# RII based Seamless Mobility Connectivity Architecture

Mr. Amit B.Kalyani
*Assistant Professor - MCA Department*
*Murlidhar Group of Institutions*
*Rajkot, India*
e-mail: **kalyani.amit@gmail.com**

*Abstract*: **Presently users expect an easy, ubiquitous – universal – uninterrupted access to information, entertainment and communication environment. They also require more advanced data services and also expect to be connected and communicate different technologies and networks at anywhere, anytime. At present, customer demands seamless transition across different access technologies. For the mobility management there are mainly three problems: seamless roaming, security and QoS. This paper analyzes the underlying Network Architecture and the techniques that are suitable for providing easy & ubiquitous user experience. The studied Roaming Intermediary & Interoperability (RII) network architecture analyzes how to manage the network. RII is the global architecture designed to support convergence between any two networks, including public and private networks, and to support different AAA mechanism. This paper also analyzes the challenges and how to provide solution to make real life of seamless mobility.**

***Keywords: RII, Vertical Handover, heterogeneous networks architecture, vertical handoffs, horizontal handoffs, ubiquitous***

## I. INTRODUCTION

A real world interworking architecture can cover a large number of network configurations and possible circumstances.

To manage and offer solutions for seamless mobility, there are mainly two characteristics: inter system mobility management by **vertical handover and network control**.

Mobility is one important issue in heterogeneous networks. When a mobile user is switch from one network to another network or base station to another base station is known as **"Handover".** Handover is used to redirect the mobile user service from current network to a new one. To select suitable network and make seamless handover, handoff/handover processing delay must be as small as possible.

When the mobile users (terminal) –MT moves from one network to another network with the same technology (i.e. for e.g., WiMAX to WiMAX) then this process is known as Horizontal HandOff/HandOver (HHO) **[The term handoff and handover interchangeably used.].** This process occurs in horizontal i.e. intra system based network scenario. HHO is the process of transferring an MT from one base station (BS) or access point (AP) or channel to another within the same radio access technology.

When the mobile users (terminal)-MT moves from one network to another network with the

different technology (i.e. for e.g., WiMAX to WiFi) then this process is known as **Vertical HandOff/HandOver (VHO).** That means two access nodes of two different technologies. This process occurs in vertical i.e. inter-system technology based network scenarios.

How users can overcome some obstacles and improve the performance of Vertical Handovers with the use of their smart mobile terminals is the main role of inter system mobility management. A terminal-controlled handover management is built on the top of a new utility-based access

network selection. To control the handover initiation, handover preparation and also control its radio interfaces, a terminal is required which optimize the power consumption and ensure seamless services. A handover prediction scheme is used to assist the handover preparation at the application level by the terminal itself.

In the second aspect, the role of network control in the inter-system mobility management. In the converged network trend, the complementary characteristics of different access technologies promote their interworking. The resources of the interworked networks can be viewed as a shared resource pool. Balancing the traffic load across the integrated networks is both a motivation and a challenge. An efficient load balancing will lead to best utilization of the pooled resources and thereby to improve the user satisfaction level. In fact, the load balancing is related to the mobility management since it involves the users' network selection and the network-controlled vertical handover enforcement. The inter-system handover is a process involving the management of network entities and end-user terminals.

## II. CHALLENGES AND SOLUTIONS

The challenge in managing the Wireless Networks concludes to how securely we can address the mobility management without compromising the QoS to provide the Seamless Roaming.

There is a need to examine the interworking and roaming solution across independent access networks using intermediary entities using the RII components. The study explain and conclude that Roaming Intermediary & Interoperability (RII) platform designed to support convergence of different access technologies that would address the seamless mobility problem by providing secure mobility management with the desired QoS.

A Roaming Interworking Intermediary (RII) platform also supports all combinations of different radio technologies in a multi operator environment to design it. The RII will support secured roaming and seamless mobility across different independent access networks. For the seamless mobility, how different approaches like user control, Network control aspects, tight and loose coupling interworking approaches works as below:

## III. USER CONTROL AND NETWORK CONTROL ASPECT INTERWORKING APPROACH

The access networks should be integrated to support the seamless handover from one technology to another. To address the different facets of the inter-system mobility management for seamless roaming, the interworking architecture between heterogeneous access technologies must be defined.

To support seamless handover, the mobile device should be able to perform the inter-system measurement without affecting the on-going communications and complete the handover decision before moving out of the serving cell coverage. The latter requires a sufficient overlap area between adjacent cells. If the overlap area is unnecessarily large, it increases the operators' building cost. If the cell overlap area is too small, the network's connection loss ratio is increased because mobile terminals at the edge of a cell cannot receive support from neighboring cells in time to prepare the handover. In the vision of open access networks where users can connect to any available access network of any operator, a more flexible and open solution is required to interwork the networks to offer real global interworking and roaming facilities.

In User control aspect, we look forward to address the seamless handover management from the terminal perspective and investigate the role of the user in the mobility management. This will show how users with their smart terminals can overcome some obstacles in the vertical handover management and how the performance can be proved under the user-centric terminal controlled approach.

In User controlled aspect, three important points need to be considered:

1. **Utility-based Access Network Selection-** where in we review the existing utility models including the single-criterion utility form and aggregate utility form used in access network selection and resource management problems. We propose to build up the utility theory and propose new single-criterion and multi-criteria utility forms to best capture user satisfaction and sensitivity in varying access network characteristics.

2. **Terminal-controlled Mobility Management Framework** – where in we look forward a terminal-controlled mobility management framework. The solution is devoted to mobile devices equipped with multiple radio interfaces. The proposed mobility management consists of a policy-based power-saving interface management coupled with a user-centric network selection solution, an adaptive handover initiation algorithm and a handover execution. It gives a complete solution from the architecture design to handover signaling exchanges and seamless optimization techniques.

3. **Handover Prediction-Assisted Seamless Media Streaming-** Where in we look forward to address seamless media streaming during horizontal and vertical handovers in heterogeneous access technologies. The solution is based on the terminal-controlled pre-buffering adjustment policy, running at the terminal side to maintain the appropriate amount of media content in the buffer. A practical handover prediction scheme is proposed to assist the right pre-buffering boosting decision.

In Network controlled aspect, we look forward to address the seamless handover from the network perspective and highlight the crucial role of network control in the inter-system mobility management. We look to investigate how the network can assist and improve handover measurement, handover preparation, traffic load balancing, and security management.

In Network controlled aspect, three important points need to be considered:

1. **Interworking Architecture-** for facilitating interworking and roaming in Multi-operator Environment.
2. **Inter-system Measurement and Required Cell Overlap-** We should analyze the minimum cell overlap required to support seamless handovers between two adjacent cells within the same technology or different technologies.
3. **Load Balancing over Wireless Packet Networks -** define a new load metric and a new balancing objective which makes it possible to reconsider the load balancing problem as a classic optimization problem.

## IV. INTERWORKING APPROACHES FOR ARCHITECTURING SEAMLESS MOBILITY PROBLEM

The interworking between different technologies, mainly between LTE, UMTS, GSM and WLAN, has caught the attention of the research community and standardization bodies in the last few years. Broadly, the interworking can be classified into two approaches: loose coupling and tight coupling. From a macro point of view the main difference is how and where a non-3GPP access network is coupled to the 3GPP/3GPP2 network. The distinction between tight-coupling and loose-coupling is based on the integration point of two networks involved as illustrated below:

**Loose and Tight Coupling Architectures:**

In below Figure 1 show, 3GPP -WLAN coupling interworking architecture:

 

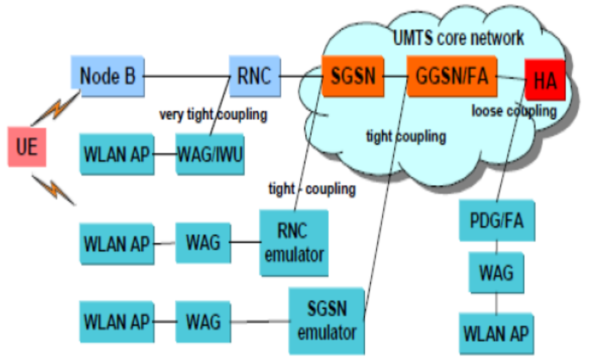


**Fig.1 Loose coupling, Tight coupling, Very tight coupling interworking architecture**

Loose coupling offers a common interface for the exchange of information between the networks to guarantee service continuity. The core networks are connected together with two different access networks. Loose coupling refers to the IP layer interconnection. WLAN and UMTS are assumed to be in different IP address domains. The IP address is changed when the mobile terminal moves from one network to another. Mobile Internet Protocol (MIP) managed and hides the heterogeneity of different access networks. The integration point is the Home Agent (HA) of the MIP mechanism implemented in the Internet/external Packet Data Network (PDN). In general, the interworking point is placed after Gateway GPRS Support Node (GGSN).

The key of mobility management of this architecture is the MIP. The Foreign Agent (FA)s are located in the GGSN and the PDG while the HA is located in the PDN/Internet. When the mobile user moves across the networks, its home address is maintained. The major drawbacks are the handover latency and the packet loss due to MIP mechanism. In order to remedy this problem, pre-registration, pre-authentication, packet buffering and forwarding techniques have been studied. Many extensions of MIP have been proposed such as: Fast MIP, Hierarchical MIP, multiple Care of Address (CoA) registration MIP, layer-2 triggering based MIP, etc. The loose coupling interworking architecture offers an easy and independent deployment. The Loose-coupling interworking does not need drastic changes in existing infrastructures. There exists a variant of the loose coupling interworking that is sometimes referred to as an open coupling. In the latter scheme, no real integration between the two networks is present. WLAN and 3GPP are two independent systems that share a single billing scheme.

The non-3GPP access network is working as a new radio access technology with in the cellular technology in tight coupling scheme. The tight coupling makes two different Radio Access Technology (RAT)s working together with a single core network. The interworking point is at the 3GPP core network or at the UMTS Terrestrial Radio Access Network (UTRAN) as illustrated in Figure above. When the integration point locates in the UTRAN, the interworking is known as a very tight coupling. The 3GPP control protocols are reused in the WLAN and the data traffic is routed via the 3GPP core network to the outer entities. Two radio access networks are interconnected via layer 2. All the layer 3 protocols remain unchanged. The handover does not involve the change of remote IP address as well as the AAA policies. In the interworking reference model architecture depicted in Figure above, the Radio Network Controller (RNC)/Serving GPRS Support Node (SGSN) emulator provides functionalities that are equivalent to those of an RNC/SGSN in an attempt to hide WLAN access network particularities from the UMTS. To provide a standard interface to the UMTS core network is the main functionality of it.

In the very tight-coupling solution, the WLAN is considered as part of the UTRAN. An important issue with the very tight-coupling scheme is the ownership of the WLAN. The most envisioned solution is that the 3GPP operator owns the WLAN part. Due to the scalability issue, it makes sense to introduce an Interworking Unit (IWU) between the WLAN Access Point (AP) s and the RNC to share the control task of the RNC. The IWU will be implemented in the WLAN AP to either act as a pure traffic concentrator or be further responsible for control and supervision functionality.

## V. RII FRAMEWORK SOLUTION

To support different interworking/roaming scenarios three kinds of RII: local RII, core RII and global RII are necessary:

**Local RII** is a control agent and a signaling gateway of a non-3GPP access system in the interworking/roaming architecture. The local RII can be implemented as a separate entity or integrated with an access gateway (e.g., ASN GW or WAC).

**Core RII** is located in the 3GPP core network and served as a control agent and a signalling gateway between 3GPP and non-3GPP systems. The core RII performs as a local RII in respect of the global RII and as a global RII for different local RIIs under its control.

**Global RII** is an intermediary for interconnecting access networks of different independent operators. It is an independent entity located outside the 3GPP core network and can be deployed by a Mobile Virtual Network Operator (MVNO). The global RII is a higher-tier RII that interconnects different core RIIs and local RIIs.

This architecture takes into account the different contractual relationships between operators while designing the interworking & roaming among different access systems.

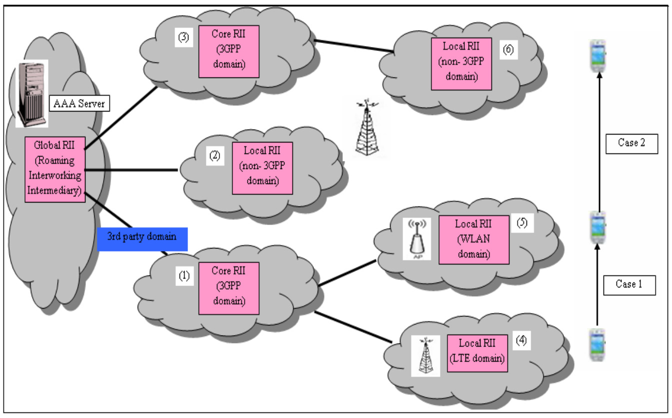


**Fig.2 RII mobility management architecture**

An example of hierarchical RII-based mobility management is represented in above Figure 2. If the handover occurs between two indirectly interconnected access networks, handover signals will go through intermediaries. For example, if the handover occurs between access network (4) and (5) (case 1), the core RII (1) will play the role of a mediator. If the handover occurs between two access systems that have no direct roaming agreement, case 2 in above Figure for instance, the handover is achieved with help of the global RII.

## VI. RII COMPONENTS AND INTERATIONS

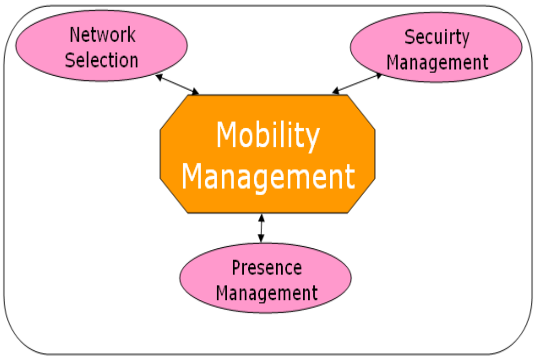


**Fig.3 Generic RII Component Interactions**

The RII consists of four different components: Mobility Management (MM), Security Management (SM), Network Selection (NS) and Presence Management (PM). Within an RII entity, the MM is a centralized component that interworks with three other components as illustrated in the above Figure 3.

In the global interworking and roaming architecture, the coordination between two interconnected RIIs is shown in below Figure 4:

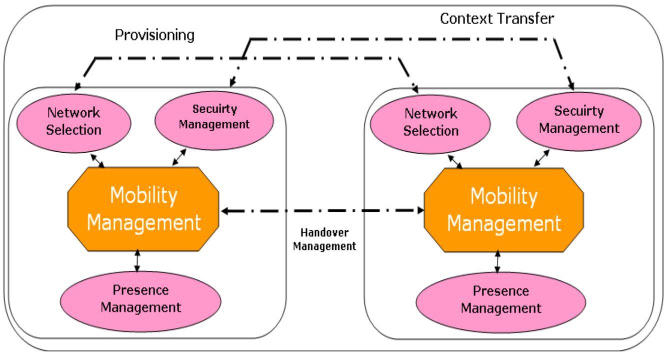


**Fig.4 Information flows between two RIIs**

We can distinguish three kinds of information exchanged between RIIs: provisioning information between the NS components, security context between the SM components and all information related to handover and roaming between MM components. The details of such coordination will be presented through the handover procedure. The functionalities of these four components are:

**Mobility Management:** The MM is responsible for preparing the handover by triggering the network selection (i.e., interaction between the MM and the NS), routing the handover preparation request based on the information from the PM component, checking the QoS support in candidate target access networks and assigning the connection setup information for an imminent handover terminal. It makes the handover decision and notifies the handover to the data plane anchor for handover execution preparation. The security context transfer between two involved systems is triggered by the MM (i.e., interaction between the MM and the SM). Once the handover is complete, the MM initiates the presence update (i.e., interaction between the MM and the PM) and the resource release in the old access network.

The mobility within each access network is managed by its own mobility solution. The intersystem mobility is managed by MIP-based global mobility protocols. The MM in a local RII acts as an FA or a Proxy MIP client whereas the MM in a global RII can implement a HA for its own subscribers. There is no need to implement the FA/HA in the MM component if it has been already deployed in another entity within the same administrative domain. In addition to above functionalities, the MM of a global RII contains the operator database which stores the information like policy, SLA, accounting of the operators that connect to it.

**Security Management:** The SM is responsible for handling authentication, authorization and billing issues for roaming users. In addition, the SM can manage and communicate the user's security context (authentication identity, user identity, certificates, authorization and encryption keys) for the roaming and inter-system handover preparation. It is in charge of authenticating and authorizing users based on subscriber profiles retrieved from the Home Subscriber Server (HSS) or from the security context transferred by the users' serving/home network. The SM in a core RII and in a local/global RII having its own subscribers acts as an AAA server. The SM in a global RII plays the role of a mediator for the roaming contract establishment and for the mobility context transfer to optimize the handover latency caused by the re-authentication procedure.

**Network Selection:** The NS provides the provisioning information to serving users. Once the MM receives a list of candidate target networks from the UE during the handover preparation, the MM communicates with the NS to eliminate undesirable access networks.

**Presence Management:** The PM stores and manages the presence information of users which describes how to reach them. The presence information specifies the serving access network, the serving RII and the location of users. Whenever a user roams to a different access network, at the end of the handover procedure, the user's presence information is updated in the RIIs involved. The paging mechanism is included in the PM to wake up standby users. The PM may also provide functionalities of a presence server.

## VII. INTER SYSTEM HANDOVER PROCEDURE IN THE CONTEXT RII

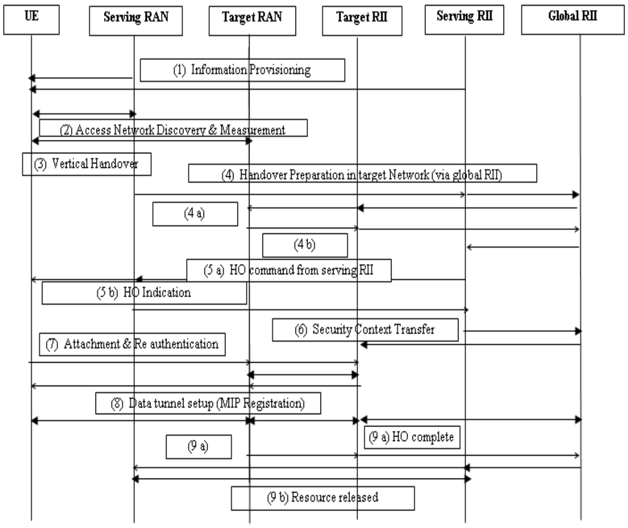


**Fig.5 Handover Inter system procedure**

**Step 1:** During the communication, the serving RAN sends the provisioning information to the UE to indicate the radio information of available neighboring cells. Such information helps the UE to synchronize with the neighboring cells and to monitor their signal strength. The NS component of the serving/home RII can provide the UE the information such as preferable or undesirable access networks and charging information of access networks for the UE's access network selection.

**Step 2:** The UE selects preferred available access networks for the measurement purpose. The UE measures their link quality and send the measurement report to the network either periodically or event-based. The UE can also perform the scanning to discover new available access networks.

**Step 3:** The handover can be initiated by the terminal or the network. An inter-system handover is triggered when i) the coverage of the same access system is not available, ii) the current system is heavily loaded or iii) the current system cannot satisfy user preferences or application requirements.

**Step 4:** Once the vertical handover is initiated, the serving RAN will perform the handover preparation: checking whether the candidate target access network can support the imminent handover and performing the resource reservation in advance. The HO preparation request (message 4a) including potential target identities (ID) and the required QoS is sent to the serving RII which performs a network selection to eliminate undesired IDs. The request is then routed to the indicated target IDs via the global RII if needed. If the target RAN can allocate successfully the resource, the target RII will return a HO support (message 4b) to the serving RII. This message includes connection setup information.

**Step 5:** The serving RII sends the UE a HO command (message 5a) including the recommended target IDs associated with their corresponding connection setup information. The serving RII may select one target cell, and send a strict HO command including only one selected target cell to the UE. If the UE receives a list of recommended IDs, it will select a suitable one and send a handover indication (message 5b) to notify its choice to serving RII for the handover execution preparation. Upon receiving the indication from the UE or after sending the strict handover command, the serving RII will send a HO notification to the user plane anchor point (e.g., SAE Anchor or HA) for the traffic redirection. Some techniques to minimize packet loss such as bi-casting and buffering can be used.

**Step 6:** The serving RII sends the user's security context to the target RII to support the fast re-authentication. By transferring old security context from the serving network to the target network and reusing it with necessary adaptation, in this way a full security context creation is avoided. It reduces the handover latency which is significant in a roaming scenario between independent operators.

**Step 7:** The UE performs attachment and re-authentication with the target access system. Based on the security context information, the target RII authenticates the UE without need to communicate with its home network.

**Step 8:** Once the connection to the target RAN is successfully achieved, the UE sends the MIP registration to the HA to update the data plane path. The data tunnel is established to route the packets to the UE.

**Step 9:** After the handover completion is notified (message 9a), resources in the old access network will be released (message 9b) and the presence information will be updated in the RIIs involved.

## VIII. CONCLUSION

A mobility management, security and QoS are the most important in heterogeneous access technologies to enhanced seamless mobility. This paper analyzes a Roaming Intermediary & Interoperability (RII) architecture approach for authentication across heterogeneous access technologies, for intelligent preferred-network selection, global presence, context management, mobility management and handover of telephony and data sessions between different access technologies such as Wi-Fi, GSM, WiMAX, LTE etc. The Roaming Intermediary & Interoperability (RII) platform is the global architecture designed to support convergence between any two networks, including public and private networks, and to support different AAA mechanism. The network of RII platforms and the potential distribution of RII platforms can support all combinations of different radio technologies. This would help in attaining seamless mobility.

## IX. REFERENCES

[1] 3GPP, "3GPP System Architecture Evolution: report on technical options and Conclusions,"

[2] J. Korhonen, Introduction to 3GMobile Communications. Norwood, MA, USA: Artech House, Inc., 2003.

[3] Q. Wang and M. Abu-Rgheff, "A multi-layer mobility management architecture using crosslayer signalling interactions," in Proc. of the 5th European Personal Mobile CommunicationsConference, 2003, pp. 237–241.

 

[4] H. J. Wang, R. H. Katz, and J. Giese, "Policy-enabled handoffs across heterogeneous wireless networks," in IEEE Workshop on Mobile Computing Systems and Applications '99, Louisiana.

[5] Thesis on Mobility management and seamless Mobility in heterogeneous networks by Quoc-Thinh Nguyen-Vuong

[6] S. Dixit, "Wireless IP and Its Challenges for the Heterogeneous Environment," Wireless Personal Communication