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Technical Report

Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Impact of mobility for access-technology independent networks in the TISPAN NGN architecture

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN).

1 Scope

The present document identifies TISPAN NGN mobility scenarios and the impact of mobility between access-technology independent networks.

The main impact of these scenarios is expected to be on the NASS and RACS architectures, but does not preclude other impacts within the TISPAN NGN architecture. The present document may also recommend a way forward to support these scenarios; however, it may also conclude that no further work in TISPAN is required.

The present document is expected to be access-technology independent and as such will require coordination of the TISPAN work with external SDOs and Fora such as 3GPP, ITU-T, ECMA, and the WiMAX Forum.

2 References

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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

[i.1] ETSI ES 282 001: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture".

[i.2] ITU-T Recommendation Q.1706/Y.2801: "Mobility management requirements for NGN".

[i.3] ETSI ES 282 004: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture; Network Attachment Sub-System (NASS)".

[i.4] ETSI ES 282 003: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control Sub-System (RACS): Functional Architecture".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

access network: collection of network entities and interfaces that provide the underlying IP transport connectivity between end user devices and NGN entities

NOTE: See ES 282 001 [i.1].

core network: portion of the delivery system composed of networks, systems equipment and infrastructures, connecting the service providers to the access network

NOTE: See ES 282 001 [i.1].

handover: ability to provide service with some impact on their service level agreements to a moving object during and after movement

NOTE: This may include a session break and resume, or a certain degree of service interruption or loss of data while changing to the new access point. See ITU-T Recommendation Q.1706/Y.2801 [i.2].

MIP-based mobility: approach for service continuity in NGN which is implemented in network layer using MIP

nomadism: ability of the user to change his 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 session continuity or handover possible

NOTE: It is assumed that normal usage pattern is that users shutdown their service session before moving to another access point. See ITU-T Recommendation Q.1706/Y.2801 [i.2].

service continuity: ability for a moving object to maintain ongoing service over including current states, such as user's network environment and session for a service

NOTE: This category includes Seamless Handover and Handover. See ITU-T Recommendation Q.1706/Y.2801 [i.2].

seamless handover: special case of mobility with service continuity since it preserves the ability to provide services without any impact on their service level agreement to a moving object during and after movement

NOTE: See ITU-T Recommendation Q.1706/Y.2801 [i.2].

SIP-based mobility: approach for service continuity in NGN which is implemented in the application layer using SIP signalling

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AN Access Network
CN Core Network
CNG Customer Network Gateway
CPN Customer Premises Network

NASS Network Attachment Sub-System

NOTE: See ES 282 004 [i.3].

AMF Access Management Function

NOTE: See ES 282 004 [i.3].

UE User Equipment

NOTE: See ES 282 004 [i.3].

RACS Resource and Admission Control sub-System

NOTE: See ES 282 003 [i.4].

4 Overview of Mobility in NGN

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

The solution of the mobility in NGN should take into account the long-term trend for future network, the need for a smooth evolution of the infrastructure, and the impact on existing network.

In current NGN, the mobility for nomadism has already been supported, while the mobility for service continuity (i.e. handover and seamless handover) is not yet supported.

4.1 SIP-based mobility and MIP-based mobility

There are two approaches for service continuity in NGN:

1) Implemented in network layer using MIP, which is called MIP-based mobility.

2) Implemented in the application layer using SIP signalling, which is called SIP-based mobility.

For SIP-based mobility, the solution requires network to support handover using SIP. It may support a make-before-break handover scheme. It is IP version and Access technologies agnostic and the service characteristics may be changed during the mobility procedure (e.g. add or remove media).

For MIP-based mobility, the solution bases on the well established MIP protocol family. The mobility is transparent to the applications and access technologies. It may support the different IP version. Consequently, some kind of network assistance during handover is needed to provide MIP-based seamless mobility. MIP-based mobility is also chosen for inter-access mobility management in heterogeneous networks involving both 3GPP and WiMAX.

5 Mobility Scenarios in NGN

Various types of mobility scenarios exist in NGN environments. The present document considers the classifications illustrated in figure 5.1. In figure 5.1, the mobility scenarios in NGN are classified into four categories: intra-AN mobility scenarios, inter-AN mobility scenarios between same type of access networks, inter-AN mobility scenarios between different types of access networks, and inter-CN mobility scenarios.

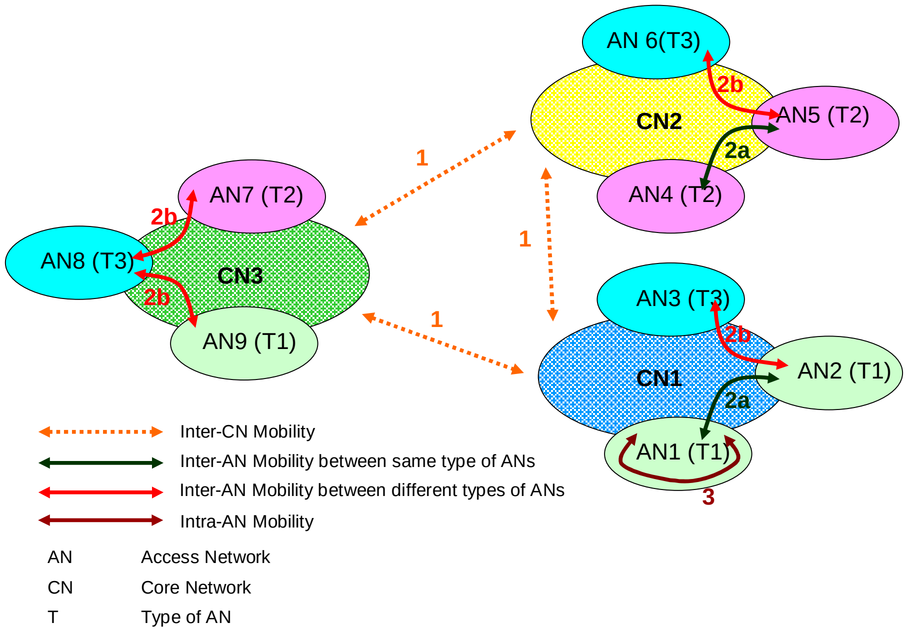

Figure 5.1: Classification of Mobility Scenarios

5.1 Intra-AN Mobility Scenarios

Intra-AN mobility scenarios address mobility within an AN. In figure 5.1, for example, mobility within AN1 of CN1 can be classified as Intra-AN mobility scenarios, marked as "3" in the figure.

Scenario A: Mobility between WiMax Access Networks owned by the same NGN Operator

User Bob is at the office (i.e. corporate network) and originates a voice call with User Alice via terminal supporting the WiMAX mode. When the call/session is established between Bob and Alice, Bob keeps the voice session ongoing and sets off from the office to the home. There are several WiMAX access nodes between Bob's office and Bob's home. In this way, Bob's WiMAX terminal needs to be moved from one access node (e.g. WiMAX BS) to another between the office and the home that are owned by the same NGN Operator. In this scenario, only one service control subsystem (e.g. IMS), one RACS and one NASS are considered in the access network.

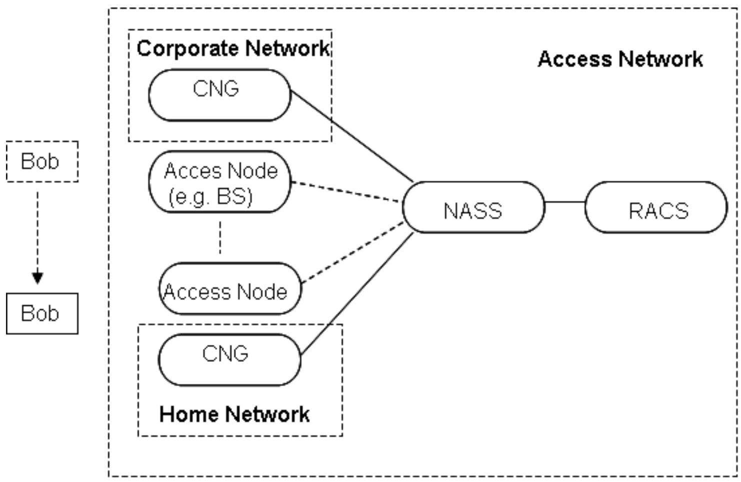

Figure 5.2: Mobility between WiMax Access Network owned by the same NGN Operator

Scenario B: Mobility between WiFi Hotspots owned by the same NGN Operator

User Bob has a WiFi enabled terminal and originates a voice call with User Alice at anywhere. During the call, User Bob roams between WiFi Hotspots that are owned by the same NGN Operator whilst keeping the call/session established.

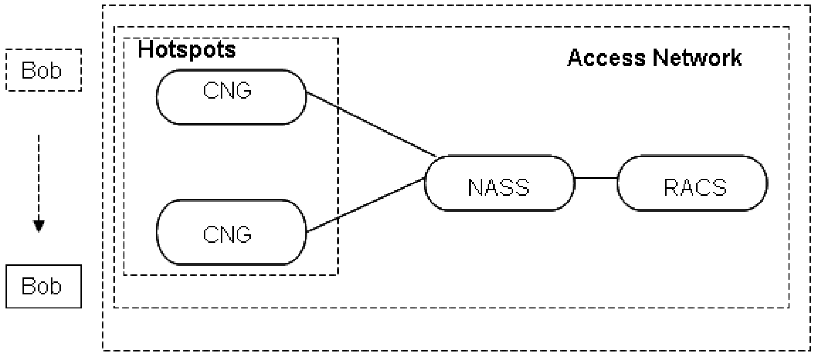

Figure 5.3: Roaming between WiFi Hotspots owned by the same NGN Operator

For this specific scenario, the CNG operates in bridge mode and directly attaches to the NASS.

Scenario C: Roaming between WiFi Hotspots owned by different NGN Operator's

This scenario is not described in the present document.

Scenario D: Mobility between a WiFi Hotspot and WiMAX owned by the same NGN Operator

User Bob has a dual mode phone which supports WiFi/WiMAX. Because WiMAX mode has poor indoor coverage and potentially has a higher cost than using WiFi mode, Bob chooses the WiFi mode, whilst at home, to originate a voice call with User Alice (Alice could be anywhere). When the call/session is established between Bob and Alice, Bob leaves his home and in doing so roams from the WiFi access to the WiMax access that is owned by the same NGN Operator. The call/session remains established during the handover.

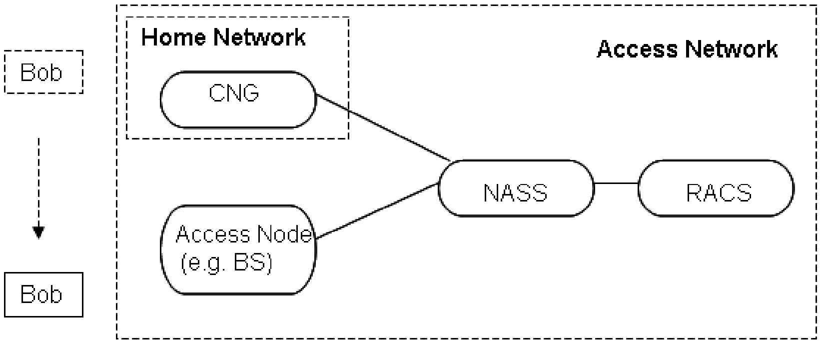

Figure 5.4: Mobility between WiFi Hotspot and WiMAX Access owned by the same NGN Operator

5.2 Inter-AN Mobility Scenarios

Inter-AN mobility scenarios address mobility between different ANs within the CN.

Inter-AN mobility scenarios can be further classified into the following two sub-types:

1) mobility scenarios between the same type of ANs (e.g. mobility between AN1 and AN2 within the CN1, marked as "2a" in figure 5.1); and

2) mobility scenarios between different types of ANs (e.g. mobility between AN2 and AN3 within CN1, marked as "2b" in figure 5.1).

5.2.1 Inter-AN Mobility Scenarios between same type of access networks

Scenario E: Mobility between WiMax Access Networks owned by the different NGN Operators

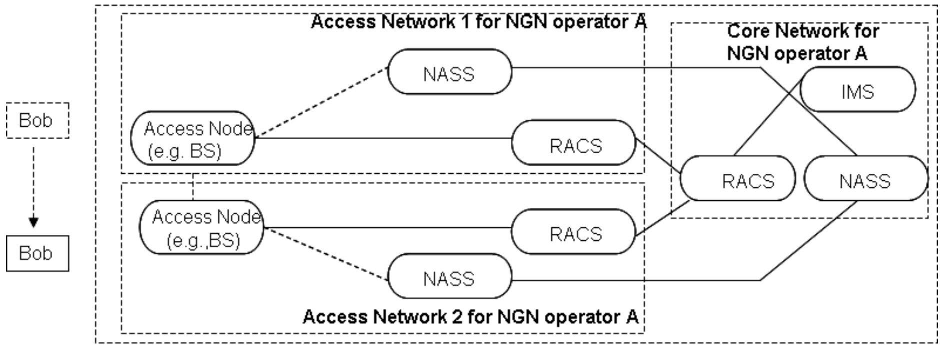

Figure 5.5: Mobility between WiMax Access Network owned by the different NGN Operators

User Bob is on the moving train and originates a conference call with his colleagues in his company via terminal supporting the WiMAX mode. When the call/session is established between Bob and his colleagues, Bob keeps the voice session ongoing and sets off from the Birmingham to London. There are several WiMAX access nodes between Birmingham to London. These access nodes belong to two different NGN operators. In this way, Bob's WiMAX terminal needs to be moved from one access node (e.g. WiMAX BS) owned by one NGN operator to another owned by another NGN operator. In this scenario, the two different access networks are owned by the different NGN operators and share the same service control subsystem (e.g. IMS), each access network has one RACS and one NASS.

5.2.2 Inter-AN Mobility Scenarios between different types of access networks

Scenario F: Mobility between WiMax Access Networks and WiFi hotspot owned by the same NGN operator

Also if we agree that NASS can be split into access part and core part, UAAF/PDBF is considered as functions on a core network, similar change should be made to ES 282 004 [i.3], clause 6. Otherwise, the link between NASS in access network and NASS in the core network should be removed and the link between NASS in the access network 1 and NASS in the access network 2 should be added.

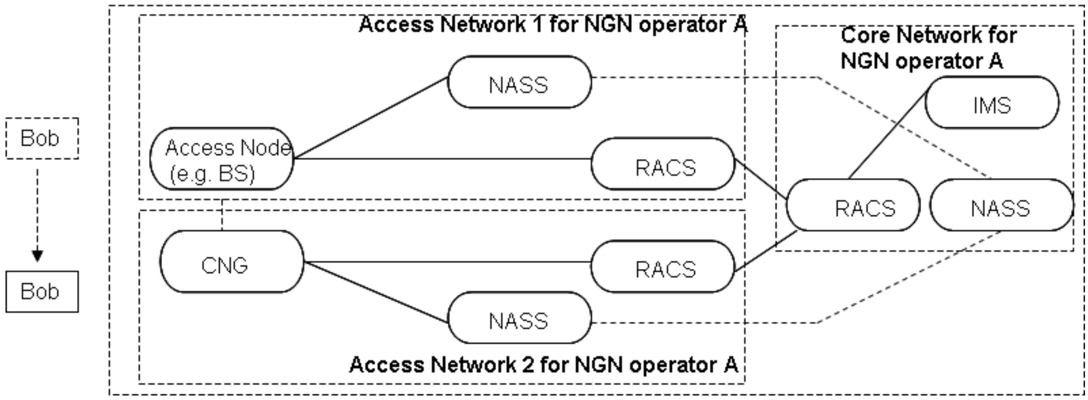

Figure 5.6: Mobility between WiMax Access Networks and WiFi hotspot owned by the same NGN operator

User Bob has a dual mode phone which supports WiFi/WiMAX. When Bob is on the way home, he originates a voice call in WiMAX mode to User Alice, utilizing the WiMAX access service of NGN operator A, by attaching to the access node (e.g. BS). When Bob reaches home, Bob switches from WiMAX mode to WiFi mode by attaching to the CNG managed by NGN operator B and keeps the voice call established with User Alice.

5.3 Inter-CN Mobility Scenarios

Inter-CN mobility scenarios addresses mobility between networks. Inter-Network mobility will always accompany the mobility between two ANs, i.e. Inter-AN mobility. In figure 5.1, for example, the mobility management between CN1 and CN3 is Inter-CN mobility, marked as "1" in the figure.

5.3.1 Scenario G: Mobility between WiMax Core Networks owned by different NGN Operators

Also if we agree that NASS can be split into access part and core part, UAAF/PDBF is considered as functions on a core network, similar change should be made to ES 282 004 [i.3], clause 6. Otherwise, the link between NASS in access network and NASS in the core network should be removed and the link between NASS in the access network 1 and NASS in the access network 2 should be added.

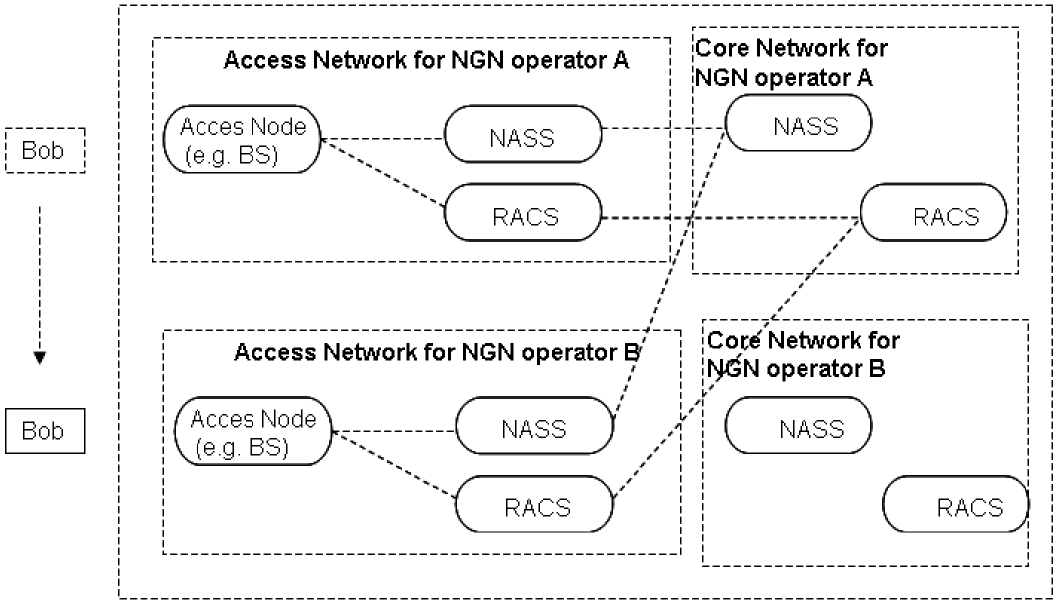

Figure 5.7: Mobility between WiMax Core Networks owned by different NGN Operators

User Bob is on a moving train which moves across several countries in European. Before the train moves out of his own country France, Bob originates a voice call with User Alice who could be anywhere. NGN Operator A provides NASS service and RACS service for him. Bob's subscriber profile and QoS session parameters are obtained from the NASS and RACS of the core network for NGN opertator A. When the train moves out of his own geographic service area or country, Bob keeps the voice call established and re-authentication will be performed through communication with the NASS in the network owned by NGN operator B with the NASS in the home core network owned by NGN operator A. The QoS session needs to be re-established by interaction between the RACS in the network owned by NGN operator B and the RACS in the home core network owned by NGN operator A.

6 Mobility control and management considerations for NGN

The term mobility has been used a little differently according to its specific application areas. However the general feature of the mobility aspects are described as follows.

6.1 Moving Object

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

- Terminal mobility

Mobility for those scenarios where the same terminal equipment is moving or is used at different locations. This includes the ability of a terminal to access telecommunication services from different static locations and/or while in motion, and the capability of the network to identify and locate that terminal.

- Network mobility

  Ability of a network, where a set of fixed or mobile nodes are networked to each other, to change, as a unit, the point of attachment to the corresponding network based upon the network's movement itself.

- Personal mobility

  Mobility 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

  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.

6.2 Moving Qualities

Mobility also could be classified as figure 6.1 according to service continuity.

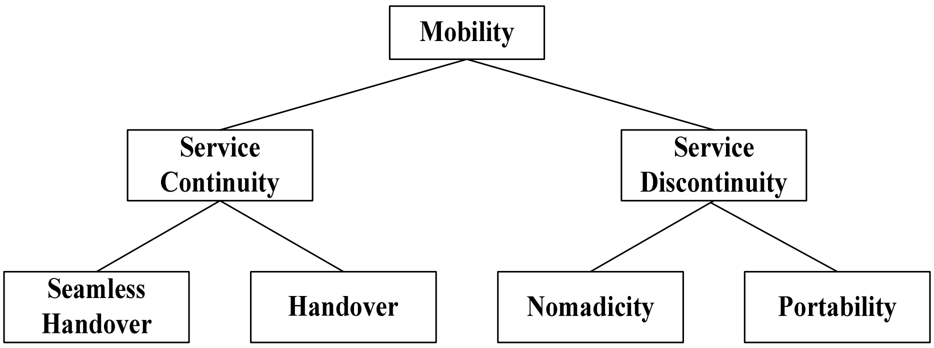

Figure 6.1: Mobility classification according to service quality

- 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 includes Handover and Seamless Handover.

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

  - Seamless Handover: It is one special case of mobility with service continuity, when it is preserved the ability to provide services preserved without any impact on their service level agreements for a moving object during and after movement.

- Service discontinuity

  aThe ability to provide services regardless of the environment changes of a moving object, but without being able to maintain ongoing service. This includes Nomadicity and Portability.

  - Nomadicity: 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 applies and that users shutdown their service session before attaching to a different access point.

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

6.3 Moving Level

Mobility could be classified according to access technologies:

- Horizontal mobility

  Movement from one position to another within the same transport level. Generally referred to as the mobility within the same access technology.

- Vertical mobility

  Movement from on position to another within the different transport levels. Generally referred to as the mobility between different access technologies.

7 Mobility Impacts on TISPAN NGN

Mobility scenarios addressed in clause 5 are classified into three types: intra-AN mobility, inter-AN mobility and inter-CN mobility. Further these mobility scenarios can be classified into the following major categories:

a) Intra-subnet:

   Movement from the old access link to the new access link within one subnet. A logical division of an access network, e.g. a physical network served by one router could be viewed as an example of subnet.

b) Inter-subnet:

   Movement between two access links belong to different subnets.

c) Intra-tech (i.e. Intra-access technology):

   Horizontal mobility as addressed in clause 6.

d) Inter-tech (i.e. Inter-access technology):

   Vertical mobility as addressed in clause 6.

e) Intra-NASS:

   Movement from the old access link to the new access link within the same NASS.

f) Inter-NASS:

   Movement from the old access link served by one NASS to the new access link served by another NASS.

g) Intra-RACS:

   Movement from the old access link to the new access link within the same RACS.

h) Inter-RACS:

   Movement from the old access link served by one RACS to the new access link served by another RACS.

Table 7.1 shows the relationship between mobility scenarios in clauses 5.1, 5.2, 5.3 and all the major categories mentioned above.

Table 7.1: Relationship between mobility scenarios and major categories

	Intra-subnet/inter-subnet	Intra-tech/Inter-tech	Intra-NASS/ Inter-Nass	Intra-RACS/ Inter-RACS
Scenario A	Both	Intra-tech	Intra-NASS	Intra-RACS
Scenario B	Both	Intra-tech	Intra-NASS	Intra-RACS
Scenario C	Inter-subnet	Intra-tech	Inter-NASS	Inter-RACS
Scenario D	Both	Inter-tech	Intra-NASS	Intra-RACS
Scenario E in clause 5.2.1	Inter-subnet	Intra-tech	Inter-NASS	Inter-RACS
Scenario F in clause 5.2.2	Inter-subnet	Inter-tech	Inter-NASS	Inter-RACS
Scenario G in clause 5.3.1	Inter-subnet	Intra-tech	Inter-NASS	Inter-RACS

7.1 Mobility Impacts on NGN Requirements (Stage 1)

As described in other subclause of clause 7, there are some identified mobility impacts on TISPAN NGN. Therefore, NGN requirements should also take mobility into account.

7.2 Mobility Impacts on NGN Architecture (Stage 2)

Depending on the NGN Architecture constitution, the present document only considers the mobility impacts on the following two subsystems of NGN Architecture:

a) Mobility Impact on NASS.

b) Mobility Impact on RACS.

7.2.1 Mobility Impacts on NASS

Mobility impacts on NASS can be classified into three aspects:

a) Mobility impacts on IP address allocation mechanism.

b) Mobility impacts on authentication and authorization mechanism.

c) Mobility impacts on location binding mechanism.

Mobility impacts on IP address allocation mechanism can be analyzed in terms of move qualities.

From the perspective of move qualities, nomadicity and handover are two typical mobility types. In the intra-subnet mobility scenario, IP address will be kept the same and there is no explicit impact on IP address allocation mechanism.

In the inter-subnet mobility scenarios, IP address will be reallocated due to subnet change. Table 7.2 is shown below.

Table 7.2: Mobility Impact on IP address allocation mechanism

		Move Qualities	
		Nomadicity	**Handover**
Intra-NASS	**Intra-subnet**	Keep the same IP address	Keep the same IP address
	Inter-subnet	IP address reallocation	IP address reallocation
Inter-NASS	**Inter-subnet**	IP address reallocation	IP address reallocation

Mobility impacts on authenticator and authorization mechanism can also be analyzed in terms of move qualities. Table 7.3 is shown below. Providing that the difference in CNG type has no explicit impact on authentication and authorization, the feature of CNG type is not reflected in table 7.3.

In the intra-subnet mobility scenario, re-authentication is not necessary unless key materials expire. Because the subnet UE moves around are under the control of the same AMF.

In the inter-subnet mobility scenario, there are two cases for consideration. In the nomadicity case, when UE moves around visited networks, if the subscriber profile is located in the home network, UE can access the home service through the UAAF in the visited network. Otherwise, the UE can not access the subscriber profile without interconnection between the adjacent visited access network.

In the handover case, the handover latency introduced by full authentication has proven to be larger than that is acceptable for real-time applications scenarios. Some optimized approaches (which are FFS) are needed to improve handover latency performance, e.g. pre-authentication and re-authentication mechanism specified in IETF working group.

For both two cases, a new AMF discovery mechanism is required to decide upon the new authenticator or the new network access point.

Table 7.3: Mobility Impact on Authentication and authorization mechanism

		Move Qualities	
		Nomadicity	**Handover**
Intra-NASS	**Intra-subnet**	Under the control of the same AMF, Re-authentication is not necessary	Under the control of the same AMF, Re-authentication is not necessary
	Inter-subnet	New AMF discovery Allow the UAAF access the home service profile from the visited network	New AMF discovery Pre-authentication/ Re-authentication
Inter-NASS	**Inter-subnet**	New AMF discovery Allow the UAAF access home service profile from the visited network	New AMF discovery Pre-authentication/ Re-authentication

Mobility impacts on location binding mechanisms can also be analyzed in terms of move qualities.

From the perspective of move qualities, nomadicity and handover are considered as two typical mobility types. In the intra-subnet mobility scenario, the difference between nomadicity and handover is that the binding between the network location information and the geographic location information should be maintained in the network side for the nomadic case; while the binding between the current location of the UE and the global identifier of the UE (e.g. NAI, IMSI) is maintained in the network side for the handover case. The current location of UE can be part of the network location information received from NACF and the global identifier UE can be received from UAAF or NACF. In the handover case, this binding information can be used to deliver the traffic from other UEs to the current location of UE.

In the inter-subnet mobility scenario, the difference between nomadicity and handover is that nomadicity requires the new binding to be re-established and the old binding will be deleted, while handover requires the same binding to be updated in the network side by the current location of UE after UE moves to the new subnet. In the handover case, if the binding fails to be updated, the traffic from the other UEs will be forwarded to the wrong place where UE has already moves out. These associations are detailed in table 7.4.

Table 7.4: Mobility Impact on Location Binding mechanism

		Move Qualities	
		Nomadicity	**Handover**
Intra-NASS	**Intra-subnet**	Maintain the binding between the network location information and geographic location	Maintain the binding between the current location and the global identifier for the UE
	Inter-subnet	Create the new binding between the network location information and the geographic location	Update the current location of UE to the same binding
Inter-NASS	**Inter-subnet**	Create the new binding between the network location information and the geographic location	Update the current location of UE to the same binding

7.2.2 Mobility Impacts on RACS

Mobility impact on dynamic session establishment procedure can be analyzed in terms of move qualities. From the perspective of move qualities, nomadicity and handover are considered as two typical mobility types. In the nomadicity scenario, the session interruption will occur. Because each time the UE moves to one new place, especially when UE may move to the new network using different access technologies or different models of the same access technology, the session needs to be re-established and the session in the old path will be terminated. This also can be called break before make mode. On the other hand, in the handover scenario, each time the UE moves to the new place, the QoS context needs to transparently transfer from the old path to the new path, the session needs to be updated or modified to keep service continuity, this also can be called make before break mode.

Table 7.5: Mobility Impact on dynamic session establishment procedure

	Moving Qualities	
	Nomadicity	**Handover**
Intra-RACS	Session interruption	Session continuity
Inter-RACS	Session interruption	Session continuity

7.2.3 Mobility Impacts on other Subsystems

Mobility impacts on other subsystems are not described.

7.3 Mobility Impacts on NGN Protocols (Stage 3)

Mobility impacts on NGN protocols are not described.

7.4 Mobility Impacts on NGN Security

Mobility impacts on NGN security are not described.

7.5 Mobility Impacts on NGN Management

Mobility impacts on NGN management are not described.

7.6 Mobility Impacts on NGN NNA

Mobility impacts on NGN NNA are not described.

7.7 Mobility Impacts on NGN CPN

Mobility impacts on NGN CPN are not described.

8 General Conclusions

The present document identifies TISPAN NGN mobility scenarios, NGN mobility features and takes TISPAN NGN mobility scenarios into consideration to analyse the impact of mobility on NGN architecture. The present document shows more optimized mechanisms and new features for TISPAN NGN are required to support these TISPAN NGN mobility scenarios.

History

Document history		
V3.1.1	September 2009	Publication