.8 procedure.

Keywords

Network capability framework, service capability framework, systems beyond IMT-2000.

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.

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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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ITU-T Recommendation Q.1703

Service and network capabilities framework of network aspects for systems beyond IMT-2000

1 Scope

The scope of this Recommendation is to provide a service and network capabilities and requirements framework, from the network aspect, for systems beyond IMT-2000 around the year 2010, as specified by ITU-R (Rec. M.1645) and ITU-T (Rec. Q.1702). It is expected that various advanced services can be offered via the combination of radio aspect of service capabilities and network aspect of service capabilities, the ones described herein. However, due to the numerous possibilities of such advanced services, the concrete service contents but the framework to support those will not be discussed in this Recommendation.

This Recommendation follows the vision described in ITU-R (Rec. M.1645) and ITU-T (Rec. Q.1702). To fulfil the vision and accomplish the objectives for systems beyond IMT-2000, this Recommendation identifies the general capabilities and/or requirements framework. These capabilities and/or requirements framework can be studied in order to develop the detailed capabilities and/or requirements for systems beyond IMT-2000.

2 References

2.1 Normative 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.

[1] ITU-T Recommendation Q.65 (2000), *The unified functional methodology for the characterization of services and network capabilities including alternative object oriented techniques*.

[2] ITU-T Recommendation Q.1214 (1995), *Distributed functional plane for intelligent network CS-1*.

[3] ITU-T Recommendation E.410 (1998), *International network management – General information*.

[4] ITU-T Recommendation E.418 (2003), *Framework for network management of IMT-2000 networks*.

[5] ITU-T Recommendation M.3400 (2000), *TMN management functions*.

[6] ITU-T Recommendation M.3210.1 (2001), *TMN management services for IMT-2000 security management*.

[7] ITU-T Recommendation Q.1701 (1999), *Framework for IMT-2000 networks*.

[8] ITU-T Recommendation Q.1702 (2002), *Long-term vision of network aspects for systems beyond IMT-2000*.

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

[10] ITU-R Recommendation M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000*.

[11] ITU-T Recommendation H.323 (2003), *Packet-based multimedia communications systems*.

[12] ITU-T Recommendation G.1010 (2001), *End-user multimedia QoS categories*.

[13] ITU-T Recommendation Y.1541 (2002), *Network performance objectives for IP-based services*.

[14] ITU-T Recommendation M.3100 (1995), *Generic network information model*.

[15] ITU-R Recommendation M.687-2 (1997), *International Mobile Telecommunications-2000 (IMT-2000)*.

[16] ITU-T Recommendation Q.1241 (2001), *Introduction to Intelligent Network Capability Set 4*.

[17] ITU-T Recommendation Q.1721 (2000), *Information flows for IMT-2000 Capability Set 1*.

2.2 Informative references

[18] ITU-T *Handbook on Quality of Service and Network Performance* (1993).

[19] ETSI ES 201 915 series: *Open Service Access (OSA); Application Programming Interface (API)*.

3 Definitions

This Recommendation defines the following terms:

3.1 attachment and access capability: The ability of a terminal to power on and gain access to a serving network, home or visited.

3.2 billing: Administrative function to prepare bills to service customers, to prompt payments, to obtain revenues and to take care of customer reclaims.

3.3 continuous mobility (handover): The ability of a mobile user/terminal/network to change location while media streams are active. Handover is further called seamless when the mobile entity's location change does not result in delay or loss of data that would be perceived by the user as degradation of quality of service.

3.4 discrete mobility (roam): The ability of a mobile user/terminal/network to make discrete changes of location, i.e., to change location while no media streams are active.

3.5 mobility: The ability to provide services irrespective of environment changes that may occur by mobile user/terminal/network's activities.

3.6 mobility management: The set of functions used to manage a mobile user accessing a network other than that user's home network. These functions include communication with the home network for purposes of authentication, authorization, location updating and download of user information.

3.7 network capability: A capability of a network that is utilized to support service capabilities but which is not itself a service capability.

3.8 network mobility: The ability of a network, where a set of fixed or mobile nodes are networked to each other, to change, as a unit, its point of attachment to the corresponding network upon the network's movement itself.

3.9 personal mobility: The ability of a user to receive subscribed service independent of the terminal in use as long as that terminal and access network can support the subscribed service.

3.10 Quality of Service (QoS): The collective effect of service performance which determine the degree of satisfaction of a user of a service. It is characterized by the combined aspects of performance factors applicable to all services, such as bandwidth, latency, jitter, traffic loss, etc.

3.11 QoS parameters: QoS parameters are quantifiable characteristics of a service that can be specified by users of that service and which collectively determine the quality of the users experience, e.g., bandwidth, delay, jitter, packet loss, priority, traffic class, etc. QoS parameters are non-subjective characteristics of a service and are specified in terms of numeric values.

3.12 seamless service: Seamless Service will prevent users experiencing any service disruptions while maintaining mobility or portability.

3.13 service: A stand-alone commercial offering, characterized by one or more core service features, and can be optionally enhanced by other service features. Business aspects of a service offering may include bundling of various services, pricing, terminal subsidies, the provisioning of the sales channels, end-user consulting, etc.

3.14 service capability: The capability of a network to offer a service or service feature to subscribers. A service capability becomes visible to a user or subscriber as part of a service or service feature provided by a network operator. Service capabilities depend on network capabilities.

3.15 service creation: The conception, design and implementation of a capability to provide a service.

3.16 service feature: A specific aspect of a telecommunication service that can also be used in conjunction with other telecommunication services/service features.

3.17 service interface: The interface between a service application and the core network capabilities used by that service application in delivering a service to a user.

3.18 service level agreement: An agreement between operators/service providers or between users and service providers defining the level of service to a user(s), that is used as a basis for a business contract.

3.19 service portability: The ability to access any services offered anywhere within the roaming domain of the users at any time.

3.20 session mobility: The ability of the mobile user/terminal/network to maintain sessions while changing between terminal devices and across various access and core networks.

3.21 subscription portability: Consistency of certain service attributes when a subscriber changes service provider (e.g., mobile number, email address).

3.22 terminal: The customer's access equipment used to request and terminate network associated connectivity services.

3.23 terminal mobility: The ability of a terminal to access telecommunication services from different locations and while in motion, and the capability of the network to identify and locate that terminal. Terminal mobility can be further classified into: continuous terminal mobility (handover) and discrete terminal mobility (roam).

3.24 traffic flows control: A set of mechanisms used to control the flow of packets. Traffic Flow Control can be used to prevent the network from becoming overloaded by regulating the input rate transmissions, or to prevent unauthorized use of network resources.

3.25 transport: The functional process of transferring information between different locations.

3.26 Virtual Home Environment (VHE): The provision of a service experience to the mobile subscriber identical to, or as similar as possible to the service environment the subscriber experiences when served at his/her home location.

3.27 virtual home services: The ability of users to receive their home services with the same look and feel from any network and on any terminal on the basis of personal (private) identification.

3.28 Virtual Reality Environment (VRE): The ability for users to access the sights and sounds of remotely located complex systems in real-time.

4 Abbreviations

This Recommendation uses the following abbreviations:

2G	Second Generation
3G	Third Generation
API	Application Programming Interface
AS	Application Server
CS	Capability Set/Circuit Switched
CaS	Call Server
DoS	Denial of Service
DSL	Digital Subscriber Line
ETSI	European Telecommunications Standards Institute
ID	Identity
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IMT-2000	International Mobile Telecommunications-2000
IP	Internet Protocol
IPv6	Internet Protocol version 6
ISP	Internet Service Provider
LAN	Local Area Network
NNI	Network-Network Interface
OAM&P	Operations, Administration, Maintenance and Provisioning
OSA	Open Service Access
PS	Packet Switched
QoS	Quality of Service
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SS	Subscription Server
TMN	Telecommunications Management Network
UE	User Equipment
UIM	User Identity Module
VAS	Value-Added Service
VHE	Virtual Home Environment
VoIP	Voice over IP

VRE Virtual Reality Environment

WIN Wireless Intelligent Network

WLAN Wireless Local Area Network

5 Introduction

In defining a vision for the future of mobile telecommunications, a number of layers of detail are required. The highest layer is an overall end-user service oriented perspective. This is provided in ITU-T Recs Q.1701 and Q.1702.

In order to progress towards the realization of the architecture and interface specifications to achieve these services, the next level of detail is the definition of the service capabilities that are required, and along with these service capabilities, the network capabilities that are required to realize these service capabilities.[1]

This Recommendation provides a service and network capability framework, from the network aspect, in support of the envisaged service needs and key network design objectives for systems beyond IMT-2000, as specified in ITU-R Rec. M.1645 and ITU-T Recs Q.1701 and Q.1702.

5.1 Envisaged capabilities for systems beyond IMT-2000

The prospective network for systems beyond IMT-2000, as noted in ITU-T Rec. Q.1702 and ITU-T Rec. M.1645, consists of diverse and different access systems and IP-based core network, such that the network can support interworking between these diverse access systems and should have the following features:

- Systems Beyond IMT-2000 will be flexible, versatile and new services will be easy-to-deploy.
- Systems Beyond IMT-2000 will use the modular construction using expandable components.
- Systems Beyond IMT-2000 will employ the open interfaces between various systems.

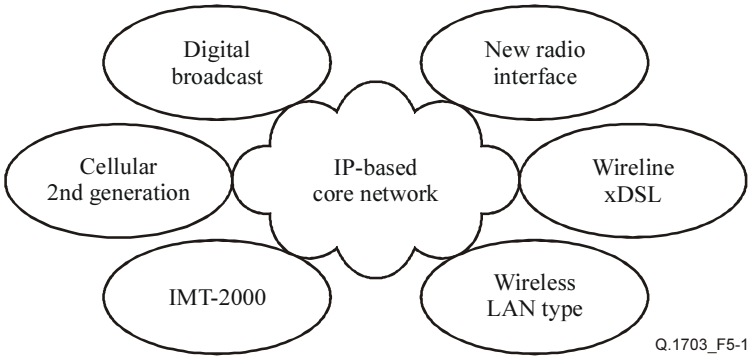

Figure 5-1/Q.1703 – Network of systems beyond IMT-2000

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[1] This layered approach closely parallels the Intelligent Network Conceptual Model described in the Q.1200-series of Recommendations, where a Service Plane, a Global Functional Plane, a Distributed Functional Plane and a Physical Plane are described, each representing a different level of abstraction of the whole of the Intelligent Network.

Systems beyond IMT-2000 may be envisaged to include:

- service provisioning platform;
- IP-based network platform, composed of:
  - access network components;
  - core network components;
- user platform.

5.2 Key study items for systems beyond IMT-2000

As noted in ITU-T Rec. Q.1702 and ITU-R Rec. M.1645, there are many key technical areas that require focused study over the next several years leading to the establishment of standards for Systems Beyond IMT-2000. Based on the market trends, technology trends, key long-term network design objectives, and long-term network architecture concepts, as identified in ITU-T Rec. Q.1702, the following study items are identified in order of priority:

1) Advanced mobility management:
   - To allow flexible, efficient, and integrated mobility management that supports advanced location management, advanced routing management, session continuity, efficient and adaptive location registration, dynamic handling of Quality of Service (QoS) during handover, etc.
   - Support of moving network consisting of several nodes.
   - Support of mobility across heterogeneous access technologies.
2) Separate control and transport functions:
   - Separation of control and bearer planes for scalability and architectural flexibility.
   - Transport functions should fully utilize IP transport capability to direct user traffic.
   - Open interface between control and transport functions.
3) Diversified radio access support:
   - Access independent network.
   - Support heterogeneous access technologies with plug and access.
4) Seamless service support:
   - Network-seamless service capability to support services in the same way across wireless networks, fixed networks, Internet Service Providers (ISPs), and private networks (e.g., Wireless LAN (WLAN)).
   - Terminal-seamless service capability (i.e., session continuity even with environment change).
   - Content-seamless service capability (i.e., video/audio to audio only or vice versa).
5) Application service support:
   - Support diversified Application Service Providers (ASPs) by supporting their services and offering additional values to them.
   - Simplify service expansion and dynamic creation of multi-facet services at session level.
6) Enhanced security and location privacy:
   - Seamless security protection across heterogeneous systems.
   - Enhanced location privacy in a fully IP-based network.

6 Service capability framework from network aspects

The following service capability framework from network aspects is envisaged to facilitate the identification of service capabilities around the year 2010.

6.1 Service capability design objectives

The service capability for Systems Beyond IMT-2000 should support, if needed, the existing services for current IMT-2000 Family Member Systems. In addition, Systems Beyond IMT-2000 network will provide both a number of new and diverse sets of services and an adequate service environment through its service capability framework, whose key long-term design objectives are listed in the following clauses. The service capability framework for Systems Beyond IMT-2000 will:

- Encourage appearances of diversified ASPs by supporting their services and offering additional values to them.
- Provide multiple service combination capabilities with appropriate mechanisms to handle service interaction and service invocation.
- Support modularized service control and open service architecture.
- Simplify service expansion and dynamic creation of multi-facet services at session level.
- Support flexibility for adoption of new services.
- Provide network seamless service capabilities across different networks.
- Provide content seamless service capabilities to adapt service to the suitable format or type for each user in accordance with its location, its status, its preference or terminal capability.
- Provide terminal seamless service capabilities across various terminal environments.
- Support the applications with diverse QoS needs, e.g., non-real time/best effort service.
- Support the secure mechanisms to protect application services.
- Provide the service based on the environment information of a user such as location information with high precision and/or attendant information.
- Provide the service which depends on the validation and/or invalidation of user's preference.

6.2 Service creation

The envisaged service creation in Systems Beyond IMT-2000 should include a well-defined service architecture support and a specific handling to the different categories of service created in those systems. In addition, the network should have a capability to provide the environmental information in response to the request from the service creation support.

6.2.1 Service creation support

The service architecture of Systems Beyond IMT-2000 will support the capability for rapid service creation. Rapid is considered from real-time to a week rather than from weeks to months.

The support should include for joint or independent rapid service creation by the following entities:

- User/Terminals;
- Network Operators;
- Service Providers;
- Independent Third Party Platforms (brokered by Network Operators);
- Manufacturers/Vendors; and
- Content Providers.

6.2.2 Envisaged service category

The services created in Systems Beyond IMT-2000 will, but not limited to, fall into the following category:

6.2.2.1 Basic telecommunication service

Systems Beyond IMT-2000 network should provide the basic telecommunication services, such as tele-services and bearer-services. Tele-services may be offered in a value-added form through possible service combinations, e.g., video telephony.

6.2.2.2 Value-Added Services (VAS)

The VAS services offered by Systems Beyond IMT-2000 network will include multimedia services such as streaming video. It will be divided into subscribed and unsubscribed services. These services may be provided by application servers residing on platforms either internal or external to the network as described below:

The application server platform(s) of the service architecture of Systems Beyond IMT-2000 offering value-added services and/or operator specific services may reside in the home or the visited networks. Platform offering subscribed VAS will be considered to be within the user's home environment. When offered from a third party service provider's platform, these VAS services may not be available/offered by either of the home or the visited networks. They are services offered and authorized to visiting/roaming users through a flexible and real-time access authorization scheme. The VAS will be enabled through the distributed functionalities over the network.

6.2.2.3 Supplementary services

Supplementary services are used to complement, modify and personalize the usage of basic telecommunication services. The same supplementary service may be offered with a number of different telecommunication services. It cannot be offered to a user as a standalone service and must be offered together with or in association with a basic telecommunication service. Multiple supplementary services within a call will be supported and the interactions between them will be handled accordingly based on prioritization.

Systems Beyond IMT-2000 may provide a brand new supplementary service. Systems Beyond IMT-2000 should support the existing IMT-2000 supplementary services mainly for backward compatibility purpose, e.g., call deflection, call line identification, call forwarding, call hold, multi-party calling and advice of charge, etc.

Operator specific supplementary services may at first, not be standardized, but be created using Virtual Home Environment (VHE) capability.

6.3 Service provisioning

6.3.1 Service provisioning model

The service provisioning model of Systems Beyond IMT-2000 is envisaged to have a modularized approach to increase flexibility and scalability, so that the services are provisioned through dynamic cooperation of each entities in such a manner to maximize user satisfaction. Those entities would include: User, Subscriber, Service Provider, Content Provider, Network Operator and Independent Third-Party Platform Operator, as shown in Figure 6-1.

Clearly, this model ensures the functional separation of each entity, which, however, is a logical one and thus more than one function might be implemented in a real entity.

Users may directly subscribe their desired services to each network entities. In most cases, however, it is envisaged that they will utilize the Subscriber such that it manages the contract stuffs between network entities on behalf of users. Therefore, the users would be able to choose services only, remaining transparent to the complicated network related details.

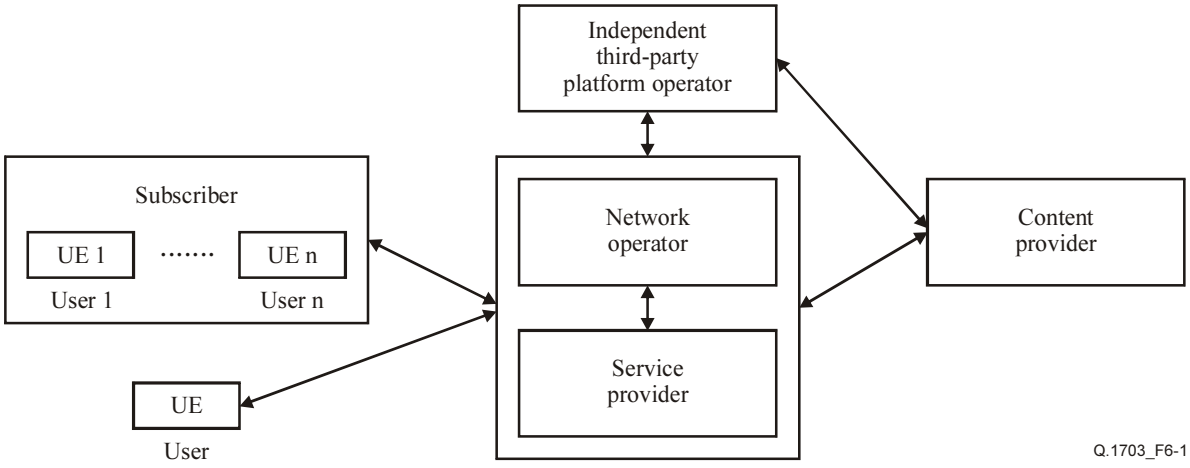


Figure 6-1/Q.1703 – Service provisioning model for Systems Beyond IMT-2000

The Subscriber is the customer of the Service Provider. Commercial agreements are set up and maintained between them for the provision of services from the Service Provider to the User Equipment. The Subscriber may have contracts with multiple Service Providers. The Subscriber informs the Service Provider as which services each user should have access to. The Subscriber may also choose to set limits for users on the user of a particular service and at a pre-assigned QoS level.

The Service Providers may enter into a static or dynamic commercial agreement with one or more network operators in order to deliver services to its subscribers. A company wishing to sell services without having a contract with a network operator, may adopt the role of "Third-Party Platform Operator" and provide services via the Service Provider. A company intending to sell and provide just service contents, i.e., the Content Provider, may develop a commercial relationship with either a Service Provider or a Third-Party Platform Operator.

A user initiates a service by requesting it to the Service Provider (not from the Network Operator). On receipt of a service request, the Service Provider uses the Network Operator or Third-Party Platform Operator to serve the request in the best way possible. An independent Service Provider may choose to use different Network Operators for services with various QoS levels.

6.3.2 User customization of services

It will enable the subscriber and/or user to change the behaviour of their services to suit their requirements. That is, it will support the capability for the subscriber and/or user to modify their service profile (within the limits of their subscription) in both dynamic (real-time) and static (non real-time or semi-permanent) manner as required.

Modification of the user's service profile should be possible through various schemes (e.g., voice, text, DTMF and graphical interface) and independent of the access technologies.

For example, when applied to the basic telecommunication service, user customization of services should allow end users to customize their call features (such as when they want to be called, on what device, under what user or device condition, and by whom).

An example method of user customization of services can be found in Appendix III.

6.3.3 Multi-facet services

Service provisioning in Systems Beyond IMT-2000 should support multi-facet services where various types of services can be provided in a combined form, to facilitate flexible service expansion. Multi-facet services in Systems Beyond IMT-2000 should have the following features:

- With the multiple service combination capability, service provision components in the IP-based network platform should be to provide unlimited service expansion.
- Not only users can enjoy multimedia multi-facet services that service provision components supported, but also should be possible to provide their unique services to other service entities, within the capability framework of service provision components, as far as regulation permits.
- The role of service providers within service provision framework is not static, that is, one service provider may become the user of another service provider in one particular service session, and then, exchange their role later during another service session.

6.3.4 QoS provisioned services

Systems Beyond IMT-2000 should be able to provide diverse levels of QoS upon various types of service requirements. An envisaged service categorization in view of QoS requirements is:

- Interactive service: Mobile Web Access, etc.
- Real-time service: Mobile Telephony, etc.
- Non-real-time service: Mobile Data Applications, etc.
- Streaming service: Video Streaming, etc.

6.4 Service management

The services provided in Systems Beyond IMT-2000 should be managed to support the service features in the following clauses.

6.4.1 Seamless service

The following three types of seamless service will be served in Systems Beyond IMT-2000:

- *Network-seamless service capabilities*

  For many years, roaming has been implemented between mobile networks so that mobile users can be reached via their own telecommunication numbers in any visited networks. Moreover, "Virtual Home Environment" is being implemented so that mobile users can enjoy the same services, namely "Virtual Home Services", in visited networks as in home networks. Thus, network-seamless services have until now only been offered under partnerships between mobile networks.

  In the future, partnerships for network-seamless services are envisaged to be extended to include fixed networks, ISPs, and complementary networks such as wired/wireless LANs. This is the concept of network-seamless service capabilities between heterogeneous networks.

- *Terminal-seamless service capabilities*

  Users may need or desire to change terminals depending on changes of mobile environments. For example a user may wish to use a big terminal with a high-resolution screen in the home. When the user gets on a vehicle, the user may be obliged to use a portable terminal with a low-resolution screen. Even when the mobile environments change from a home to a vehicle, the user may wish to continue enjoying services. This is the concept of terminal-seamless service capabilities between heterogeneous terminals.

- *Content-seamless service capabilities*

  A change of environments may lead to a necessity of a content change. Let us assume that a user attends a TV conference in an office and then the user has to leave for a business trip by car. The user may wish to continue attending the conference in the car by changing contents, or media, from video to voice or text only. This is the concept of content-seamless service capabilities between heterogeneous contents.

As an example of such seamless service support in Systems Beyond IMT-2000, Appendix I describes a use case scenario where session continuity is preserved across heterogeneous network environments.

6.4.2 Session continuity

Session continuity is essential in providing seamless services in Systems Beyond IMT-2000. Session continuity is the ability of the user to maintain continuity of ongoing sessions while changing between terminals and across various access and core networks. In Systems Beyond IMT-2000, session continuity of real-time and non-real-time services is an essential requirement. This implies that all services that were available to an active communications session before passing the network's boundary or changing the terminal will still be available to that same active communications session after moving into another network or after changing the terminal. For example, the user of a mobile terminal may wish to switch from his mobile equipment attached to a wireless network to a laptop connected to a wire-line or Digital Subscriber Line (DSL) connection. This should be supported without any session disruption. Appendix I shows a use case scenario of Systems Beyond IMT-2000 with session continuity support.

6.4.3 Subscription portability

Subscription portability allows subscribers to maintain service attributes across heterogeneous network environments, e.g., different network domains or terminals. Service attributes include mobile number, email address, and/or change of ISP for application services, etc. For example, a user can retain its mobile number when changing the subscribed administrative service provider or when, even instantly, using different terminal – this specific case is called number portability.

6.5 Virtual environment service

One of the applications of services in Systems Beyond IMT-2000 is virtual environment services and Systems Beyond IMT-2000 should support it.

Virtual environment service includes virtual home service and virtual reality service described in the following clauses.

6.5.1 Virtual home service

Virtual home service provides the ability for users to receive their home services with the same look and feel from any network and on any terminal, on the basis of their personal (private) identification.

The virtual home service includes two essential capabilities as follows:

- A user will be able to use his/her own terminal in the same way as when located in the home area, wherever he/she goes.
- A user will be able to make use of another person's terminal and use it in the same way as his/her own terminal, wherever he/she goes.

It should be noted that the above capabilities might be restricted or limited due to visited network capability limitations or restrictions, or due to borrowed terminal capability limitations.

6.5.2 Virtual reality service

A virtual reality system is the electronic creation of an actual system. It enables users to access the sights and sounds of remotely located complex systems in real-time.

A few examples of the Virtual Reality Environment (VRE) services are listed below:

- A conference session depicting, to every participant, the presence of others in a virtual conference room with projector screen, drawing board, and so on.
- A virtual movie theatre where the user can view movies in real size and sound.
- A hospital operation room where a surgeon can perform a real operation remotely or train interns by showing the procedure in a virtual operating room.
- A virtual concert hall where a conductor can have the virtual presence of all or a selective number of players participating from all over the globe for rehearsals.
- A house, a shop, or a storage where a user can do security check, identify product availability or determine inventory level of various items, respectively.
- Navigating an aircraft, conducting a train, or driving a motor vehicle where the virtual environment is created for the cockpit, the locomotive and the driver seat, respectively.

7 Network capability framework

7.1 Network design objectives

The capabilities for Systems Beyond IMT-2000 network should include, as needed, the set of network capabilities existing for current IMT-2000 Family Member Systems. The key network design objectives for Systems Beyond IMT-2000 are listed in the following clauses.

7.1.1 High performance and system efficiency

- Efficient handling of very large IP multimedia traffic with various predefined service parameters.
- Support of a wide range of traffic ratios within the network, including unicast, multicast, broadcast and bursty traffic.
- Distributing service provisioning according to provider's resource control policy.

7.1.2 System flexibility

- Support moving networks.
- Accommodate diverse access technologies/schemes.
- Automatically manage the access means (including both wired access and wireless access) based on user-defined criteria such as cost, speed, QoS, privacy, applications, etc.
- Separation of user environment from the transport network.
  - Make the network transparent to the user so there is no need of changing user parameters (e.g., phone number, address, book settings, etc.) when changing access networks.
- Separate control and transport functions.
  - Separating the control and transport planes for scalability and architectural flexibility. Data path and control planes are separated to allow changes or upgrades to the network without affecting other sections of the network.
  - Control functions in the IP-based network platform should be open to support various existing and future evolution signalling systems, and its function will be more focus on signalling processing.

  - Transport functions should fully utilize IP transport capability to direct user traffic flows to their proper destinations.
  - The interface between control and transport functions should be open and standardized.
  - When the control and transport functions are implemented in the same physical equipment, the interface(s) between them still should be opened.
- Facilitate support of multiple switching control methods, signalling at different layers and their combinations.
  - Switching components in the IP-based network platform may provide multiple switching control methods, and may also provide interoperation among these methods.
  - Switching control methods may be implemented according to their service support requirements, and thus, may be functioning at different internetworking layers.
  - The usage of IP transport for various switching control signalling should be used according to service requirements.
- Have flexible, efficient, and integrated mobility management, i.e., flexibility to support advanced mobility management schemes.
  - Advanced and efficient location management.
  - Support an efficient and adaptive combination of location registration and IP paging functions.
  - Diversified fast handover across access and core networks.
  - Session continuity should be provided for seamless session transfer.
  - Mobility type dependent mobility management schemes.
- Support open interface for roaming and handover among various networks.
- Support dynamic network capacity changes.

7.1.3 System scalability

Scalability is an essential capability of large systems because they change and grow. They distribute themselves, controlling more facilities with more devices, and are constantly expanding their range of activities.

In this regard, Systems Beyond IMT-2000 are expected to handle very large amounts of multimedia traffic to/from a large number of mobile users and must take into consideration all the access technology choices the user may have in a particular network environment. The multimedia applications run by the mobile users will have diverse traffic and performance/QoS requirements.

Systems Beyond IMT-2000 should therefore be scalable, being able to continue to meet diverse service performance (e.g., latency, bandwidth, jitter, traffic loss) requirements as the traffic volume increases and/or as the number of mobile users grows, regardless of the access technologies being used.

7.1.4 System interoperability

- Support global standards, e.g., standardized interfaces between networks.
- Effective and user-friendly Operations, Administration, Maintenance and Provisioning (OAM&P) facilities.
- Interoperability with existing third generation mobile networks. Interoperability in this case means the availability of well-defined gateway points and functions between both networks.
- Integration/inter-operation with alternative networks, e.g., a Personal Access Network, a WLAN.

7.1.5 System robustness

Large systems put strain on their network, requiring that it meet the most rigorous operating performance criteria, providing also network security among heterogeneous interconnected networks. The objectives should include the following aspects:

- Comprehensive and cross-provider security infrastructure support.
- Well-defined and conducted routine system risk analysis.
- Robust system intrusion monitoring and response system to control damage.
- Low overhead security protocols to accommodate wireless bandwidth limitation.
- Provide seamless security across heterogeneous access technologies.

In addition to security aspect, it is essential for system robustness to keep the network available as much as possible. The objectives for network availability come as follows:

- Well-defined parameters to measure the level of network availability.
- Optimal network design that provide enough redundancy to maintain the network availability at the pre-defined level.
- Efficient network monitoring methods and immediate response systems to cope with the monitored network status.
- Prioritization of the access to the basic telecommunication services in case of damages.
- Faster service re-establishment than provided by current systems, in case of damages.

7.2 Mobility management

As future service needs more mobile-oriented features to provide ubiquitous service, Systems Beyond IMT-2000 will support mobility through appropriate location and routing management of a user terminal. This clause describes several mobility types to be considered, classification of movement types and basic and advanced functionalities to manage such mobility.

7.2.1 Mobility aspects

7.2.1.1 Classification of mobility types

Systems Beyond IMT-2000 should support five types of mobility, i.e., terminal mobility, personal mobility, network mobility, service mobility and session mobility to provide mobility-related services to its users or subscribers. They are terminal mobility, personal (or user) mobility and session mobility. These mobility types would be supported through appropriate signalling and management of mobile users/terminals. Diverse future services can be developed through the combined application of these mobility supports.

7.2.1.1.1 Terminal mobility

Terminal mobility refers to the ability of a terminal to access telecommunication services from different locations and while in motion, and the capability of the network to identify and locate that terminal. Terminal mobility is also concerned with a mobile terminal that is changing its point of attachment to the network.

The aim of the terminal mobility is that during a session a mobile terminal can move around the network without disrupting the service. This is the most obvious feature that a mobile network must support.

Systems Beyond IMT-2000 should support such terminal mobility.

In order for terminal mobility, the mobile terminal should have the following capability:

- Attachment and access capability:

  The ability of a terminal to power on and gain access to any serving network, home or visited.

Terminal mobility can be further classified into intranetwork and internetwork mobility.

7.2.1.1.2 Personal mobility

Personal mobility refers to the ability of a user to access telecommunication services at any terminal on the basis of a personal identifier, and the capability of the network to provide those services delineated in the user's service profile. The personal mobility may be used for a user that is involved in two or more terminal devices.

The goal of the personal mobility is to support the ability of the user to maintain the services while changing between terminal devices. At a desired level of the personal mobility support, the user may be able to continue an active session even during the transition between two different terminal devices.

Systems Beyond IMT-2000 should support such personal mobility feature.

7.2.1.1.3 Network mobility

Systems Beyond IMT-2000 should support the ability of a network, where a set of fixed or mobile nodes are networked each other, to change, as a unit, its point of attachment to the corresponding network upon the network's movement itself. A network with network mobility is called moving network. Moving Network could be in a train, ship or aeroplane, etc.

7.2.1.1.4 Service mobility

Systems Beyond IMT-2000 should support service mobility. Service mobility refers to the ability of a user to use the particular (subscribed) service irrespective of the location of the user and the terminal that is used for that purpose.

Service mobility can be achieved through the combination of the following capabilities:

- Service portability:

  Service portability is the ability to access any services offered anywhere within the roaming domain of the users at any time.

- Subscription portability:

  Subscription portability allows subscribers to maintain service attributes across heterogeneous network environments, e.g., different network domains or terminals. Service attributes include mobile number, email address, and/or change of ISP for application services, etc. For example, a user can retain its mobile number when changing the subscribed administrative service provider or when, even instantly, using different terminal – this specific case is called number portability.

7.2.1.1.5 Session mobility

Session mobility is the ability of the mobile user to maintain sessions while changing between terminal devices and moving across various access and core networks. For example, the user of a mobile terminal will be able to transition to a laptop/DSL connection and also move to another network, without losing a specific session. Session mobility should be tightly coupled with handover management.

7.2.2 Classification of movement types

An administrative domain in Systems Beyond IMT-2000 may have more than one access network systems. Hence, as for the service areas concerned, three types of mobile user/terminal/network movement is envisaged:

- movement within an access network in an administrative domain;
- movement between access networks in an administrative domain;
- movement between administrative domains.

Movement types can be further divided upon whether the session continuity is provided:

- Continuous mobility (Handover):

  The ability of a terminal to change location while media streams are active, i.e., while maintaining session continuity. Handover is further called seamless when the terminal location change does not result in delay or loss of data that would be perceived by the user as degradation of quality of service.

- Discrete terminal mobility (Roam):

  The ability of a terminal to make discrete changes of location, i.e., to change location while no media stream is active.

7.2.3 Basic mobility management functionalities

Mobility management in Systems Beyond IMT-2000 will be realized by using basic mobility-related functionalities and its associated functionalities. The basic functionalities are concerned directly with the mobility management for the mobile users/terminals, whereas the associated functionalities are used for supporting mobility management for better performance.

The basic MM functionalities are described in the following clauses.

7.2.3.1 Location management

Location management is performed to identify the current network location (i.e., the network point of attachment) of a mobile user/terminal/network and to keep track of its changes as it moves on.

By location management, the information on location and its change will be registered and updated as the mobile user/terminal/network moves on.

The location management will be used for establishment of the calls/sessions terminated at the mobile user/terminal or the mobile terminal belongs to a mobile network, such that the correspondent call-originating node is able to locate the mobile user/terminal and establish a session via an appropriate signalling process.

7.2.3.2 Paging management

Paging management is used to efficiently manage the location of the mobile terminals that are in the idle state (or dormant mode), by saving the electrical power of mobile terminals and also reducing the location management control traffic to update the current location of the mobile terminals.

In general, the location update and paging scheme have a trade-off relationship in performance aspects. Accordingly, the location and paging management needs to be designed more efficiently by coordinating their respective features.

7.2.3.3 Routing management

Routing management is used to manage the data packet forwarding and routing which may be associated with the call/session establishment. Routing management will govern the routing path or the routing policy for data packets toward the mobile terminal.

For corrective and effective data packet routing toward the mobile terminal, the location information managed by the location management will be queried by the routing management. Based on the obtained location information, the call-originating node or the corresponding routing manager may determine the routing path for the data packets destined to the mobile terminal. In this regard, the routing management may be used and implemented along with the location management.

7.2.3.4 Handover management

Handover management is used to provide a mobile terminal for seamless handover or session continuity, whenever it moves across different network regions. The main objective of the seamless handover is to minimize the service disruption due to data loss and delay during the handover. Handover management is typically performed together with an appropriate location management scheme.

Handover management may be regarded as a sub-functionality of the routing management, since both management are involved in the routing of data packets destined to a mobile terminal. However, it is noted that the routing management will be done in an end-to-end basis between two endpoint terminals, whereas the handover management will be implemented locally for the moving terminal.

As per the scope of the handover concerned, the handover can be classified into the following two types: "handover within a network", where a mobile terminal moves within the same network or administrative domain in Systems Beyond IMT-2000, and "handover across networks," where it changes its concerned access networks or administrative Systems Beyond IMT-2000.

For effective handover, it is required to select the optimum routing path, usually the shortest one to reduce unnecessary use of network resources in routing the data packets. A localized handover would help in minimizing the service disruption during handover.

7.2.4 Advanced mobility management functionalities

Systems Beyond IMT-2000 should provide advanced mobility management functionalities for more advanced and efficient location and handover management.

7.2.4.1 Advanced location management

- Resource optimization and load balancing in performing location management:

  Location registration and management require the resources for processing, signalling and storing. The examples of the resources are CPU time, bandwidth for signalling transfer, and memory capacity. The resources used for location registration and management should be minimized through optimized procedure. In addition, the load for processing, signalling and storing should be optimally distributed and balanced across the network without sacrificing its functionality.

- Registration latency optimization:

  Some activities may have to be performed with low latency for faster registration and less network processing load. The case of optimizing location updates by limiting registrations based on internal policy would be one possible way to minimize registration latency and should be allowed. It should also be possible to dynamically and adaptively establish location areas under local policy upon different mobile environments for minimizing the signalling traffic. Proper aggregation of location update message for mobile users/terminals would be another possible solution for latency reduction.

- Support of an efficient and adaptive combination of location registration and IP paging functions.

7.2.4.2 Advanced handover management

- Handover latency optimization.
- The latency during handover should be minimized such that the service disruption during handover due to packet loss can be minimized. Possible solutions would include hierarchical and localized cell composition, optimized routing mechanism to minimize packet loss. Support of diverse handover across access and core networks:
  - Fast handover, handover with minimum data loss, handover with minimum service interruption, and handover with minimum resource consumption with satisfying desired QoS should be supported.
  - Diversified handover mechanisms should be supported, for example, Local Handover minimizing re-established handover path, Network Overall Handover, minimizing end-to-end routing path.

7.2.4.3 Other advanced features

- Mobility type dependent mobility management:
  - Various mobility management schemes dependent on movement characteristics.
  - Mobility management applied to the user should change according to the movement characteristic, which is ever-changing. For example, when the moving speed of the user changes from moment to moment.
- Support of open interface for roaming and handover among various networks.

7.3 Session management

7.3.1 Concept of service session and connectivity session

The Service session is set up between the nodes that have capabilities to execute, control or manage the services for the end user. The node refers to a user's end node or a service provider's end node. For example, Session Initiation Protocol (SIP)/IP Multimedia Subsystem (IMS) session is an example of the service session. The service session uses one or more connectivity session(s) for service specific control, generic session controls, and session management between the nodes. It may span different networks and is transparent to intermediate nodes within the communication environment that provides the connectivity.

The Connectivity session is set up between the nodes that have capabilities to provide, control or manage the connectivity to transport data for the associated service session. The node refers to a user's end node or a gateway in a single network. For example, PDP session in 3G network is an example of the connectivity session. The single network is probably not enough to support end-to-end connectivity for all users, service providers or other business players. End-to-end connectivity is achieved by interconnecting the networks with each other through Network-to-Network Interface (NNI) and Service Level Agreements (SLAs).

Figure 7-1 shows how the service session uses the connectivity session between end nodes. In the figure, the service session uses a connectivity session to transport the associated data among end nodes and gateways. But the service session can also use separately more connectivity sessions between the nodes in each network.

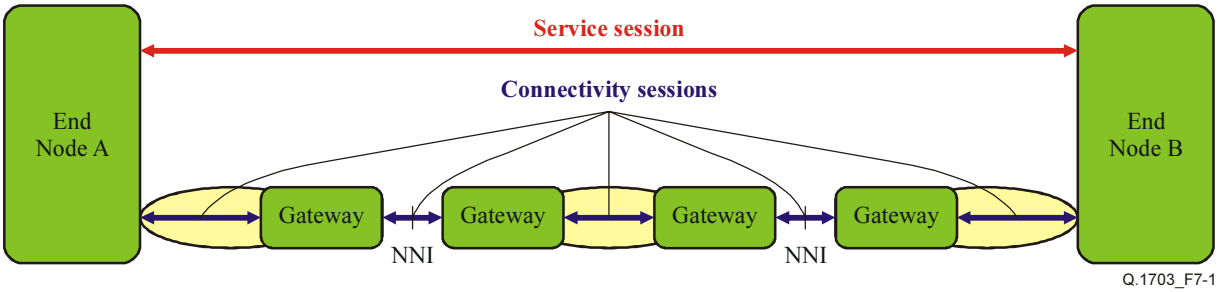


Figure 7-1/Q.1703 – Concept of service session and connectivity session

7.3.2 Service session management

Service session management is the capability to establish, maintain and terminate the service session according to user's request.

- *Establishment of service session*
  - Service session management establishes service session by request of user.
  - It can also set up one or more service sessions at the same time between an end node and the others. In that situation, the user browsing a website can set up other service sessions for other services with another user.
- *Maintenance of Service Session*
  - Service Session Management manages the service session while session is active or mobile terminal with the service session is in session mobility.
- *Termination of Service Session*
  - Service Session Management terminates the service session when user requests termination of service.
  - It should be able to terminate the service session when the network determines termination of service. In the mobile services, there are situations where user cannot request the termination of services because of wireless link status.

7.3.3 Connectivity session management

Connectivity session management is the capability to establish, maintain and terminate the connectivity session according to user's request.

Connectivity session management should have capability to determine and maintain identification for each connectivity session and the parameters that characterize the connectivity session.

- *Establishment of Connectivity Session*
  - Connectivity Session Management should have the capability to establish connectivity session by request of Service Session Management. Also, it should have the capability to establish various types of connectivity session for point-to-point, multicast and broadcast connectivity services.
  - Connectivity Session Management should have the capability to give priority to connectivity session for such as Emergency session and Prioritized session.
- *Maintenance of Connectivity Session*
  - Connectivity Session Management should have the capability to maintain information about the relation of nodes while the connectivity session(s) is active or mobile terminal with the service session is in session mobility.

- *Termination of Connectivity Session*
  - Connectivity Session Management should have the capability to terminate connectivity session(s) when service session(s) is terminated.
  - It should be able to terminate the connectivity session when the network initiates the termination of the connectivity session(s).

7.4 QoS management

Quality of Service is described in ITU-T Handbook on Quality of Service and Network Performance [18].

The customer and service/network provider view points of QoS are different as illustrated in Figure 7-2 below.

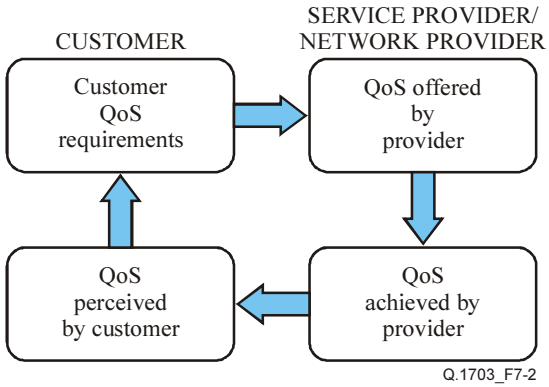


Figure 7-2/Q.1703 – The four viewpoints of QoS

7.4.1 Requirement for QoS

7.4.1.1 General requirements

Systems Beyond IMT-2000 should satisfy the following general QoS requirements:

- *Different service categories based upon the QoS requirements*
  - Examples:

    Interactive service (Mobile Web Access, etc.).

    Real-time service (Mobile Telephony, etc.).

    Non-real-time service (Mobile Data Applications, etc.).

    Streaming service (Video Streaming, etc.).
- *Easy QoS management*
  - Capabilities for easy operation/management of QoS.
- *High levels of QoS*
  - At least existing service (e.g., 3G) QoS should be supported.
  - Wider bandwidth, lower transport delay, lower packet loss rate and smaller jitter than those in the 3G system should be available.
  - Being able to handle huge multimedia traffic.
- *Adaptive QoS*
  - Being able to specify bandwidth ranges or multiple bit rates that an application can operate (e.g., the bit rate could be a constant bit rate value or a variable bit rate value), and associated control/prioritization values (depending on the mechanism utilized) that will ensure an agreed level of performance to enable resource allocation decisions.

- *Diverse combinations of services with different QoS requirements*
  - Combination of large number of multimedia services is possible prior to or during communication.
  - The network will be able to support simultaneous real-time and non-real-time IP multimedia (voice, data and video).
- *End-to-End Quality of Service*
  - Services will need to meet end-to-end quality-of-service requirements.
  - The same quality of service for a given application will be expected in all places and at all times, real time and non-real time, with minimum delay and minimum error per the needs of the application.
  - QoS should be provided end-to-end irrespective of operators through appropriate negotiation of QoS profiles between operators.
  - Systems Beyond IMT-2000 should provide the capabilities for supporting interoperability of QoS of Systems Beyond IMT-2000 with those of other Internet services.

7.4.1.2 Service platform requirements

Service platform in Systems Beyond IMT-2000 should meet the following QoS requirements in addition to the general QoS requirements in 7.4.1.1:

- *Bandwidth*
  - "Bandwidth" in the form of an average, maximum or combination average + maximum data transfer rate and QoS will be allocated per user demand derived from the needs of the applications being run.
  - The services can have equal bit rates (symmetrical) or different bit rates (asymmetrical) upstream and downstream.
  - A "lightweight" yet sufficient protocol stack should be used to minimize the overhead required to support the bandwidth needed by the user's applications.
- *QoS class/profile per application*
  - QoS class/profile per application should be available, when one user uses multiple applications simultaneously.

    Example: Streaming (Voice Conversation) service is prioritized and E-mail service is non-prioritized.
- *QoS parameters*
  - QoS parameters should be easy to understand for the end users by e.g., minimizing the number of parameters and having the meaning of parameters easy-to-understand.
  - QoS subscription parameters are stored where they can be accessed by the network. They identify the maximum permissible QoS class that a user may negotiate with the network based on the subscription parameters paid for.
- *Clear display of QoS performance*
  - User terminals should clearly display performance indicators whenever actively communicating with the network.
- *QoS resource management*
  - To allow efficient usage of QoS resources, the provisioning of QoS resources needs to be coupled with application requirements for QoS. Initiating and controlling the coordination between the QoS provisioning and the application requirements for QoS should be done by either the network or the user.

7.4.1.3 Network operator requirements

Network capability in Systems Beyond IMT-2000 should meet the following QoS requirements in addition to the general QoS requirements in 7.4.1.2:

- *QoS class/profile*
  - It should be possible to select QoS class/profile per user and per application.
  - QoS class/profile within a single operator should be available.
- *QoS parameters*
  - To allow efficient usage of QoS resources, the provisioning of QoS resources needs to be coupled with application requirements for QoS.
  - Initiating and controlling the coordination between the QoS provisioning parameters and the application requirements for QoS should be done by either the network or the user.
  - Network should support different QoS parameters in uplink and downlink for wireless links, respectively.
- *QoS guarantee in the radio section*
  - Network should guarantee the negotiated level of QoS in the radio section, e.g., between heterogeneous radio access networks, during or after high-speed handover, in asymmetric bidirectional transmission for both uplink and downlink, etc.
- *End-to-end QoS*
  - Networks should have the capability to support end-to-end QoS across multiple operators and a framework for QoS negotiation between operators.
  - Service Level Agreement/Negotiation on QoS support (latency, packet loss, etc.) should be provided, if the end user desires to confirm QoS provided by the network.
  - Networks should support QoS mechanisms that are not tied to any specific link technologies, but which instead provide a common basis for QoS coordination across multiple access technologies, and standard-based interoperability across multiple network domains to provide an end-to-end QoS solution.
- *QoS granularity*
  - Network should be able to provide different QoSs for different applications.

    Example: Streaming (Voice Conversation) Service is prioritized and E-mail service is non-prioritized.
  - Network should be able to control the QoS in the unit of packet, flow, and session.
- *QoS measurement*
  - QoS measurement capabilities should be provided so as to determine whether subscribed levels of QoS are provided.
- *QoS report*
  - The status of QoS parameters or classes should be reported by the network function(s) to the application server and/or end users involved in a session.
- *Charging/Billing*
  - Appropriate charging/billing capabilities and mechanisms for the used level of QoS services should be provided.
- *Resource management*
  - Network resource (e.g., CPU processing, bandwidth) consumption for QoS control should be minimized.

- *Scalability*
  - QoS mechanisms should scale to large number of flows and large networks.

7.4.2 Classes of QoS

7.4.2.1 QoS classifications by services

It is envisaged that Systems Beyond IMT-2000 will support the following types of services upon its respective QoS requirements:

- *Interactive service (Mobile Web Access, etc.)*
  - Imposes relatively stringent delay and loss requirement on the network service.
- *Real-time service (Mobile Telephony, etc.)*
  - Imposes stringent delay, though its loss requirements are less stringent as other applications.
- *Non-real-time service (Mobile Data Applications, etc.)*
  - Similar to data application on wireline networks (file transfer).
  - Not real-time, but have stringent packet loss and error requirements.
- *Streaming service (Video Streaming, etc.)*
  - Imposes relatively stringent delay and loss requirement on the network service.

7.4.2.1.1 Application QoS continuum

In addition to the above coarse-grained characterization of QoS by application service classes, more fine-grained classification, associated with an extremely large set of QoS attribute values/value ranges (on availability, delay, jitter, packet loss, throughput, etc.) may be necessary to characterize the wide range of service applications expected to run over Systems Beyond IMT-2000. These values may depend not only on the application, but also on other factors such as the user's service tier, or network conditions. Such fine-grained characterization will enable QoS differentiation of applications frequently considered to belong to a single category. For example, although both real-time voice telephony and videoconferencing applications have stringent low delay requirements, they have different bandwidth needs. Interactive games may vary in delay requirements.

7.4.2.2 QoS classifications by (QoS) parameters

Systems Beyond IMT-2000 should treat at least the following parameters as independent attributes. Upon further identification additional parameters can be included as such QoS attributes.

- Bandwidth.
- Throughput.
- Latency/Delay.
- Latency/Delay Deviation (Jitter).
- Packet loss.
- Bit Error Rate (BER).

Based on the parameters used to define the level of QoS in Systems Beyond IMT-2000, various kinds of QoS classification will be possible. The following shows an example of such classification when "bandwidth guaranteed" is used:

- *Bandwidth guaranteed class*
  - high priority class;
  - low priority class.

- *Non-guaranteed class*
  - best effort class.

7.4.3 Types of QoS negotiation

Systems Beyond IMT-2000 should provide full-blown flexibility by allowing dynamic QoS negotiation and change between users and network operators, or between network operators, prior to or during the active communication, even while change in network environment, e.g., high-speed user mobility. Such resilient QoS negotiation will contribute to the seamless end-to-end QoS provisioning in Systems Beyond IMT-2000. In this regard, the following items on QoS negotiation should be supported in Systems Beyond IMT-2000:

- Possible to select QoS class.
- Capability to change QoS of an application instance at any time should be available in case of radio environmental or network traffic condition change through negotiation or pre-arrangement between the user and the operator.
- QoS required by each individual media component can be negotiated prior to the execution of the media component (establishment) or during its execution.
- Negotiation of QoS and Roaming Service capabilities can be performed manually or automatically.
- Support the control and negotiation of QoS end-to-end when operating with a third party provided service platform.

7.4.4 Span of QoS provisioning

Basically the QoS provisioning in Systems Beyond IMT-2000 should span end-to-end. In order for this, the systems should:

- Support flexible QoS control (End-to-End QoS control, Changing QoS during communication, etc.).
- Provide mechanism to enforce QoS across administrative boundaries by both network techniques and business policy enforcement between companies and networks.
- Support "Locally applicable QoS".

7.5 Transportation control

7.5.1 Enhanced naming and addressing

Systems Beyond IMT-2000 will provide the capability to separate IP address from subscriber name or device number. The name or number is used to uniquely identify the call parties whereas addresses are used to determine routing of the call or session.

Addressing will remain the link between different network technologies while naming (and numbering) may evolve towards higher level common identification mechanisms covering all communication systems (IP, mobile, fixed). Systems Beyond IMT-2000 should support such evolution.

Although a called party may be addressable via different means, Systems Beyond IMT-2000 will allow the user to be reachable through a given name, independent of her/his location.

Systems Beyond IMT-2000 will, therefore, support the following:

- Static and dynamic IP addresses for mobile terminals.
- Associating public IP addresses with mobile terminals.
- Associating private IP addresses with mobile terminals.
- Mapping Network Access Identifiers to mobile terminals.

- Connection of subscribers to private IP networks.
- Common user ID independent of the user or user equipment's location.

7.5.1.1 Global database system

For the purpose of routing and address resolution/translation, Systems Beyond IMT-2000 will support a multi-level database system (e.g., Domain Name Server). Such a hierarchical database system will offer mapping of user/subscriber's name or number to its IP address and vice versa.

7.5.2 Routing management

Systems Beyond IMT-2000 will support different routing policies for different service classes (voice, data, multimedia, etc.) according to their service specifications. Routing policy will be based on quality-of-service, cost, time zone, time, date, among others. Routing management should have minimum impact to the routing scheme where the path length for user data flow should be minimized.

The overhead added to routing by mobility management should be kept to a minimum. In the case of handover, it is required to select the optimum (which normally is the shortest path) routing path to reduce unnecessary use of network resources. Handover process should reduce the number of paths in the network.

- *Prioritization: Emergency call*

  An example of routing management in Systems Beyond IMT-2000 will be prioritized traffic handling. Traffic prioritization can be implemented through appropriate QoS specification.

  In an emergency call, as a specific application of traffic prioritization, the wireless terminal will be able to link to emergency places (ambulance, fire and police stations). Beyond IMT-2000 networks will enable prioritized access and transportation of data to identified emergency services calls (overriding the normal access and charging procedures) and provide the emergency services bureaux with enhanced capabilities (call back) and information (location or geographical position) about the user. Emergency calls have a much reduced authentication requirement, but may have more stringent privacy requirements. Such calls may also require specific routing. Anyone can make an emergency call free of charge.

7.5.3 Traffic flow control

Systems Beyond IMT-2000 are envisaged to handle large volume of traffic, e.g., multimedia traffic, from a number of users. Therefore, traffic flow control in Systems Beyond IMT-2000 should be provided. There would be three types of such traffic control: admission control, flow control and congestion control.

- *Admission control*

  The essence of traffic admission control is to determine when a new connection can be accepted or not within a network. For this, the network should be able to evaluate if a certain connection, with a certain QoS profile, can be supported by the network with the available resources, without prejudice to existing active connections.

- *Flow control*

  Flow control is a network function to control the amount of data disseminated at its source so as not to overload the data processing capability of receiving entity.

- *Congestion control*

  Systems Beyond IMT-2000 should be able to function under peak loads while maintaining fairness to all subscribers based on the services and capabilities they are paying for. Network congestion should be handled such that users will not be aware of it until it

reaches a level where it becomes essential to the health of the network that some traffic is slowed or stopped.

7.6 Traffic transportation

This clause provides the requirements for transport of data in Systems Beyond IMT-2000. It is envisaged that:

- *IP-based transport*
  - All user data traffic and signalling should be on IP transport.
  - Support of IPv4/IPv6/Possible next version of IP and interworking between those.
  - Interfaces between IP network and legacy transport networks are necessary. These interfaces will also be part of the IP network.
- *Interoperability*
  - Interfaces between IP network and legacy transport networks are necessary. These interfaces will also be part of the IP network.
- *Convergence of fixed and wireless network*
  - Common transport technology should be provided for the integrated service for fixed and wireless access.
- *Transport technology independence*
  - Architecture and operation that are independent of the transport technology should be developed and used.
- *Multicast and broadcast*
  - The transport layer should support IP broadcast and multicast.
- *Extensive router capability*
  - Router should have capabilities of IP routing (e.g., filtering, encapsulating, etc.), QoS provisioning, traffic information collection for accounting and resource management. Also it should implement features for mobility and security.
- *Virtual private network support*
- *Modular architecture*
- *Modular transport architecture*
  - Control and transport functions should be separated.
  - The access technologies utilized should be transparent to the common and standardized transport infrastructure.
  - Separation of service entity from IP transport should be allowed, and separation of intelligent entities such as Mobility Management, QoS Management and Security Management from transport network may also be allowed.
- *High transport performance*
  - High performance and throughput for packets data processing, e.g., packet routing and forwarding should be provided.
- *Transport information provisioning*
  - Transport network entities should have capability to report some information regarding themselves, e.g., geographical information of access points, to other entities, to be used for network control or for some services. Geographical information of access points could be used for mobility management.

- *Scalability*
  - The target transport architecture should be flexible to accommodate the network growth.
- *Operability*
  - The transport architecture should be fault and heavy load tolerant.
- *Cost efficiency*
  - The transport technology utilized should cost less than 3G. However, the cost factor should not compromise quality or system performance.

7.7 Network resource management

It is imperative for Systems Beyond IMT-2000 to utilize its resources as effectively as possible, through optimal resource management. Because of this, the status of network resources in Systems Beyond IMT-2000 should be monitored through appropriate methods, and then the network loads should be distributed in such a manner that the resources operate at their best performance.

7.8 System interoperability

7.8.1 Open interface

- *Open interfaced network entities*

  Systems Beyond IMT-2000 should provide open interface to ensure a multi-vendor environment where a network operator is able to configure its own network with network equipment from different vendors. It is also envisaged that the networks composed of open interface network entities can be easily interoperable. Such open interface environment will support the economical creation of large number of new services to end users, stimulating competitive development of service and network components.

- *Simple interface specification*

  The interface specifications should be kept simple, minimizing the number of options. Such interface specifications will reduce the cost of the equipment and improve interoperability between different network elements.

- *Open and standard subscriber application environment*

  A standard software execution environment, including open Application Programming Interfaces (APIs) (for example, standardized access to consistent mobility information and user state information), should be available to all interested parties. Such environment will provide to services the access to consistent information on the user's situation.

- *Open access interface provided by service creation environment*

  Service creation environment should provide open access interface to service for the rapid creation and deployment of session-related services.

  It should be possible for service to make use of service capabilities, including its support environment, through an open standardized interface.

  Contents, service capabilities, including its support environment, should be able to execute an open standardized interface.

  Such an open standardized Interface should be provided with mechanisms that enable related players to securely make use of an open standardized interface.

7.8.2 Interoperability with existing and Non-IP networks and services

Systems Beyond IMT-2000 will provide support for roaming users (removable User Identity Module (UIM)) and roaming terminals (with appropriate multimode and multiband functions). This will include users roaming into Systems Beyond IMT-2000 from 2G or 3G networks, and Systems

Beyond IMT-2000 users roaming into 2G or 3G networks. In this respect, the Systems Beyond IMT-2000 will support interworking with both 2G and 3G signalling networks and protocols.

Systems Beyond IMT-2000 will provide gateways to existing networks.

7.8.3 Interoperability with IP-based networks and services

Systems Beyond IMT-2000 should also provide the interoperability with IP-based networks and services such as WLAN, for complete user roaming support. Since the core network of Systems Beyond IMT-2000 is envisaged to be IP-based, the interoperation between Systems Beyond IMT-2000 and IP-based networks would be smoother.

7.9 Multiple access support and radio resource management

Future mobile devices are expected to support numerous access technologies (including a variety of wireless and/or wire-line choices). Systems Beyond IMT-2000 should be able to facilitate a judicious choice of appropriate access technology for a particular usage environment. The choice could be based on:

- availability of access technologies at the mobile user location;
- speed and QoS requirements of the user application;
- cost of using the access technology, etc.

Also, smooth transition from existing networks should be realized, while meeting the following requirements:

- *Separation of access technologies from transport technologies*
- *Heterogeneous access network support*
  - Common network architecture to support a multiplicity of underlying radio access technologies.
  - Vertical handover (handover between different access technologies) should be supported by the architecture.
- *Support of diverse radio access technologies*
  - Wide-area single and multiradio access (among digital cellular systems such as 2G, 2.5G, 3G, 3.5G, 4G, etc.).
  - Local-area single and multiradio access (among hotspot-type systems such as WLAN, Bluetooth, etc.).
- *Different access technologies coordination*
  - To provide optimum service to the user through different radio access technologies, there should be efficient coordination regarding the available radio resources of respective radio access technologies (or networks). Protocol level coordination (interworking) is also needed to support seamless handover, security, etc.
- *High speed access*
  - Communication Speed follows the definition of ITU-R, e.g., 100 Mbit/s in high mobility.
- *Efficient wireless system discovery and selection of optimal configuration*
  - The user should be able to efficiently discover the available access technologies at his/her current location, before actually initiating an application service (e.g., Voice over IP (VoIP), Video-on-Demand (VoD), etc.) access.
  - The architecture should support the selection of optimal configuration of radio and network resources depending on the radio access capabilities and user preferences.

- *Simple, scalable, low cost, energy efficient, secure radio access system*
  - The radio access technologies are expected to be simple for development and deployment with low investment and running cost. Moreover, the systems should be energy efficient and secure, from the viewpoint of both the users and the operators.
- *Multicast support*

7.10 Enhanced accounting, charging and billing support

Subscriber billing is based on a charging algorithm applied to usage information. Therefore, sufficient and appropriate usage information must be collected to allow for a variety of charging algorithms, which will enable service providers to compete on billing aspects of their service offering as well as other, functional, aspects.

The envisaged accounting, charging and billing capabilities of Systems Beyond IMT-2000 are described in the following clauses.

7.10.1 Accounting capabilities

The following usage information should be recorded and made available to accounting functions for each session at the user's mobile terminal:

- Number of sessions.
- For each session:
  - service level (QoS) requested;
  - changes of service level during the session;
  - geographic location of the user terminals at the start of the session;
  - changes to the geographic location of the user terminals in the form of transition to adjacent service areas, including identification of the new area of service.
- For each service level within the session:
  - duration;
  - number of packets sent and received;
  - form of transferred data.

The requirements for the format and transfer to a clearing house of usage information obtained are:

- Support of an extensible usage information format for the information transferred to enable future enhancements to the usage information and accompanying data.
- Support of batch transfer.
- Support of transfer immediate after the session termination.
- Support of periodic transfer during the session.

7.10.2 Charging capabilities

The clearing house receiving the usage data and applying the service provider's specified charging algorithms should be able to provide:

- Volume-based and constant per unit time, e.g., monthly charging.
- Distance-based charging and flat rate charging for any distance.
- Content-based charging.
- Service fee charging for each user or service.
- Third-party charging.

7.10.3 Billing capabilities

The clearing house should support:

- Billing data privacy: billing data must be hidden from unauthorized third parties.
- Real-time user access to billing information.

User is notified of charges before, during and after significant events.

7.11 Enhanced OAM&P support

OAM&P Support has been described extensively in ITU-T Rec. M.3400. The OAM&P support of Systems Beyond IMT-2000 should consider such description in conjunction with the capabilities described in the following clauses.

7.11.1 Performance management

- Systems Beyond IMT-2000 should support the following performance management capabilities:
  - real-time monitoring of current network status and performance; and
  - taking prompt action to control network resources and improve network performance (e.g., through traffic controls that affect the routing and processing of calls), as required.
- Performance management capabilities of Systems Beyond IMT-2000 should be built upon the IMT-2000 network status checking and performance monitoring functions specified in ITU-T Rec. E.418.

7.11.2 Fault management

Systems Beyond IMT-2000 should support the following fault management capabilities:

- Setting reliability criteria for network outage and service availability.
- Reporting service, network, and network element outages.
- Monitoring, detecting, and indicating network element failures in near-real time.
- Locating failed equipment and facilities.
- Restoring the ability to perform a required function after locating the failed equipment or facilities.
- Testing of service features and end-to-end connectivity.
- Trouble reporting from and status update to customer.

7.12 Security provisioning and management

7.12.1 Challenges for Secure Systems Beyond IMT-2000

Security is an essential capability that is used to support the deployment of applications and services.

Current forms of Internet attacks and current vulnerabilities of the Internet will exist in the case that wireless mobile networks start using IP as its transport protocol. In addition, new threats will arise from the very nature that the wireless networks could be mobile as well. In other words, although there are a lot of security mechanisms developed for IP networks, they may not satisfy all security needs of IP-based wireless systems, and thus new or enhanced IP security measures may have to be developed specifically for IP wireless systems, and security must be addressed not only for the radio interface but also for end-to-end service provisioning. It must be flexible in order to provide various levels of security appropriate to the service/application being provided. With the deployment of

IP services and applications, security becomes much more important to the user, the operator and the service provider.

Hence, at least the following security services should be provided:

- *Integrity*

  Integrity is a mechanism to assure that the contents of a message received are exactly the contents sent, with no modification, replay, reordering or duplications.

- *Confidentiality*

  Confidentiality is a mechanism to keep user data secret from unintended listener such as eavesdropper.

- *Non-repudiation*

  Non-repudiation prevents a communication participant from denying a transmission it initiated.

- *Mutual authentication*

  Authentication is a mechanism to provide assurance that a participant is the one who it claims to be. Mutual authentication should be provided for provider or users to verify the other party, for either applications/services or network accesses.

- *Authorization*

  Authorization is a mechanism to control user access to various network resources.

Systems Beyond IMT-2000 should provide the following security services to enable enhanced security and location privacy and to account for the heterogeneity of access networks and communication devices:

- Systems Beyond IMT-2000 should support the following security management capabilities:
  - Detection and prevention of intrusion.
  - Denying access to an intruder, repairing damage done by an intruder, and recovering losses.
  - Security administration (e.g., management of security policy, security alarms, encryption keys, etc.).
- Security management capabilities of Systems Beyond IMT-2000 may be built upon the IMT-2000 Fraud Information Gathering System functions specified in ITU-T Rec. M.3210.1 [6].
- Systems Beyond IMT-2000 should support at least same level of security as in existing mobile networks.
- The security services and architecture should be extensible to counter new threats and attacks.
- Systems Beyond IMT-2000 should support advanced authentication, authorization and accounting for users and also should support some form of authentication between network elements.
- Systems Beyond IMT-2000 should support internetwork security services. Hence, the security services should be standardized and compatible between them and with legacy services to enable global roaming.
- Systems Beyond IMT-2000 should support copyright protection and digital rights management to facilitate service provisioning such as contents distribution.
- Systems Beyond IMT-2000 should support prevention of abuse (e.g., spam; for instance abuse or indiscriminate use by an authorized user that annoys other users or take too much resources away from legitimate users, etc).

- Systems Beyond IMT-2000 should support privacy protection, which means prevention of unwanted disclosure of user identity, location history and communication history.
- Fraudulent use of services should be disabled with the security services. The security services should support robustness to malfunctioned or malicious applications.
- The security services should be provided on the wired interface as well as on the radio interface.
- The security mechanisms should be light-weighted and suitable for mobile devices.
- An adequate security should be ensured during homogeneous or heterogeneous handoff.
- Mechanisms to ensure end-to-end security should be provided.
- The security services should be visible and customizable to meet diverse needs. Users should be able to check and configure security services; hence, they should be easy to use. Security processing should need minimal human intervention.

The security services should be provided to both provider network control and user plane to protect both control data and user data.

7.12.2 Generic threats in Systems Beyond IMT-2000

This clause classifies threats in four generic modes that could affect the communications infrastructure including up to the end user device. The threats can be defined as follows:

- *Privacy Invasion*

  This is the passive interception of user data by an adversary.

- *Theft of Service*

  This refers to any access of the system by unauthorized parties, including the modification or replay of legitimate traffic by an adversary. The term "Theft of Service" is generic, and literally applies more directly to the public subscriber network model.

- *Denial of Service (DoS)*

  DoS is a form of compromise intended not to compromise information, but to disrupt the operation of a device or network. DoS attacks are common in the wired world, and can be exceptionally disruptive to public safety agencies, much of whose traffic is mission-critical.

- *Tracking*

  Monitoring of radio traffic could potentially allow an adversary to infer the deployment and status of assets in an operation. If the adversary can identify specific network or users' assets using MAC or IP addresses, tactical information is compromised in even greater detail.

7.12.3 Scalable security architecture across all devices/spaces

Security provides the foundation for two of the most important customer concerns, trust and privacy. Those who stand in the value chain where products are deployed, from content and service providers to end customers/consumers, all have a very high expectation that the devices and systems developed will perform their intended functions, and only their intended functions. Users authorized to access those functions (trust), and that personal information, personal and network communications, and any other data or content will be protected from undesired or unapproved use by others (privacy).

The need to ensure trust and privacy is independent of whether a device or system is connected to a wired network, a WLAN or wide-area cellular network, any sort of hybrid network, or is simply a stand-alone device. Likewise, the assurance of trust and privacy is independent of which generation of networks or devices it is implemented for. However, the requirements and capabilities necessary for providing the appropriate level of security have become more complex as networking

technology has advanced, requiring security support for complex personal and financial transactions, and support for the secure, private delivery of value-added content and services.

7.12.4 Access security: User authentication and authorization

Security procedures should be performed efficiently to minimize negative impact on user applications and maximize user service satisfaction.

Future user authentication may include local authentication between a user and a terminal based on biometrics, e.g., a specific feature of an individual such as voice, fingerprint or iris validation. These capabilities may complement the traditional user authentication methods.

Authentication has different personalities depending on the type of network to which the authentication server is connected.

Systems Beyond IMT-2000 should support common authentication and authorization procedures by the service providers that are transparent to the access network type or mobile device type. The security services should provide seamless user experience for users having multiple devices and traversing multiple administrative domains with different network types.

7.12.5 User traffic privacy

Authentication and Authorization are required between the network and the user for security. User data is private, and both the terminal and the network capabilities will ensure that information generated by or relating to a user is effectively protected against misuse. It will be possible for the users to confirm whether or not their traffic and related information are protected. This should require minimum user involvement. In order to achieve the above explained requirement, networks should support encryption schemes according to user's and service provider's requests. The users or service providers could request those encryption schemes.

7.12.6 Separation of contents delivery function and mobile rights management

Systems Beyond IMT-2000 should separate the contents delivery function from the mobile rights management function. These functions can be handled and provided by the service providers independently. For example, the distribution systems are for the contents providers, and the mobile rights management systems (e.g., the permission control systems and the billing systems) for mobile rights manager. The purpose of this rights management is to enable the secure delivery of information to mobile terminals.

7.12.7 Contents right protection

It is expected that various multimedia contents will be widely available to mobiles where the content copyright(s) must be securely protected. Methods of protecting the copyrights of digital contents are expected to be developed (e.g., Digital Rights Management).

7.12.8 End-to-end security provisioning

End-to-end application layer security (authentication, privacy and integrity) may be required independently of the underlining network architecture. Therefore, it is expected that the network architecture and the underlining transport mechanisms will be transparent to the application layer security deployed to support end-to-end security.

7.12.9 Robustness against potential attacks

Network spamming has caused a lot of problems with Internet traffic today. The IP industry has been spending a lot of efforts trying to improve this situation but has had limited success. Due to radio bandwidth limitations and airtime cost, this problem is magnified for a wireless network operator and subscriber.

DoS attacks or Distributed Denial of Services attacks and packet spoofing are becoming common on the Internet as well as to mobile systems.

The IP-based core network of Systems Beyond IMT-2000 should provide an effective solution to minimize those damages and limit the impact to its end users.

7.13 Global roaming

Various aspects of the global roaming requirements can be outlined as follows:

- Subscribers should be able to register and obtain services in networks other than home network.
- Systems Beyond IMT-2000 should accommodate call control/session management with different capabilities (e.g., forwards and backwards compatibility with different stages of network upgrades).
- Systems Beyond IMT-2000 operators should be able to hide or reveal their internal network structure to another network. This includes network entities' names, their capabilities and their number.
- Systems Beyond IMT-2000 operators should be able to hide or reveal the explicit location of nodes within the network (excluding firewalls and border gateways).
- Systems Beyond IMT-2000 should support common, from a subscriber or terminal perspective, registration procedures across home and visited serving networks.

7.13.1 Eliminate regional/country differences in key interfaces

In setting up calls and provisioning services, no country and regional differences should exist by virtue of the use of open interfaces between the functional entities identified within the Layered Functional Architecture of Systems Beyond IMT-2000.

7.13.2 Global access to services

In order to ensure the widest level of services for subscribers, Systems Beyond IMT-2000 should support globally accessible services, through the support of VHE capability, independent of the access technology or the serving network. Systems Beyond IMT-2000 will support global access to services when roaming (regardless of access type) via the support of:

- common protocols (e.g., CAMEL/WIN (Customized Applications for Mobile Enhanced Logic/Wireless Intelligent Network), SIP, and OSA API (Open Service Access Application Programming Interface));
- common representation of user service profiles; and
- access to services from any network or server utilizing service brokering (i.e., the user can negotiate access to services from servers or networks that are neither in the home nor in the visited network).

7.13.3 Directories/databases

The implementation of Systems Beyond IMT-2000 will undoubtedly use many data types including user ID, UE identity, service authorization, inter-administration business profiles, service profile, location information and policy data. This data will operate on database systems that are global and/or local, scalable to network and subscriber growth and operated with open interfaces to other service platforms and control layer functional entities that interact with such data.

7.13.4 Service provisioning to roaming users

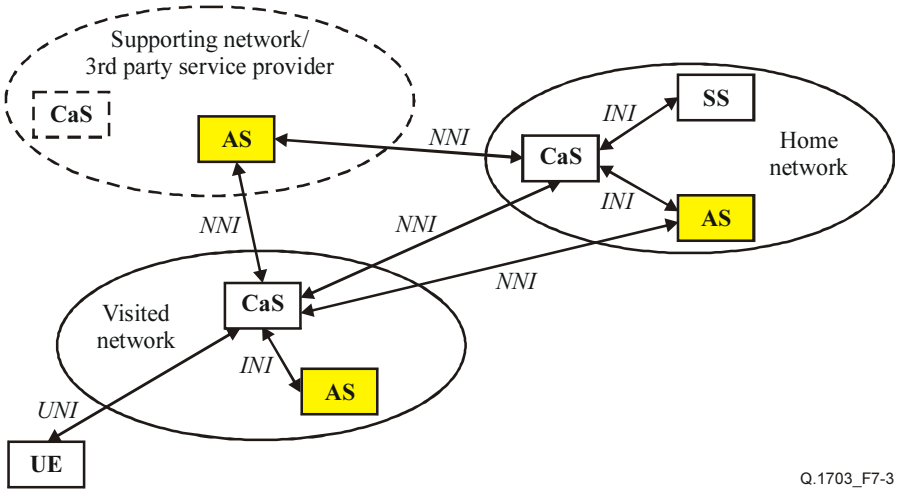
Systems Beyond IMT-2000 will support provisioning of home subscribed services as well as services that have not been subscribed but are offered by the networks/platforms within the user's roaming domain and authorized in real time.

7.13.4.1 Home subscribed service provisioning

Figure 7-3 presents a schematic architectural view of service provisioning for a roaming user or User Equipment (UE). The term "Application Server" (AS) used in this figure is defined as a service platform in either the home, visited or supporting network. The AS may also be a standalone service platform. The term "Control Server" is the network entity in control of calls, sessions, and services. The Subscription Server (SS) is a database providing information on user's service profile, subscription status, UE's location information, mobile terminal status, etc.

Visited serving network operators will support the VHE capability to provide roaming users with services identical to those available in the users' home network. This capability should exist within Systems Beyond IMT-2000 in conjunction with a certain set of guidelines. An example of such guideline with possible architectural implications is given below:

- The decision on the choice of service provision party should reside with the home network.
- The visited network should provide access through a proxy call server to the home network.
- The visited network must provide emergency service support regardless of VHE agreement between the home and visited networks.



AS Application Server
CaS Call Server
INI Intra-Network Interface
NNI Network-Network Interface
SS Subscription Server
UE User Equipment
UNI User Network Interface

Figure 7-3/Q.1703 – A Schematic architectural view of AS platform in a mobile terminal roaming environment

7.13.4.2 Real-time service provisioning

Systems Beyond IMT-2000 will support "supporting network" operators as well as standalone AS operators for having bilateral commercial agreements with the home and/or visited networks to advertise, push and/or offer to the roaming users the services available in their AS in real time.

7.13.4.3 Over-the-air service provisioning

Systems Beyond IMT-2000 will support over-the-air reconfiguration of terminal, activation, authorization, and provisioning of services.

7.14 Virtual environment support

7.14.1 Virtual Home Environment (VHE)

- Systems Beyond IMT-2000 should support the Virtual Home Environment (VHE) to enable a user to be offered the same service experience when roaming as when in the home network, i.e., users should be consistently presented with the same personalized features and services whatever network and terminal they are using and wherever they be located.
- Systems Beyond IMT-2000 that support VHE should provide session continuity, as the user moves across different domains that may use different access technologies.
- Systems Beyond IMT-2000 that support VHE should provide the following seamless service capabilities:
  - Network-seamless service capabilities between heterogeneous wired and wireless networks.
  - Terminal-seamless service capabilities between heterogeneous terminals.
  - Content-seamless service capabilities between heterogeneous contents or media (e.g., from video to voice, etc.).
- Systems Beyond IMT-2000 that support VHE should provide environment portability, thus enabling the user to receive appropriate services on appropriate terminal in the current user location. Appendix I shows an example application of environment portability.
- Systems Beyond IMT-2000 may realize VHE by:
  - Establishing a service delivery tunnel from the application server to the terminal client, thus creating a presence of the real home environment everywhere within an all-IP network; or
  - Duplicating the home environment in the visited network, for backwards compatibility with existing IMT-2000 systems in a non-all-IP (e.g., circuit-switched) environment.

7.14.2 Virtual Reality Environment (VRE)

A virtual reality system is the electronic creation of an actual system. Presently, some virtual reality fixed and real-time services such as videoconferencing and Internet-meeting with limited features are offered. The VRE capability in "Systems Beyond IMT-2000" is defined as a new network capability to allow mobile and wireless as well as fixed and wire-line network users to access to the sights and sounds of complex and live systems in real time.

There are four major components required for realizing the VRE vision:

- an associated physical environment;
- VRE capable user terminal equipment or toolkit;
- an access network of super high-speed data transmission over the air; and
- a core network functional elements for initiating, establishing, maintaining, and terminating VRE calls, sessions, events or episodes.

The first component must always exist. A VRE is not an imaginary environment. It is always associated with an actual physical environment. The second and third components are beyond the scope of this Recommendation, and they will be addressed as the terminal technology improves and the present radio access and data transmission speed evolves. The fourth component, however, requires development of a network capability for controlling and managing the VRE service applications. Furthermore, the long-term vision of the network capability for VRE requires the design of suitable network architecture and the development of the software platform capable of controlling and managing the VRE service applications.

8 User platform capability framework

8.1 User platform design objectives

- *Natural communication-oriented man-machine interface*

  With the support of IP-based network platform, multimedia communication will be easy to reach the end users. Under this situation, a more user-friendly, communication-oriented man-machine interface should be adopted. The interface should use advanced intelligent recognition technologies, such as natural language recognition, voice-text translation, etc. Service combination capability will make use, and even depend on the adopted interface technologies.

- *Ad hoc network support*

  Mobile users may form a closed ad hoc network and communicate directly with each other within that ad hoc network. In addition, these users may also wish to communicate normally for conventional communication. Such access requirements must be supported.

- *Network mobility support*

  A group of users may move collectively with respect to a core network (e.g., users in a train, aeroplane, ship, etc.) Such a group may be open or closed. Systems Beyond IMT-2000 should accommodate the access requirements of such users.

8.2 User platform capability framework

- *A variety of terminals with different capabilities*

  It is expected that there will be a large variety of Systems Beyond IMT-2000 terminals, some with limited capabilities similar to today's terminals, others with larger screens for displaying Internet pages or the face of the person being talked to, and yet others which will support extensive user interaction and display capabilities. (For example, there will be small "smart-phones" with web browsing.)

- *Diverse combination of terminal use*

  A single user can have multiple IMT-2000 terminals that are in use together or a user may utilize a single terminal to access different applications.

- *Terminal identification*

  Terminal identification will help to locate stolen and non-approved terminals.

- *IPv6 capability*

  It is anticipated that IPv6 capabilities will be utilized to support the addressing of the multiplicity of devices and terminals required for anticipated applications.

- *Diverse user interface*

  Keyboard and mouse may be available for user input along with other options such as drawing tablets and touch sensitive screens, as well as innovative voice-based interfaces which will allow people to control their mobile communication services with voice commands.

- *"Always on" terminal capability*

  Terminals are "always on" although a terminal will be able to go to a sleep or enter standby mode to optimize battery power consumption. The terminal will be able to immediately come back to the normal mode whenever it wants to send or receive data.

- *Energy efficiency*

  The terminal has low power consumption and the battery can be charged in a short and reasonable time.

- *Advanced mobility management support*

  Terminals should support advanced mobility management. In addition, terminals should support various types of handover, e.g., fast, minimum data loss, minimum service interruption with satisfying desired QoS, and should support handover of IP-based services and bearers among legacy 2G, 3G, and IP-based network platform.

- *Multiple access technology support*

  Terminals should support diversified radio accesses such as 3G, beyond 3G. In addition, terminals may have capability to connect to more than one wireless access network. Furthermore, terminals should be able to efficiently discover the available access technologies at the user's current location, before actually initiating an application service (e.g., VoIP, etc.) access, depending on the preferences of the user and the capabilities of the terminal as well as the network.

- *QoS Provisioning*

  The end user/platform QoS requirements can be found in 7.4.1.1 and 7.4.1.2.

- *Security Provisioning*

- The security capabilities of the end user/platform can be referred to 7.12.

Appendix I – Use case scenarios for Systems Beyond IMT-2000

Use case scenario for Seamless service support – Session continuity

Session continuity is the ability of the user to maintain continuity of ongoing sessions while changing between terminals and across various access and core networks. In Systems Beyond IMT-2000, session continuity of real-time and non-real-time services is an essential requirement. This implies that all services that were available to an active communications session before passing the network's boundary or changing the terminal will still be available to that same active communications session after moving into another network or after changing the terminal. For example, the user of a mobile terminal may wish to switch from his mobile equipment attached to a wireless network to a laptop connected to a wire-line or DSL connection. This should be supported without any session discontinuity.

An example of a typical user in year 2010: A user of Systems Beyond IMT-2000 is likely to carry a hand-held device with a full alphanumeric keypad and a high-resolution display, which can connect to any of several wireless and wired access networks.

During a busy workday, this user connects to a company-provided in building wired server to access email and high-volume archived storage. Also, through this server the user is able to connect to an intranet-based site that handles travel reservations. However, while engaged in making travel plans, the user notices that the user is nearly late for an appointment at a trade show at the city's convention centre. The user quickly disconnects his/her "docked" hand-held device and hurries towards the convention centre with a colleague, who offers to drive. In the automobile, the user accesses the local wide-area wireless service provider and obtains a link to the packet network, albeit at a reduced bandwidth.

The user then re-accesses the travel server and continues making travel plans. Once a convenient termination point is reached, the user disconnects prior to arrival at the convention centre. Later, the user re-connects to a high-bandwidth (public) wireless LAN at the convention centre in order to process his/her email. Finally, as the user journeys home on the commuter train, the user may entertain himself/herself by playing an interactive game that is available through a website, again using the wide-area service provider as an access link.

The case cited above serves to illustrate that, although the term "global roaming" suggests extensive travel, it would be frequently utilized even while the end-user remains in a constricted geographic area. In the example case, this user has accessed three distinct Internet link mechanisms: the wired service within her company offices, the public wide-area (cellular) provider, and the WLAN that was set up to accommodate users at the convention centre. Furthermore, the user has accessed both his/her email and the travel server, both provided by his/her company, through different link mechanisms.

NOTE – This situation is sometimes being described as "network convergence".

The user has also entered the Internet Protocol Multimedia domain, which is provided by a third party that is not directly associated with any particular link provider.

The above example illustrates that during a busy day the user has invoked complex access protocols across multiple heterogeneous networks. These heterogeneous networks will satisfy Systems Beyond IMT-2000's requirements and will be capable of offering session continuity as the user moves across different domains using different access technologies. The above example is shown via a pictorial view (see Figure I.1).

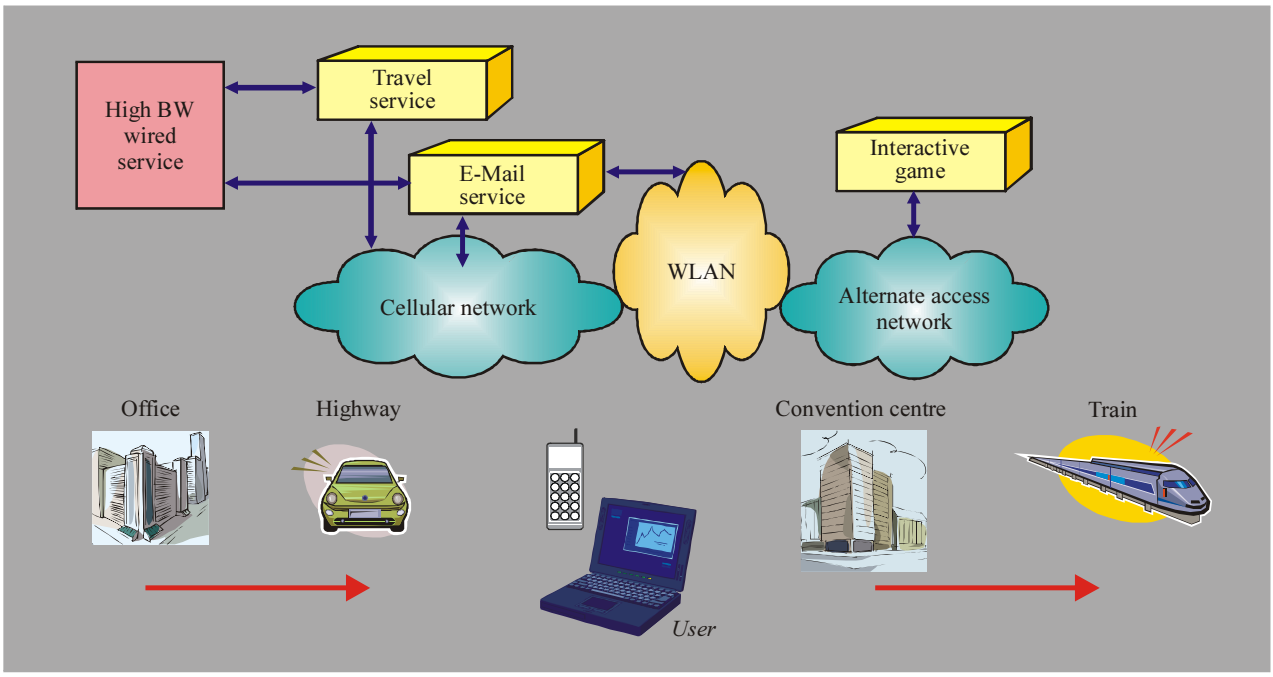


Figure I.1/Q.1703 – An example of a typical user in year 2010

Appendix II

All IP network and Virtual Home Environment (VHE)

A question for the VHE capability in an All IP network is whether or not the VHE concept has as strong a presence in a global "All IP" network system as it would in the networks of today or in the 3G networks? The speed of computing and data transport capacity has been growing exponentially. The Internet phenomenon and the IP are emerging as the dominant choices for the network and the protocol for future telecommunication systems, respectively. With these, the distance and home association and roaming are losing their meaning and their technical significance except for commercial purposes. When a full and complete All IP system prevails, the question that comes to one's mind is that: "Why creating a virtual home environment when there can be a presence of the real home environment everywhere?"

One answer to this question is that the VHE of the future will not tend to duplicate the home environment in the visited networks. It will, instead, establish a service delivery tunnel from the application server to the terminal client. The VHE in an All IP environment will take a more of commercial significance, and its technical solutions will be geared to solving the commercial problems. The dynamism of the All IP paradigm reduces the need for the multiple VHE scenarios to only one, and that is the "Actual Home Service" scenario. This scenario is consistent with home control scheme for realization of the VHE capability. All other scenarios will perhaps remain relevant to the "All CS (All Circuit Switched)", "CS-PS (Circuit Switched-Packet Switched)", and "non-IP PS (non-IP Packet Switched)" networks.

At first glance, these functions are similar to traditional 2G cellular systems and current IMT-2000 3G Systems. However, in Systems Beyond IMT-2000, we envision a network in which the number of communicating mobile endpoints (mobile devices) will far exceed the number of fixed endpoints.

The problems of mobility management need to be critically re-examined and new architecture and design approaches developed to handle billions of mobile endpoints. The ideal network design for Systems Beyond IMT-2000 should incorporate the best aspects of mobility management from cellular networks and IP networks and extend them to handle the challenges of large scale, multimedia, mobile-dominated networks of the future.

The future network must support an efficient and adaptive combination of location registration and IP paging functions. Systems Beyond IMT-2000 may have users with multiple preference choices for their applications and service classes. In order to handle varying user preferences as well as system objectives, a key goal of network design should be to accommodate hybrid and flexible, adaptive combination location registration and paging algorithms for location management.

Another important consideration in mobility management is that the signalling overhead to handle large numbers of mobile users (several hundred million to a few billion) should be minimized through adoption of suitable powerful architectural concept. Management of changes should be localized to the maximum extent possible. Important factors to consider in design should include: speed of movement of user, data rate of application, cell sizes, etc.

Handovers occur when path(s) to reach a mobile user must change because of changes in physical accessibility of the user. In Systems Beyond IMT-2000, there will be a continuing need for routing and re-routing of traffic to large numbers of mobile users. Path changes need to be executed quickly and in a manner that results in efficient use of system resources (including network and radio).

Appendix III

User selectable service methods

As an example of possible manners for user customization of services, the "User Selectable Service Methods" is the ability that a user will be able to choose an appropriate one among various service grades and provided methods to suit the users own convenience. This concept is called "One-Service Multi-Methods".

Figure III.1 shows the image of "Service Methods Selection" in "One-Service Multi-Methods" concept.

Shall we assume as follows:

> One service A (e.g., News delivery service) is consisted of visual, audio and text methods. Each general method is consisted of several concrete methods with selector that can be chosen by user or service provider's requirements.

The user will be able to choose appropriate concrete methods combination in Visual, Audio and Text methods according to the ability of the user's environment he/she can use, or according to the user's desire.

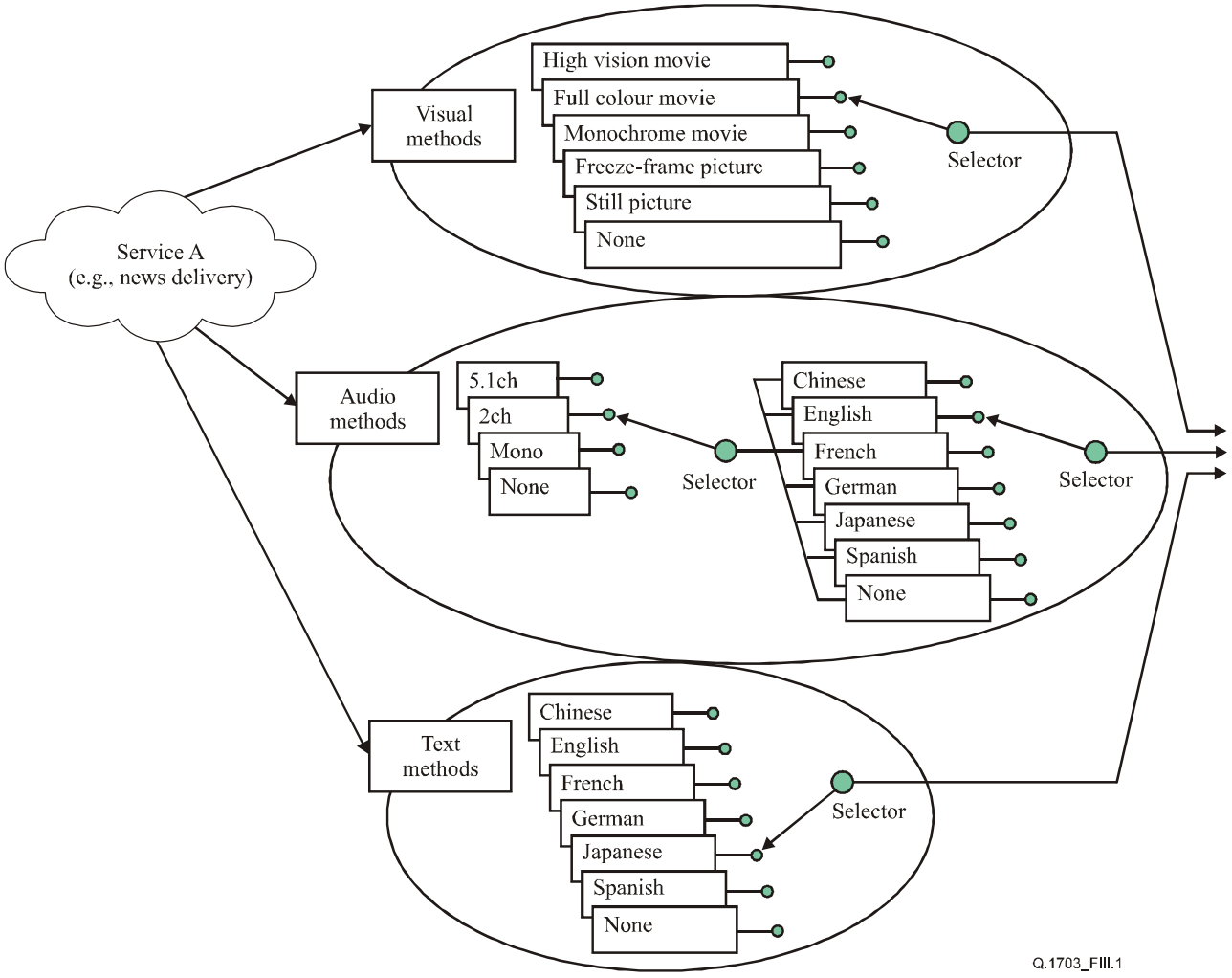


Figure III.1/Q.1703 – An image of "User Selectable Service Methods" in "One-Service Multi-Methods" concept

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