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TELECOMMUNICATION
STANDARDIZATION SECTOR
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SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for IMT-2000

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Generalized mobility

Mobility management requirements for NGN

ITU-T Recommendation Q.1706/Y.2801

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ITU-T Recommendation Q.1706/Y.2801

Mobility management requirements for NGN

Summary

This Recommendation describes the requirements for mobility management (MM) for Next Generation Networks (NGN). For this purpose, this Recommendation describes the considerations for mobility management in the NGN, classifies the types of mobility management for NGN environment, and identifies a set of the MM requirements for NGN.

Source

ITU-T Recommendation Q.1706/Y.2801 was approved on 6 November 2006 by ITU-T Study Group 19 (2005-2008) under the ITU-T Recommendation A.8 procedure.

Keywords

Mobility management requirements, NGN, Systems beyond IMT-2000.

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Mobility management requirements for NGN

1 Scope

The scope of this Recommendation is to identify the requirements for Mobility Management (MM) for NGN. Note that the scope of this Recommendation is not limited to a specific level of mobility and covers full mobility. To that end, this Recommendation describes the following:

- Considerations of MM for NGN;
- Classification of MM types for NGN;
- Requirements for MM for NGN.

Administrations may require operators and service providers to take into account national regulatory and national policy requirements in implementing this Recommendation.

2 References

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

[G.992.3] ITU-T Recommendation G.992.3 (2005), *Asymmetric digital subscriber line transceivers 2 (ADSL2).*

[Q.1741.1] ITU-T Recommendation Q.1741.1 (2002), *IMT-2000 references to release 1999 of GSM evolved UMTS core network with UTRAN access network.*

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

3 Definitions

This Recommendation uses the definitions and terms that have been defined in the relevant ITU-T Recommendations such as [Q.Sup52].

In addition, this Recommendation defines the following terms:

3.1 home network: The network to which a mobile user is normally connected, or the service provider with which the mobile user is associated, and where the user's subscription information is managed.

3.2 mobility: The ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment.

3.3 mobility management: The set of functions used to provide mobility. These functions include authentication, authorization, location updating, paging, download of user information and more.

3.4 open interface: An interface that uses open standards.

3.5 open standard: Open Standards are standards made available to the general public and are developed (or approved) and maintained via a collaborative and consensus-driven process.

3.6 roaming: [Q.1741.1] The ability for a user to function in a serving network different from the home network.

NOTE – This is the ability of the users to access services according to their user profile while moving outside of their subscribed home network, i.e., by using an access point of a visited network. This requires the ability of the user to get access to the visited network, the existence of an interface between home network and visited network, as well as a roaming agreement between the respective network operators.

3.7 seamless service: A service that is implemented such that it will ensure that users will not experience any service disruptions while changing the point of attachment.

3.8 visited network: The network outside a home network that provides service to a mobile user. This term is more business significant than geographically significant.

3.9 xDSL: [G.992.3] Any of the various types of digital subscriber lines technologies.

4 Abbreviations

This Recommendation uses the following abbreviations:

2G	Second Generation
3G	Third Generation
AAA	Authentication, Authorization and Accounting
AN	Access Network
CN	Core Network
IP	Internet Protocol
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
MM	Mobility Management
MMR	Mobility Management Requirements
MT	Mobile Terminal
NAP	Network Access Point
NGN	Next Generation Network
NNI	Network-to-Network Interface
NT	Network Termination
QoS	Quality of Service
SAP	Service Access Point
SDO	Standards Development Organization
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SP	Service Platform
SPI	Service Platform Interface
TCP/IP	Transmission Control Protocol/Internet Protocol

URL Uniform Resource Locator

VoIP Voice over IP

WLAN Wireless Local Area Network

xDSL x Digital Subscriber Line

5 Introduction

This Recommendation describes the requirements for mobility management (MMR) in NGN. This work has been motivated from the observation that the NGN continues to evolve toward the convergence of fixed networks and wireless mobile networks, and thus there is a crucial need to identify the requirements for mobility management to provide mobility for the users and services in the NGN environment.

The rationale behind NGN is the convergence of fixed and wireless networks and ultimately migration to interoperable and harmonized network architectures. This trend has caused an industry need to provide seamless services transparently to the users across different access network (AN) arrangements. This Recommendation therefore asks: "What requirements for mobility management should be considered to support the seamless services in NGN networks?"

This Recommendation identifies the considerations and requirements for mobility management for NGN.

Mobility management is an essential requirement for NGN users to communicate anytime and from anywhere. This could be facilitated through the use of various wireline or wireless access technologies to enable users to communicate over heterogeneous network environments.

In particular, with the massive growth in the number of users and the continuing deployment of heterogeneous systems, the demand to provide seamless services to the NGN users gets stronger with time, and such pursuits present new challenges and requirements for new types of MM that could provide seamless services across heterogeneous networks.

A promising solution for the new type of MM in NGN should take into account the long-term trends for future networks, the need for a smooth evolution of the infrastructure, and also the issue of backward compatibility with existing networks.

In this respect, this Recommendation will identify a set of requirements for mobility management in the emerging NGN. Clause 6 describes the considerations for mobility management for NGN, together with the general features and functionalities associated with MM for NGN. Clause 7 classifies the types of mobility management to be addressed and for which seamless services must be provided in the NGN environment. Finally, a set of NGN MM requirements are identified and characterized in Clause 8.

6 Considerations for mobility management in NGN

This clause describes the generic features and considerations associated with mobility management so as to facilitate the identification of MM requirements and protocols for NGN.

6.1 Network environments

In the NGN, it is expected that a variety of the existing and new wired/wireless access network technologies are supported, such as WLAN, xDSL and 2G/3G mobile networks etc., as shown in Figure 6-1. Each of the access networks is connected to the NGN core network (CN), to provide the same set of services for users, preferably independently of the access network type.

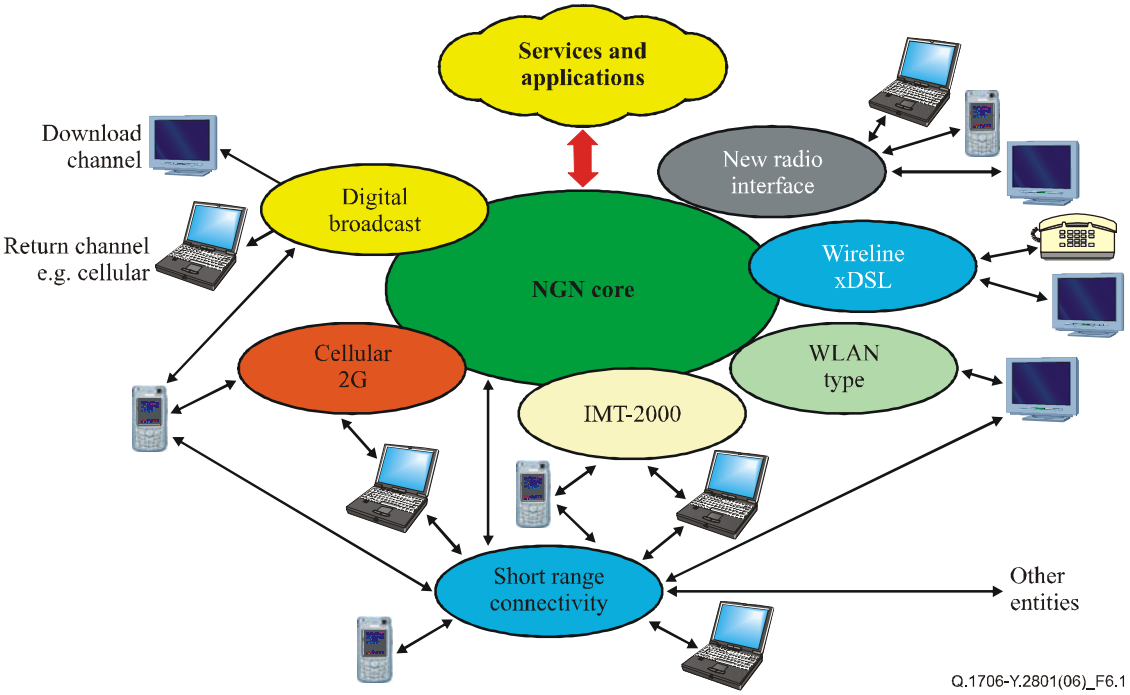

Figure 6-1/Q.1706/Y.2801 – Envisioned network environment of NGN

6.2 General mobility management features

Mobility has been used a little differently according to its application areas. However, the general feature of the mobility could be described as follows:

6.2.1 Moving object

Mobility management can be classified as follows according to what moves:

- *Terminal mobility*

  This is the mobility for those scenarios where the same terminal equipment is moving or is used at different locations. 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.

- *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.

- *Personal mobility*

  This is the mobility for those scenarios where the user changes the terminal used for network access at different locations. 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.

- *Service mobility*

  This is the mobility, applied for a specific service, i.e., the ability of a moving object to use the particular (subscribed) service irrespective of the location of the user and the terminal that is used for that purpose. Note that this service mobility is different from the *service level mobility* which is defined in ITU-T Rec. Y.2012, *Functional requirements and architecture of the NGN*, and related Recommendations.

6.2.2 Features by service continuity

Mobility also could be classified as shown in Figure 6-2 according to service continuity.

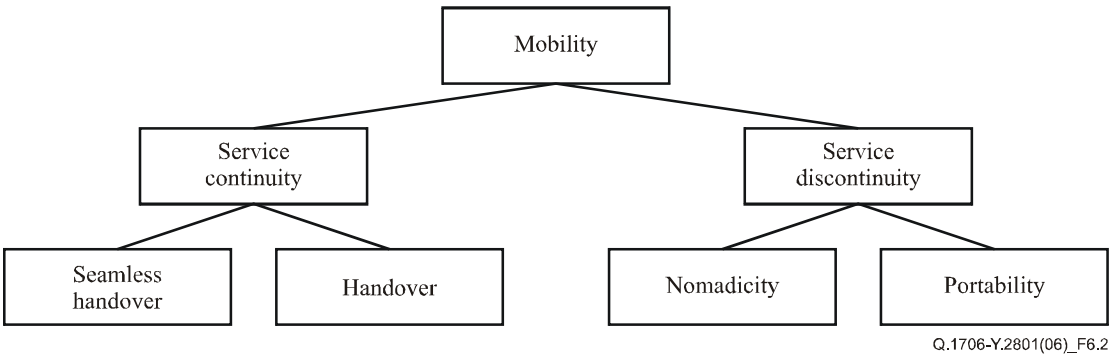

Figure 6-2/Q.1706/Y.2801 – Mobility classifications according to service quality

- *Service continuity*

  The ability for a moving object to maintain ongoing service over including current states, such as user's network environment and session for a service. This category includes Seamless Handover and Handover.

  – Seamless handover: It is a special case of mobility with service continuity since it preserves the ability to provide services without any impact on their service level agreements to a moving object during and after movement.

  – Handover: The ability to provide services with some impact on their service level agreements to a moving object during and after movement.

- *Service discontinuity*

  The ability to provide services irrespective of environment changes of a moving object, but not to be able to maintain ongoing service. This category includes Nomadism and Portability.

  – Nomadism: Ability of the users to change their network access point on moving. When changing the network access point, the user's service session is completely stopped and then started again, i.e., there is no service continuity or hand-over used. It is assumed that normal usage pattern is that users shut down their service session before attaching to a different access point.

    NOTE – This term is also intended to cover the situation where the network access point is changed as a result of use of a different network interface card as discussed in 6.3.1.

  – Portability: Ability of a user identifier or address to be allocated to different systems when the user moves from one location to another.

6.2.3 Mobility layer

The layer concept specified in [ITU-R M.1645] is used to classify mobility management.

- *Horizontal mobility*

  Mobility on the same layer as defined in [ITU-R M.1645]. Generally, it is referred to as the mobility within the same access technology.

- *Vertical mobility*

  Mobility between different layers as defined in [ITU-R M.1645]. Generally, it is referred to as the mobility between different access technologies.

6.3 Considerations on user part

NGN needs to consider more general types of user parts, i.e., user network, as well as simple forms like user terminals as depicted in Figure 6-3 below. It shows a user network with multiple Service Platforms and each Service Platform may run multiple Service Applications. In such user networks, multiple users may associate themselves with one or more service applications, by providing one of their user identifiers to the application. For example, this might typically be a SIP URL. The service application is bound to a TCP/IP socket of the Service Platform Interface. The SPI binds itself to an access network-specific Network Termination via the user's connectivity network. Finally, the network termination is bound to the Network Attachment Point of the access network.

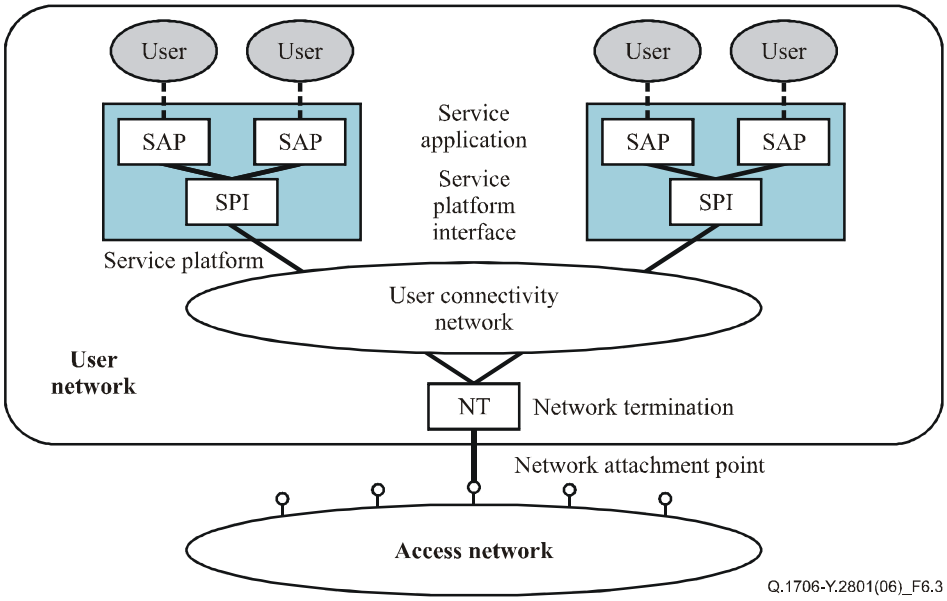

Figure 6-3/Q.1706/Y.2801 – User network configuration

Only one Network Termination is shown in the user network, but multi-homing may be considered.

In this user network scenario there is a many-to-one relation between the different types of endpoints. A mobile terminal may represent a limit case where there is a one-to-one relation between the user and the service application, the service application and the service platform interface, and between the service platform interface and the network termination.

6.3.1 Mobility scenarios according to changes of endpoints

Figure 6-4 shows a number of mobility scenarios including some that involve mobility within the end user equipment area.

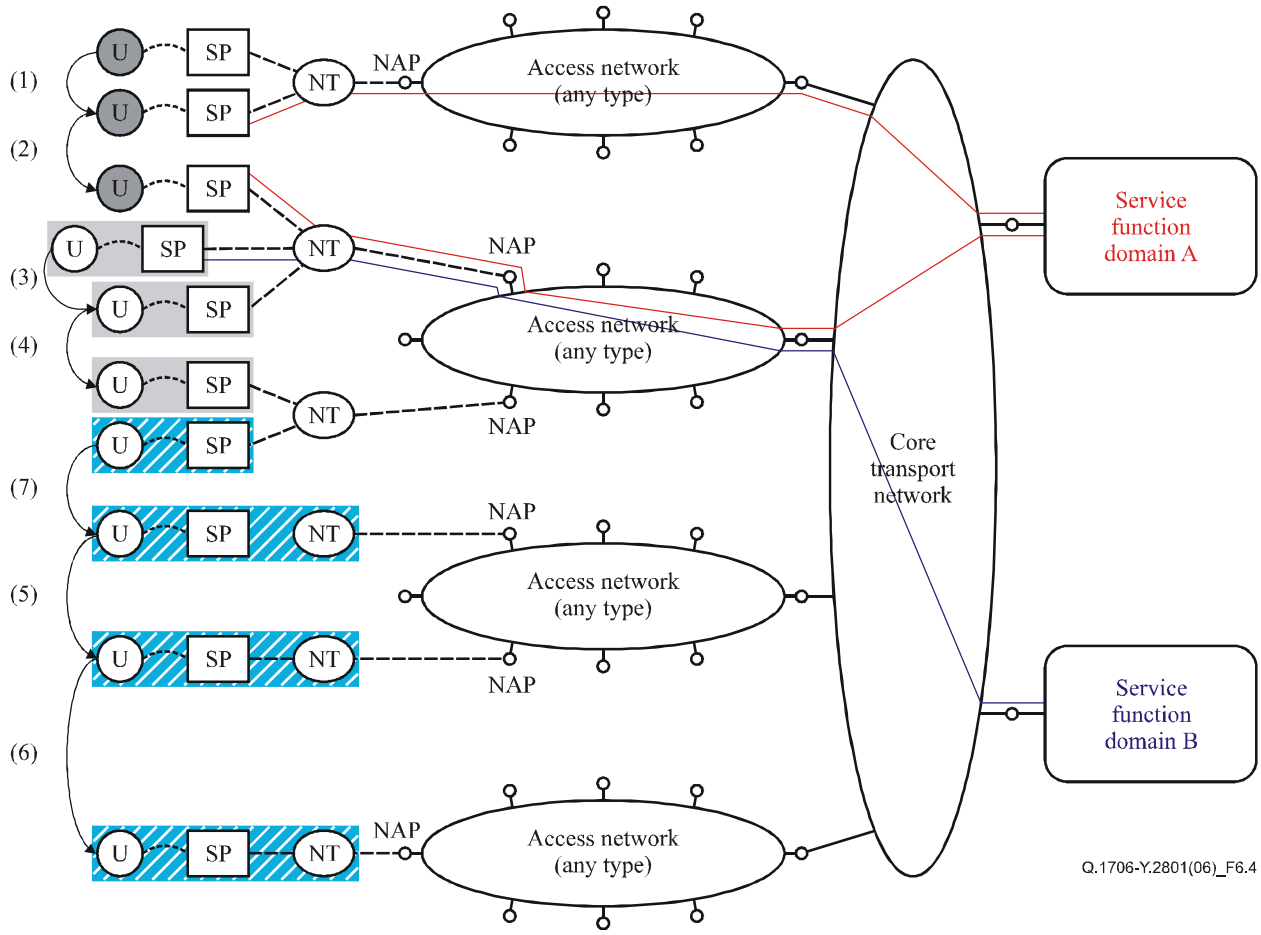

Figure 6-4/Q.1706/Y.2801 – Mobility scenarios according to the changes of endpoint

The arrows show mobility taking place as described in the following paragraphs. Each mobility scenario is numbered to the left of the figure.

A user may only change the association with a Service Application when they move from one Service Platform to another, either within a user network (1) or when they move from one user network to another (2). All other bindings remain fixed in this case.

The user may also move their Service Platform, thereby changing the binding between the Service Platform Interface and his Network Termination. Again this may be done within a user network (3) or when moving from one user network to another (4). The binding between the Network Termination and the Network Attachment Point does not change in these two scenarios.

If the Network Termination supports mobility, the user may change the binding between the Network Termination and its Network Attachment Point. The change may be to another NAP on the same access network (5) or on another access network (6). The other bindings do not change in these scenarios.

Finally, a more complex scenario is shown in (7) where the SPI supports mobility. Such a SPI could be used to bind to either a NT in a user network or act as an NT to bind to a NAP.

Figure 6-5 further illustrates the option to gain access to different Service Providers from different Service Platforms (or different Service Applications on the same Service Platform) in the same user network.

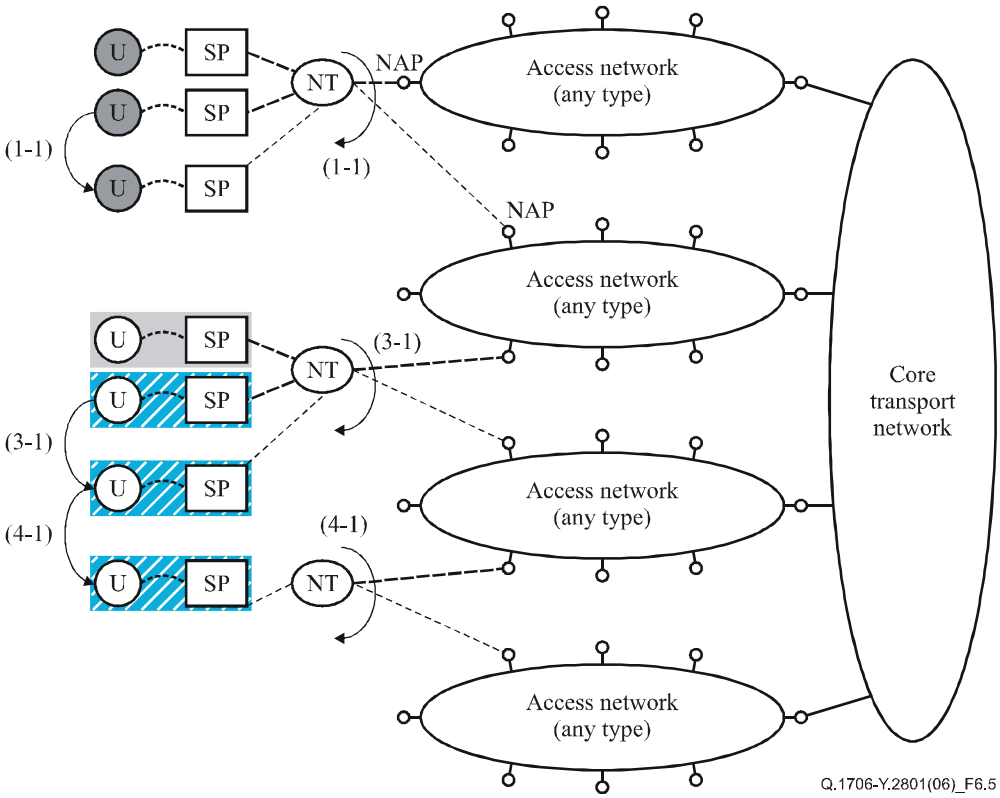

Figure 6-5/Q.1706/Y.2801 – Single NT with multiple ANs

A user uses the same service application and the same network termination but changes his network interface card within the same terminal, which has two or more network interface cards of Service Platform (1-1). In this case, the user uses the same Network Termination (NT) but can change its access network, which is matched with the network interface card.

A user can move his service platform, thereby changing the binding between the Service Platform Interface and his Network Termination. Changing the binding between the Service Platform Interface and his Network Termination is done within a user network and between two access networks (3-1) as well as between two user networks and between two access networks (4-1). These scenarios can occur for improving network performance, and so on.

6.4 Mobility management functionalities

MM in NGN will be realized by using basic mobility-related functionalities plus associated functionalities. The basic functionalities are concerned directly with mobility management for mobile users and terminals, whereas the associated functionalities are used for supporting MM or for exchanging related information for overall control and management purposes.

The basic MM functionalities include location and handover management.

6.4.1 Location management

Location management is performed to identify the current network location of a Mobile Terminal (MT) and to keep track of it as it moves. Location management is used for the control of calls and sessions terminated at the MT. Location information is given to the call or session manager for

establishing a session. With the help of location management, the correspondent node is able to locate the MT and establish a session via appropriate signalling.

Location management consists of two basic functions: location registration and call delivery/paging. The location registration is the procedure to register the current location when MTs change the attachment point to the network. Call delivery is to deliver packets to the destined MTs and paging is used to search the MTs in dormant mode.

6.4.2 Handover management

Handover management is used to provide MTs with session continuity whenever they move into different network regions and change their point of attachment to the network during a session. The main objective of seamless handover is to minimize service disruption due to data loss and delay during the handover. Most MM protocols perform handover management together with an appropriate location management scheme. According to the handover areas concerned, the handover types can be classified into "handover within an AN", where the MT moves within a region covered by the same AN in NGN, and "handover between different ANs or CNs", where the MT changes its concerned access system for ongoing sessions.

7 Classification of mobility management

Note that various types of mobility exist in NGN environments. Mobility management requirements also are different according to mobility types. This Recommendation only considers the classifications illustrated in Figure 7-1. In Figure 7-1, the MM issues for NGN are classified into Intra-Network MM and Inter-Network MM. Intra-Network MM is further subdivided into Intra-AN MM and Inter-AN MM.

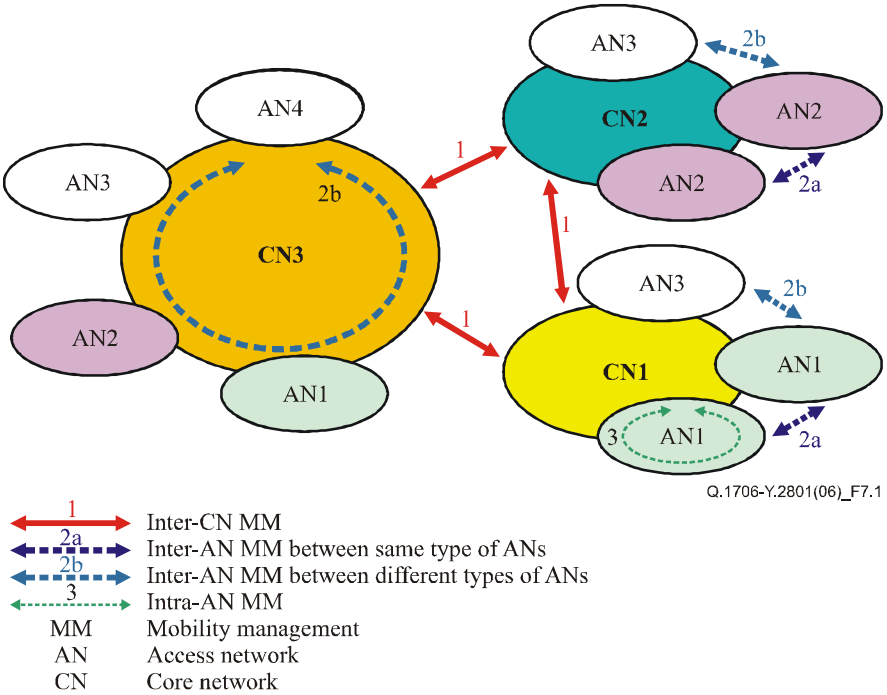

Figure 7-1/Q.1706/Y.2801 – Classification of MM

7.1 Intra-CN MM

"Intra-CN" MM addresses MM issues within a network. It can be subdivided into "Intra-AN" MM and "Inter-AN" MM.

- *Intra-AN MM*

  "Intra-AN" MM addresses MM issues within an AN. In Figure 7-1, for example, MM within AN1 of CN1 can be classified as Intra-AN MM, marked as '3' in the figure.

- *Inter-AN MM*

  "Inter-AN" MM addresses MM issues between different ANs within the CN. Inter-AN MM can be further classified into the following two sub-types:

  1) MM between the same type of ANs (e.g., MM between two AN1s within the CN1, marked as 2a in Figure 7-1); and
  2) MM between different types of ANs (e.g., MM between AN1 and AN3 within CN1, marked as 2b in Figure 7-1).

7.2 Intra-Network MM (Inter-CN MM)

"Inter-Network" MM addresses MM issues between networks and was mainly touched in [Q.Sup52]. Inter-Network MM will always accompany the MM issues between two ANs, i.e., Inter-AN MM. In addition to those, Inter-Network MM must handle the MM issues that occur with MT handovers across different core networks (i.e., Network-to-Network Interface (NNI)), such as user authorization and Service Level Agreement (SLA) negotiation. In Figure 7-1, for example, the MM between CN1 and CN3 is Inter-Network MM, marked as '3' in the figure.

8 Requirements for mobility management

The MM requirements could be given differently according to MM types such as Inter-CNs, Inter-ANs, and Intra-AN. The main differences of MM requirements are summarized in the following table.

	Administration	**Access technology**
Inter-CN MM	Different	Same/Different
Inter-AN MM	Same[a)]	Same/Different
Intra-AN MM	Same	Same

[a)] For the case of Network Sharing, the same physical core network supports two logical CNs.

Note that the following requirements are only minimum requirements, so better features could be provided in each MM type in practice. Also, this Recommendation mainly focuses on IP-based new ANs rather than legacy ANs which may already have their own MM solutions.

8.1 General requirements

This clause describes a set of general requirements for MM in NGN regardless of MM types.

8.1.1 Harmonization with IP-based networks

The NGN is envisaged to be IP-based. Accordingly, the MM protocols for NGN should be IP-based or, at least, well-harmonized with IP technology for its efficient and integrated operation in such future networks. It is also recommended to reuse to the extent possible the existing MM techniques/technologies for the design of the MM protocols for NGN, potentially through cooperation with external forums and SDOs.

8.1.2 Separation of control and transport functions

The transport plane should be separated from the control plane for efficient mobility management and scalability. Such separation of control and transport planes provides the architectural flexibility that facilitates the introduction of new technologies and services. Open interfaces between the control plane functions and the transport plane functions are necessary to implement their separation.

8.1.3 Provision of a location management function

To support the mobility of users/terminals, the location of users/terminals are tracked and maintained by one or more location management functions whenever they move. In harmony with the overall IP-based structure envisaged, location management should be based on an IP-specific approach such as the Mobile IP Home Agent or the SIP registrar.

Location management can be expanded to provide location information to service applications.

8.1.4 Provision of mechanisms for identification of users/terminals

The MM protocols in NGN must specify how the users/terminals are to be identified in the networks or systems for mobility management. This identification functionality will be the first step to be taken in the mobility management process and thus used for authentication, authorization and accounting of users/terminals.

8.1.5 QoS support

The MM protocols must support QoS, which mobile users require, to support QoS-required services such as VoIP, streaming, and so on as well as convenient Internet best-effort services. However, the required level of QoS could be different according to MM types which are described in Figure 7-1.

8.1.6 Interworking with established AAA and security schemes

The MM protocols for NGN must specify how users/terminals are to be authenticated, authorized accounted, and secured for services using standard Authentication, Authorization and Accounting (AAA) and security mechanisms.

The result of the AAA functionality will be a yes/no decision on the service request made by a user. As a next step, the access network configuration will be adapted to the mobile/nomadic user such that it satisfies the particular Quality of Service (QoS) level and security association for the requested service. These mechanisms should be based on the user's subscription profile and the technical resource constraints of the respective access networks.

8.1.7 Location privacy

The location information of particular users should be protected from non-permitted entities. This will entail mutual authentication, security association, and other IP security requirements between the mobile terminal and the location management function.

8.1.8 Support of network mobility

NGN are envisioned to include moving networks as well as moving terminals. Typical example platforms for moving networks could be bus, train, ship, aeroplane and so on. The MM protocols in NGN need to efficiently support these kinds of moving networks.

8.1.9 Support of ad hoc networks

The support for ad hoc networks is essential because this kind of network is envisioned as one of the major access technologies in NGN.

8.1.10 Resource optimization

The provision of the scheme for resource optimization is required to save power consumption in the terminals and signalling overhead in network side. The resource optimization should be provided to the terminals in idle mode as well as in active mode.

The support of resource optimization for idle mode terminals is mainly achieved with a paging procedure and this procedure is usually tightly coupled with location management.

8.1.11 Support of IPv4/IPv6 and public/private addresses

Currently, IPv4 is dominant but IPv6 is being expected to be widely deployed in the near future. Accordingly, the MM protocols must support IPv6 as well as IPv4. In addition, note that users/terminals may use their private address rather than public IP addresses according to the network environment regardless of IP version. Accordingly, MM should allow for the use of private addresses. In this case, a proxy agent might be needed to support MM-related operations such as location update and paging.

8.1.12 Provision of personal and service mobility

To realize diverse applications in NGN, personal and service mobility, which are defined in 6.2.1 as well as terminal mobility must be provided.

8.1.13 User data accessibility

Services and other network functions require some user data in order to be appropriately customized. These can be either "user subscription data" or "network data".

8.1.14 Support of several kinds of mobile endpoints

In the NGN environment there are different types of mobile endpoints to be considered. The mobile endpoint can be an application in SIP, interface in the Mobile IP, and so on as well as it can be in a core network, an access network, a user-premises network or a service platform. So, each network related to the mobile endpoints should be able to support the mobility of every mobile endpoint.

8.1.15 Maintenance of binding information

There are many types of bindings for services as follows:

- between a user and a service application;
- between an application and a network interface card;
- between a Service Platform and a Network Termination;
- between a Network Termination and a network access point;
- between two different access networks.

In NGN environment, all the above bindings should be maintained to support mobility. Because of this, binding information needs to be maintained in a relevant place.

8.2 Requirements for Inter-CNs MM

This subclause describes a set of requirements specific to Inter-CNs MM in NGN.

8.2.1 Independence from network access technologies

It is expected that NGN will consist of an IP-based core network with several access networks that may use different access technologies, as shown in Figure 6-1. In this architecture, MM should provide mobility between either homogeneous or heterogeneous types of access networks that belong to the same or different operators. Accordingly, it is required that MM be independent of the underlying access network technologies such as 2/3G Cellular, WLAN, etc.

8.2.2 Effective interworking with existing MM protocols

Existing ANs are likely to use their own MM instead of new MM. Accordingly, the NGN MM must be able to effectively interwork with the existing MM protocols.

8.3 Requirements for Inter-ANs MM

This subclause describes a set of requirements specific to Inter-ANs MM in NGN.

8.3.1 Independence from network access technologies

The same requirements apply as those listed for Inter-CN MM under 8.2.1.

8.3.2 Provision of mechanisms for context transfer

When an MT moves across different networks, the context information of the current session, such as QoS level, security method, AAA mechanism, compression type in use, etc., might be helpful in performing the handover of the session to the new access network (e.g., minimizing the latency involved in handing the session over to new serving entities). The proper use of a context transfer mechanism could substantially reduce the amount of overhead in the servers that are, respectively or in a combined manner, used to support QoS, security, AAA, and so on.

8.3.3 Effective interworking with existing MM protocols

Existing ANs are likely to use their own MM instead of new MM. Accordingly, the NGN MM must be able to effectively interwork with existing MM protocols.

8.3.4 Provision of a handover management function for seamless services

MM should support handover management for maintaining session continuity during movement. Furthermore, those mechanisms should provide fast handovers to cater for seamless non real-time and real-time service requirements (e.g., VoIP and video streaming).

In Inter-ANs MM, the handover might be a vertical handover between ANs with different access technologies because a CN can connect to various kinds of ANs.

8.3.5 Support of policy-based and dynamic network selection

After detecting the presence of a wireless network, it should be possible for the user to choose to connect to one of the networks to obtain service, based on the following policies driven by the requirements of the service or application to be used, and presented to the user.

NOTE – If the information is presented to a user, the user should not be expected to have enough technical knowledge about the parameters listed to take an appropriate decision. Rather, these should be looked after by the service's application software, and the options presented to the user should be only those that can support the needs of the service or application to be executed:

- Quality of Service level needed for a particular service, e.g., bandwidth availability, time delay, packet loss ratio;
- Cost for the particular service in each network (it is presumed that the networks will provide cost information as part of the options);
- Security level that the network can provide.

Once connected, the terminal should be able to track information of the current network based on the above-mentioned aspects. For example, when a user detects that the QoS level has gone down, it can handover the service to a new network instantly. From the user's point of view, the network switchover is not visible.

8.4 Requirements for Intra-AN MM

This subclause describes a set of requirements specific to Intra-AN MM in NGN.

8.4.1 Provision of mechanisms for context transfer

The same requirements apply as listed for Inter-AN MM under 8.3.2.

8.4.2 Provision of a handover management function for seamless services

MM should support handover management for maintaining session continuity during movement. Furthermore, those mechanisms should provide fast handovers to cater for seamless non real-time and real-time service requirements (e.g., VoIP and video streaming).

In Inter-AN MM, the handover means the horizontal handover within an AN. Accordingly, the handover in Intra-AN configurations should provide better performance than for Inter-AN configurations.

Appendix I

Classification of mobility based on network topology

Figure I.1 shows an example of multiple levels of mobility for certain access network types and mobility technologies. Other examples for other access network types and mobility technologies are, of course, possible. The figure depicts that mobility supported at lower levels in the architecture may not be visible to higher levels. It also shows that mobility may be handled at levels all the way up to the application.

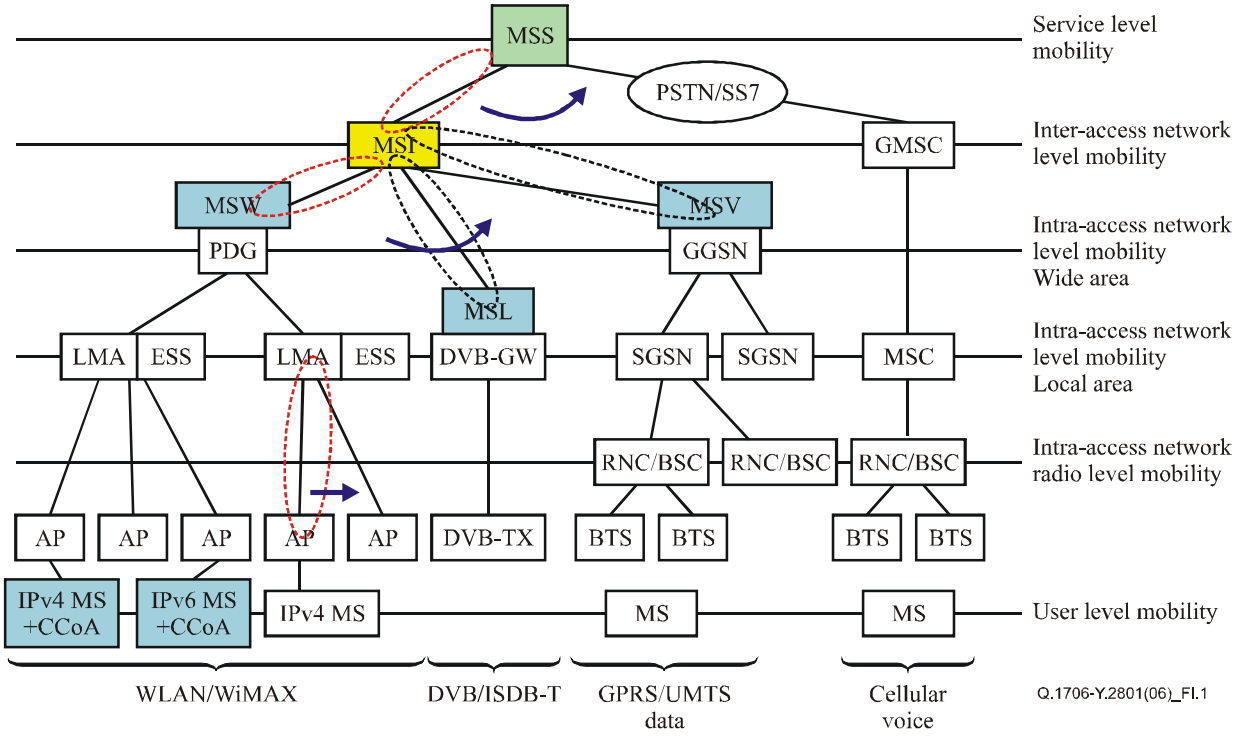

Figure I.1/Q.1706/Y.2801 – Example of levels of mobility

- *Mobility at the service level*

  Service level mobility is mobility across Circuit-Switched (CS) or Packet-Switched (PS) domains in NGN. This might be within a single NGN or across NGNs. Service level mobility might for example exploit E.164 address to Session Initiation Protocol-Uniform Resource Identifier (SIP-URI) resolution capabilities. Using these capabilities, service level mobility can be provided when a user is roaming between different administrative domains, which would necessitate inter-domain mobility at session control level. Service level mobility between different combinations of CS and PS session is possible for NGN.

- *Mobility at the inter-access network level*

  Inter-access network mobility allows for users to roam across CS or PS domains using various network mobility technologies such as Mobile IP or MAP.

- *Mobility at the intra-access level (Wide area)*

  Intra-access level mobility (wide area) refers to either the PS domain or CS domain in NGN. Mobility is provided by the access network technology. For example, mobility at this level might be provided by GPRS roaming technology for movement between a Serving GPRS Support Node (SGSNs) within a GGSN.

- *Mobility at the intra-access network level (Local area)*

  Intra-access network level mobility (local area) refers to mobility within an access that uses a particular technology, generally within a limited geographic area, but handled above the radio resource control layer.

- *Mobility at the intra-access network radio level*

  Intra-access network radio level mobility refers to the mobility at radio level (e.g., Radio Resource Control (RRC) layer in UMTS or cdma2000, Radio Resource (RR) layer in GPRS).

- *Mobility at the personal level*

  Personal level mobility refers to the mobility at the user level. For example, a user can perform mobility between terminals, such as an IPv4 MS (Mobile Station) and an IPv6 MS.

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