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Technical Report

3rd Generation Partnership Project;
Technical Specification Group Services and System Aspects;
Feasibility Study of Mobility between 3GPP-WLAN Interworking and 3GPP Systems
(Release 8)

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

Keywords

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

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3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

This TR studies and defines the appropriate solutions for supporting mobility and roaming between 3GPP-WLAN Interworking system and 3GPP Systems so that ongoing 3GPP PS based services can be maintained with minimal impact on the end-user's perceived quality on the services at a change of the access network (between I-WLAN and 3GPP Access Systems). The solutions should impose minimum changes to the 3GPP PS core network and the terminals as well as the WLAN access.

Within the TR, different mechanisms are described along with their characteristics. A comparison of the pros and cons of the different mechanisms is included.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 22. 234: Requirements on 3GPP system to Wireless Local Area Network (WLAN) interworking; Stage 1

[2] 3GPP TS 23. 234: 3GPP system to Wireless Local Area Network (WLAN) interworking; System description; Stage 2

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions given in TS 21.905 and the following apply.

3GPP - WLAN Interworking: Used generically to refer to interworking between the 3GPP system and the WLAN family of standards**.** Annex B includes examples of WLAN Radio Network Technologies.

External IP Network/External Packet Data Network: An IP or Packet Data network with access provided by the 3GPP – WLAN Interworking, rather than directly from the WLAN AN.

Home WLAN: A WLAN which interworks with the HPLMN without using a VPLMN.

Interworking WLAN (I-WLAN): A WLAN that interworks with a 3GPP system.

Offline charging: Mechanism for collecting and forwarding charging information concerning I- WLAN and core network resource usage without affecting the service rendered in real-time.

Online charging: Mechanism for collecting and forwarding charging information concerning I- WLAN and core network resource usage where the service may be affected in real-time.

PS based services: General term to refer to the services provided by a PLMN using the IP bearer capability between a WLAN UEs and the PLMN when WLAN 3GPP IP Access is used. Examples include bearer services such as Internet access, and Corporate IP network access and higher level services such as SMS and LCS.

3.2 Symbols

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

D'	Reference point between a pre-R6 HSS/HLR and a 3GPP AAA Server
Dw	Reference point between a 3GPP AAA Server and an SLF
Gn'	Reference point between GGSN and TTG'.
Gr'	Reference point between a pre-R6 HSS/HLR and a 3GPP AAA Server
Wa	Reference point between a WLAN Access Network and a 3GPP AAA Server/Proxy (charging and control signalling)
Wf	Reference point between an Offline Charging System and a 3GPP AAA Server/Proxy
Wg	Reference point between a 3GPP AAA Server/Proxy and WAG
Wi	Reference point between a Packet Data Gateway and an external IP Network
Wm	Reference point between a Packet Data Gateway and a 3GPP AAA Server or 3GPP AAA proxy
Wn	Reference point between a WLAN Access Network and a WLAN Access Gateway
Wp	Reference point between a WLAN Access Gateway and a Packet Data Gateway
Wo	Reference point between a 3GPP AAA Server and an OCS
Wu	Reference point between a WLAN UE and a Packet Data Gateway
Ww	Reference point between a WLAN UE and a WLAN Access Network
Wx	Reference point between an HSS and a 3GPP AAA Server
Wy	Reference point between a PDG and an OCS
Wz	Reference point between a PDG and an Offline Charging System

3.3 Abbreviations

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

AAA	Authentication, Authorisation and Accounting
AKA	Authentication and Key Agreement
AP	Access Point
APN	Access Point Name
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
EAP	Extensible Authentication Protocol
GGSN	Gateway GPRS Support Node
GTP	GPRS Tunnelling Protocol
HLR	Home Location Register
HPLMN	Home PLMN
HSS	Home Subscriber Server
IP	Internet Protocol
I-WLAN	Interworking WLAN
OCS	Online Charging System
PDG	Packet Data Gateway
PLMN	Public Land Mobile Network
SAE	System Architecture Evolution
SIM	Subscriber Identity Module
TTG	Tunnel Termination Gateway
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
USIM	UMTS SIM
VPLMN	Visited PLMN
WAG	WLAN Access Gateway
WLAN	Wireless Local Area Network
WLAN UE	WLAN User Equipment

4 Requirements

Editor's note: this section describes the general requirements and the requirements on architectures, service and functions, etc.

4.1 General Requirements

- The mobility solution shall allow operators to support 3GPP services and Internet access.
- The solution should allow for easy introduction of the mobility mechanism with minimized complexity and cost on both terminals and the 3GPP Access systems.
- The solution shall support service continuity between 3GPP packet switched network and I-WLAN network.

4.2 Architecture Requirements

- The solution shall have minimum impact on the pre-Release 8 UE's and 3GPP PS and the I-WLAN systems.
- The I-WLAN architecture as defined in TS23.234 shall be used as the base line architecture for defining the solutions and possible enhancement.
- The solution shall consider an architecture that is independent of IP versions, i.e. it shall support both IPv4 and IPv6.
- Multiple simultaneous sessions established for a given user shall be maintained.
- Simultaneous 3GPP and I-WLAN access should be supported.

4.3 Mobility Requirements

- The solution shall support the change of access by the UE's between 3GPP PS system and the IWLAN while maintaining the service sessions without the need for changing the IP address(es).
- The solution should minimize the interruption to the operators' services or applications being provided to the end user.
- The solution shall be possible for users to be aware of the change of the access networks, 3GPP PS system or I-WLAN.
- In conditions where dual connections are available, the solution should be possible for operators to control the handover without compromising the mobility performance and the complexity on the system and the terminals.
- The solution shall be possible to disable the mobility function where applicable to the operators' needs.
- The solutions should be optimized in terms of transmission efficiency and control complexity.

4.4 Roaming Requirements

- The solution shall be possible to support the change of accesses between 3GPP PS system and the I-WLAN by terminals in a visited PLMN.
- The solution shall allow operators to re-use existing roaming interface(s) and protocol(s).

4.5 Charging Requirements

- The solution shall be possible for operators to re-use existing charging policies and mechanisms (Policy and Charging Enforcement Function (PCEF) based on TS 23.203).
- The solution shall be possible to make distinctions on the charging policies based on the current access by the terminals.
- The solution shall allow operators to use common charging control and policy rules for 3GPP PS system and the I-WLAN access.
- Charging information shall continue to be collected irrespective of whether the UE is attached to the 3GPP packet switched network or the I-WLAN network.

4.6 Security Requirements

- The solution shall not compromise any existing security measures taken by the end users and the operators.
- The solution shall be possible for operators to apply common access control based on TS33.234 regardless of the change of the accesses by the terminals.
- The solution shall allow operators to apply legal interception without impacting the user's preferred change of the accesses.

5 Evaluation Criteria

Editor's note: this section describes considerations for comoparing different solutions.

6 Solutions and Comparisons

6.1 The baseline architecture

The key considerations for defining the baseline architecture include:

- Re-use the Pre-SAE 3GPP PS system architecture and the I-WLAN architecture.
- Supporting and re-use the existing interfaces and protocols where possible.
- Supporting existing 3GPP PS services such as IMS, etc.
- Supporting roaming with I-WLAN in VPLMN.

Figure 6.1.1 shows the baseline architecture that shows the access to 3GPP PS Services (e.g. IMS) and PDN's via 3GPP PS systems and/or I-WLAN for UE's at home network.

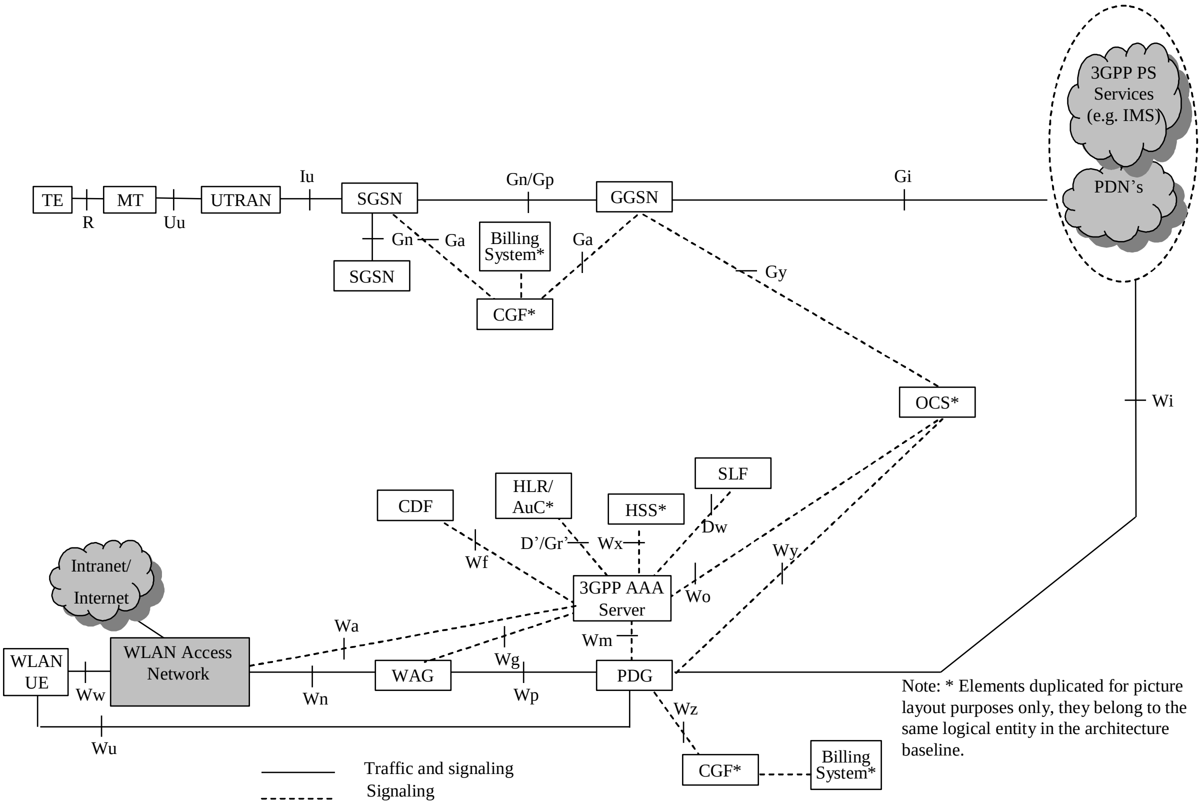

Figure 6.1.1. The baseline non-roaming architecture for defining mobility between 3GPP PS system and I-WLAN.

6.2 The Solutions

6.2.1 Alternative A

6.2.1.1 The Architecture

Figure 6.2.1 shows the architecture for the non-roaming case. There is a Gn interface between the SGSN and the TTG' element. Between the TTG' and the GGSN, there is again a Gn interface. The sessions for users who are subscribed to I-WLAN mobility service are anchored at the TTG'. UE traffic flows from the SGSN to the TTG' and then to the GGSN. The existing Gn interface between the SGSN and the GGSN may also be used at the same time, for e.g., for non-IWLAN subscribers.

Note that the Gn interface between the SGSN to the GGSN is shown only for informative purpose. It has no impact on the solution for IWLAN Mobility.

Note that the interface related to charging systems is not shown in the figures.

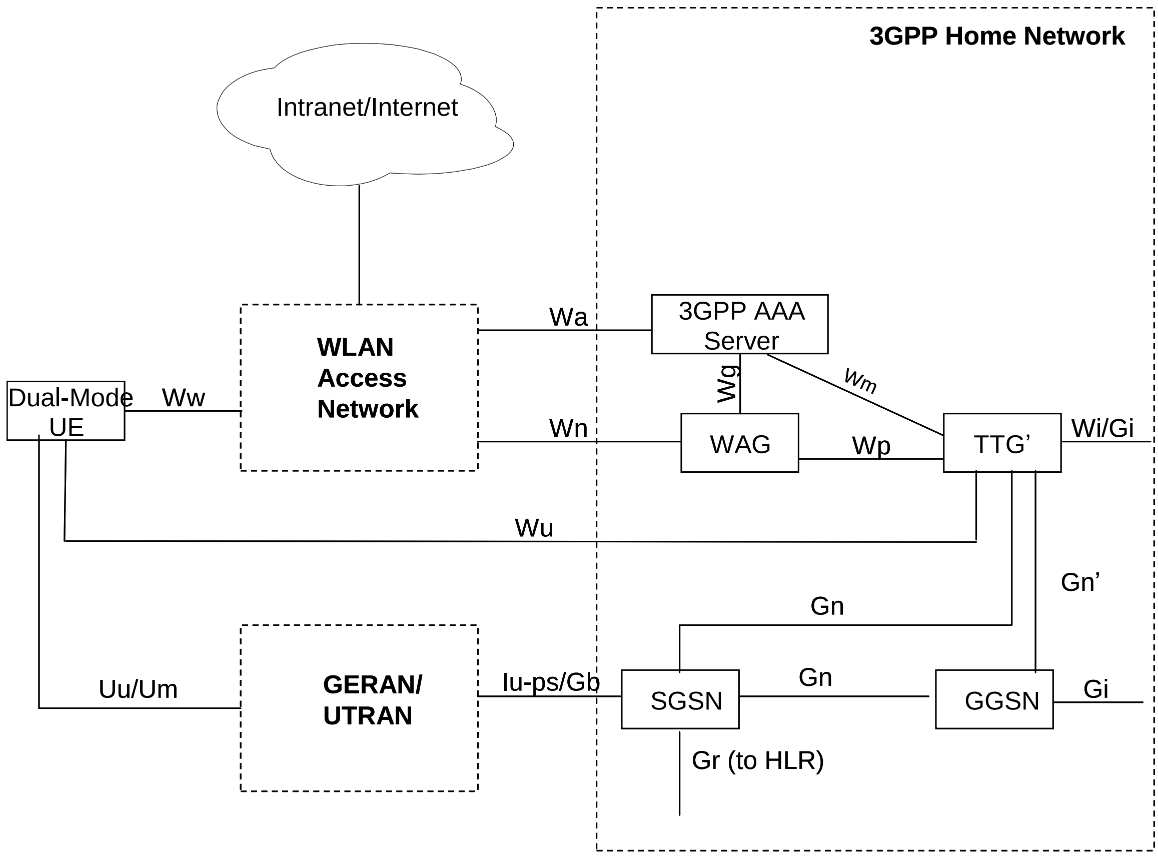

Figure 6.2.1 : Non-Roaming Architecture for I-WLAN Mobility

Figure 6.2.2 shows the architecture for the roaming case, with a Gp interface between the SGSN in the VPLMN and the TTG' in the HMPLMN. Between the TTG' and the GGSN, there is a Gn interface. The sessions for users who are subscribed to I-WLAN mobility service are anchored at the TTG'. UE traffic flows from the SGSN to the TTG' and then to the GGSN. The existing Gp interface between the SGSN and the GGSN may also be used at the same time, for e.g., for non-IWLAN subscribers.

Note that the Gp interface between the SGSN to the GGSN is shown only for informative purpose. It has no impact on the solution for IWLAN Mobility.

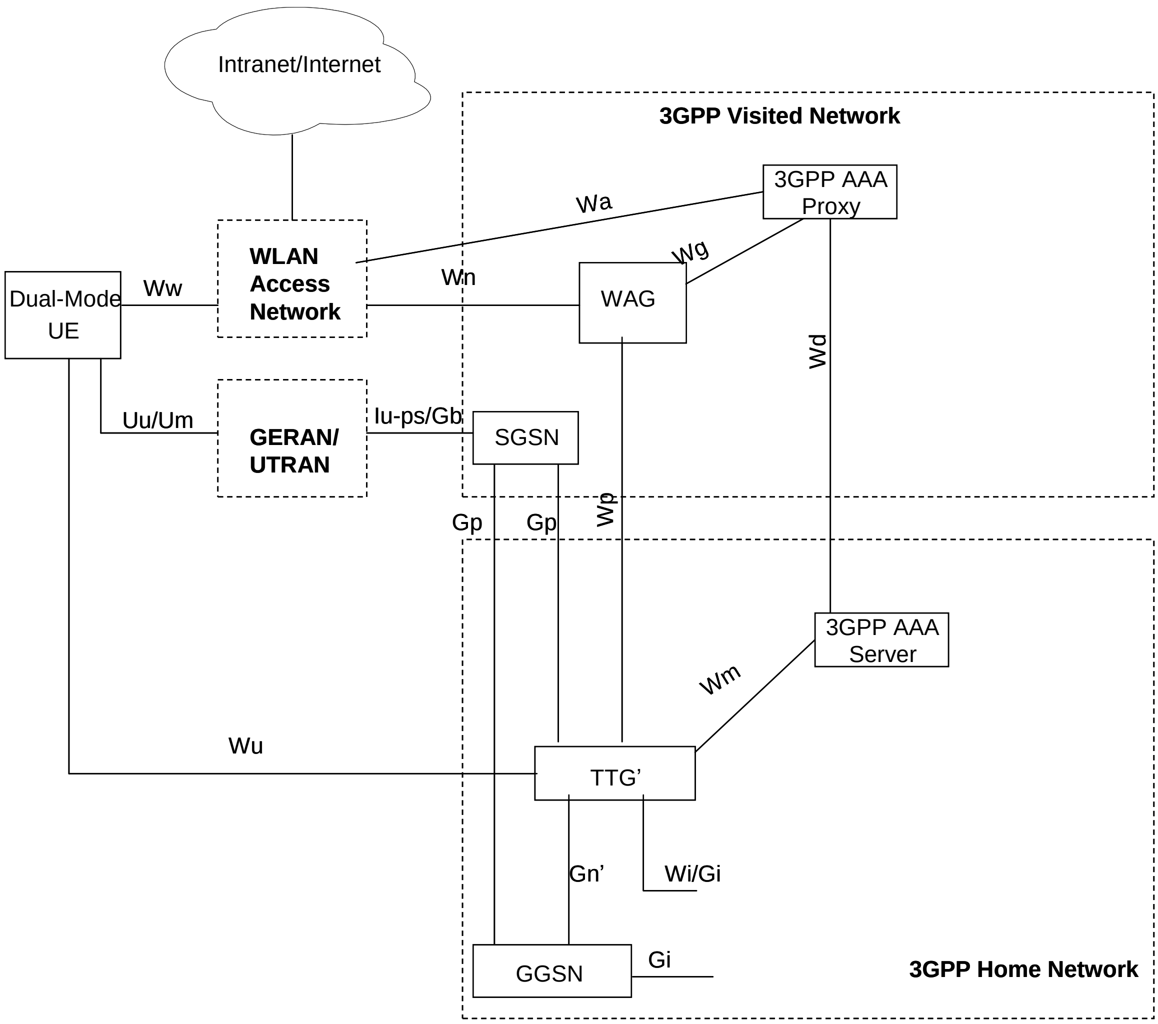

Figure 6.2.2 : Roaming Architecture for I-WLAN Mobility

In the proposed architecture, the following are the main changes done to enable I-WLAN mobility.

- TTG’: The TTG’ network element includes the functionalities and the interfaces as defined in TS 23.234. As a TTG, this node already has the Gn’ interface toward GGSN and a GTP stack. Additional support of Gn/Gp interface toward SGSN is needed to support 3GPP-WLAN session/service continuity using this architecture. Note that this reference point is already applicable to the PDG since the PDG is defined as a combination of TTG and GGSN in TS 23.234.

  Figure 6.2.3 shows an implementation option for PDG from 23.234. It shows all the interfaces supported on the PDG. Figure 6.2.4 shows a modified version of this by adding a Gn/Gp interface towards the SGSN. T

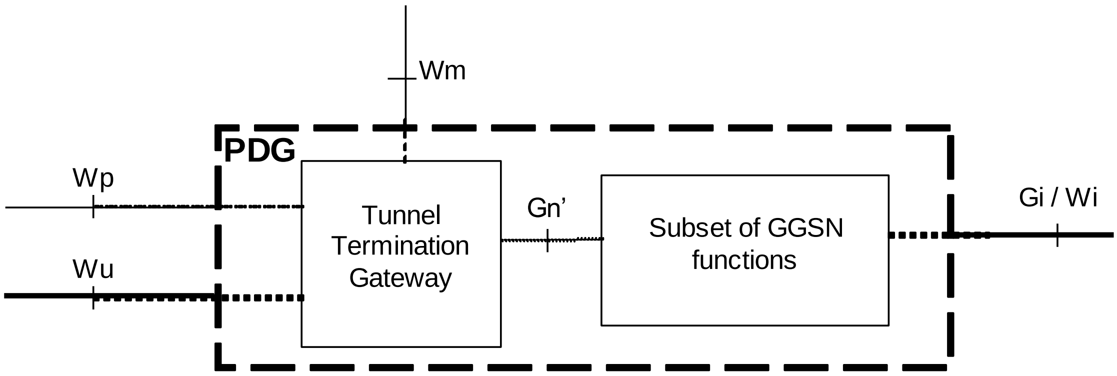

Figure 6.2.3 : PDG implementation re-using GGSN functionality (from 23.234)

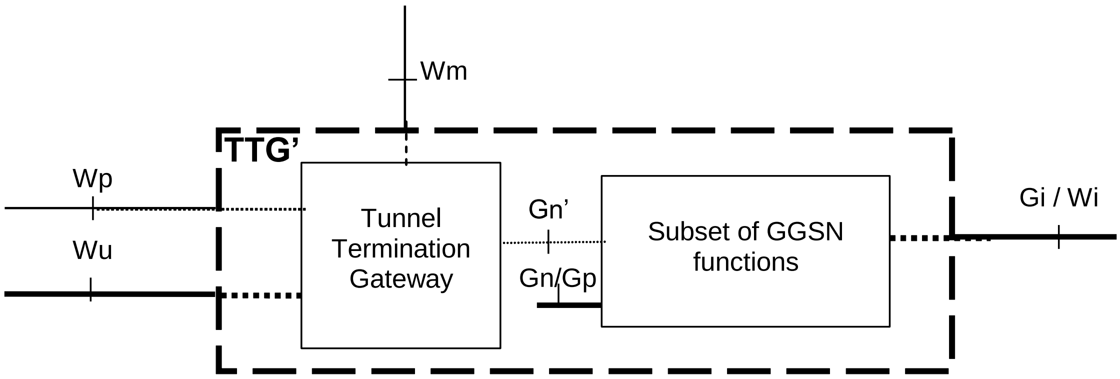

Figure 6.2.4 : TTG' implementation re-using GGSN functionality

Note that the DNS needs to be updated so that the TTG/PDG will be selected as a result of APN selection/DNS resolution as a GGSN address.

- HSS: The subscribed APN list needs to be modified to include the newly assigned APN for the 3GPP-WLAN subscribers.

No other existing network element is modified.

With this architecture, the TTG' becomes the anchor point and the IP Point of Connectivity.

Editor's Note: The UE impacts due to the requirement on the UE to support the use of same IP address on the interface associated with 2G/3G radios and the IPSec tunnel interface are FFS.

Editor's Note: The architecture described in this solution needs to be evaluated against the requirements. This is FFS.

Editor's Note: The architecture described above requires the TTG' selected by the UE while on IWLAN access to be the same as the TTG' selected by the SGSN. The means to deliver such functionality is FFS.

6.2.1.2 3G Access System to I-WLAN handover (Wi Services)

This section shows the call flows for a handover from 3GPP access system to I-WLAN with the services hosted on the TTG' via the Wi interface. The handset is assumed to comply with the existing specifications for 3GPP-WLAN interworking. 6.2.5 shows the overview call flow of the handover. Note that all the detailed message flows are not shown here for brevity.

1. The user is in pre-SAE 3GPP system coverage and requests the PDN or Operator IP service by sending 'Activate PDP context request' to SGSN. For the users that are subscribed to WLAN use, another APN will be provided for the same service. For example, if the normal APN is service1.operator.com, then the users with WLAN access will be provided with the APN w.service1.operator.com for the same service.

2. The TTG' is resolved as a GGSN, and the SGSN creates the PDP context toward the TTG'. The TTG' acts as a GGSN here and assigns the IP address of the user. The TTG' is selected at the SGSN by standard GPRS APN selection/DNS resolution. The operator's DNS entry needs to be modified so that the WLAN-converged subscribers will be routed to TTG'. In this procedure, the SGSN will authenticate/authorize the user with the APN, and if the subscriber profile in HSS contains the APN (i.e. w.service1.operator.com), then it proves that the user is allowed to access WLAN and the call will be routed to the TTG'. From the TTG' point of view, the fact that the create_PDP_context_request was provided from the SGSN means that the user is a valid WLAN subscriber.

3. The SGSN sends the response to the client with the assigned IP address, after it receives the 'create_PDP_context_ack' from the TTG'.

4. From SGSN point of view, the TTG' acts as normal GGSN and the GTP tunnel has been set up between SGSN and the TTG'. The TTG' provides the Wi interface towards PDN.

5. User is associated with WLAN.

6. The 3GPP-WLAN tunnel setup procedure starts by exchanging IKE_SA_INIT between the client and the TTG'. The TTG' is operating as specified in TS 23.234 and TS 33.234, and terminates the IKE and IPSec exchanges.

7. To authenticate and authorize the tunnel, the EAP-SIM/EAP-AKA procedure is performed inside the IKEv2 per TS 33.234. This authentication involves the client, TTG', AAA server, and HLR/HSS. Note that the TTG' assigns the **same IP address** that was used for GPRS session to the WLAN session. This is possible since the TTG' already has the knowledge of the user session through.

8. Now the traffic is switched by the TTG' from GPRS to the WLAN. The IPsec tunnel has been established between the client and the TTG' and the TTG' will route the traffic to PDN using the same Wi interface. Note that the TTG' works as the IP point of connectivity. It switches the traffic between the pre-SAE 3GPP system and the WLAN.

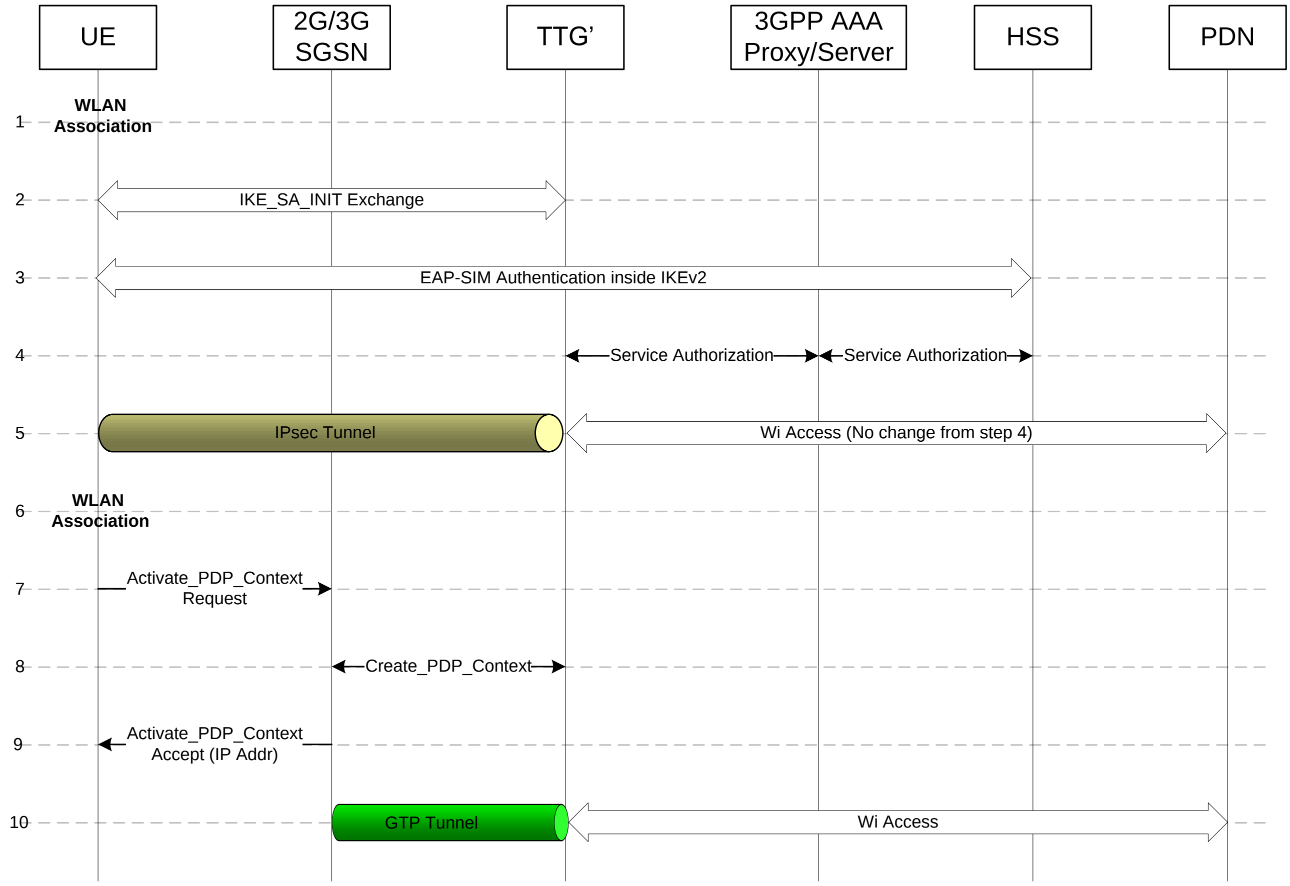

Figure 6.2.5 Handover from pre-SAE 3GPP to I-WLAN (Wi services)

Note that there are no extra messages needed during the 3GPP WLAN tunnel setup and the session is continued seamlessly as TTG' is acting as an anchor point. The TTG' manages the IP address, hence assigns the same IP address to the WLAN session as the one assigned by 3GPP session and the application is serviced without interruption. The make-before-break type handover is possible and the handover can be performed **without any service disruption** from user perspective.

6.2.1.3 I-WLAN to 3G Access System handover (Wi Services)

This section shows the call flows for a handover from I-WLAN to 3GPP access system with the services hosted on the TTG' via the Wi interface. This scenario covers mobility from I-WLAN to pre-SAE 3GPP access networks. Figure 6.2.6 illustrates the call flow. The TTG' is acting as the anchor point.

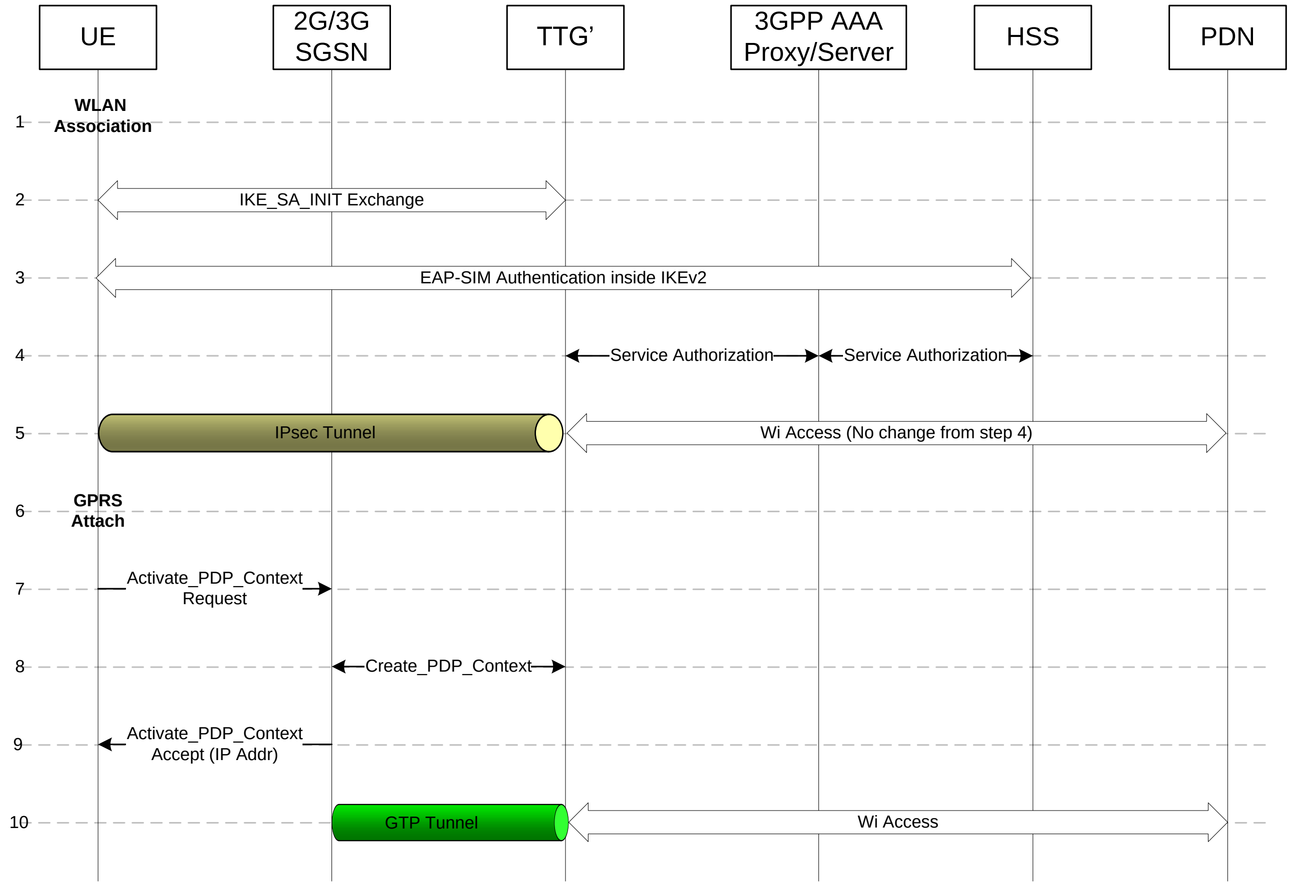

Figure 6.2.6 I-WLAN to pre-SAE 3GPP handover (Wi Services)

1. The user does not have any 3GPP connection yet, and is associated with the WLAN.

2. The client requests the 3GPP-WLAN tunnel setup to TTG'. TTG' terminates the IKE exchanges per TS 33.234.

3. The EAP-SIM authentication occurs inside IKEv2 to authenticate the user per TS 33.234. The EAP-SIM authentication involves the client, TTG', AAA server, and the HLR/HSS.

4. The service authorization occurs. The TTG' may consult AAA server or HSS for subscription profile.

5. The IPSec tunnel is established between the client and the TTG' and the TTG' provides the Wi interface to connect to PDN. This is the standard 3GPP-WLAN interworking procedure defined in TS 33.234.

6. The user is attached to a pre-SAE 3GPP system and decides to handover to this system (e.g. due to weak WLAN signal strength, etc).

7. The client requests the PDP context activation to the SGSN it is registered.

8. The SGSN sends the create_PDP_context request message to the TTG' after GGSN resolution. Since the TTG' already has the user session information, it only needs to switch the traffic route from WLAN to 3GPP. The Wi interface remains unchanged.

9. SGSN sends the response to the client.

10. The GTP has been established between SGSN and TTG'. The Wi interface remains unchanged.

6.2.1.4 3GPP Access System to I-WLAN handover (Gi Services)

This section shows the call flows for a handover from 3GPP access system to I-WLAN with the services hosted on the GGSN via the Gi interface. The existing GGSN is re-used to provide connectivity to the services as in current GPRS. This architecture works with the same concept as described in the section 6.2.1.2 and 6.2.1.3 and is provided here to describe that the proposed architecture can be used in either way, for operator's flexibility.

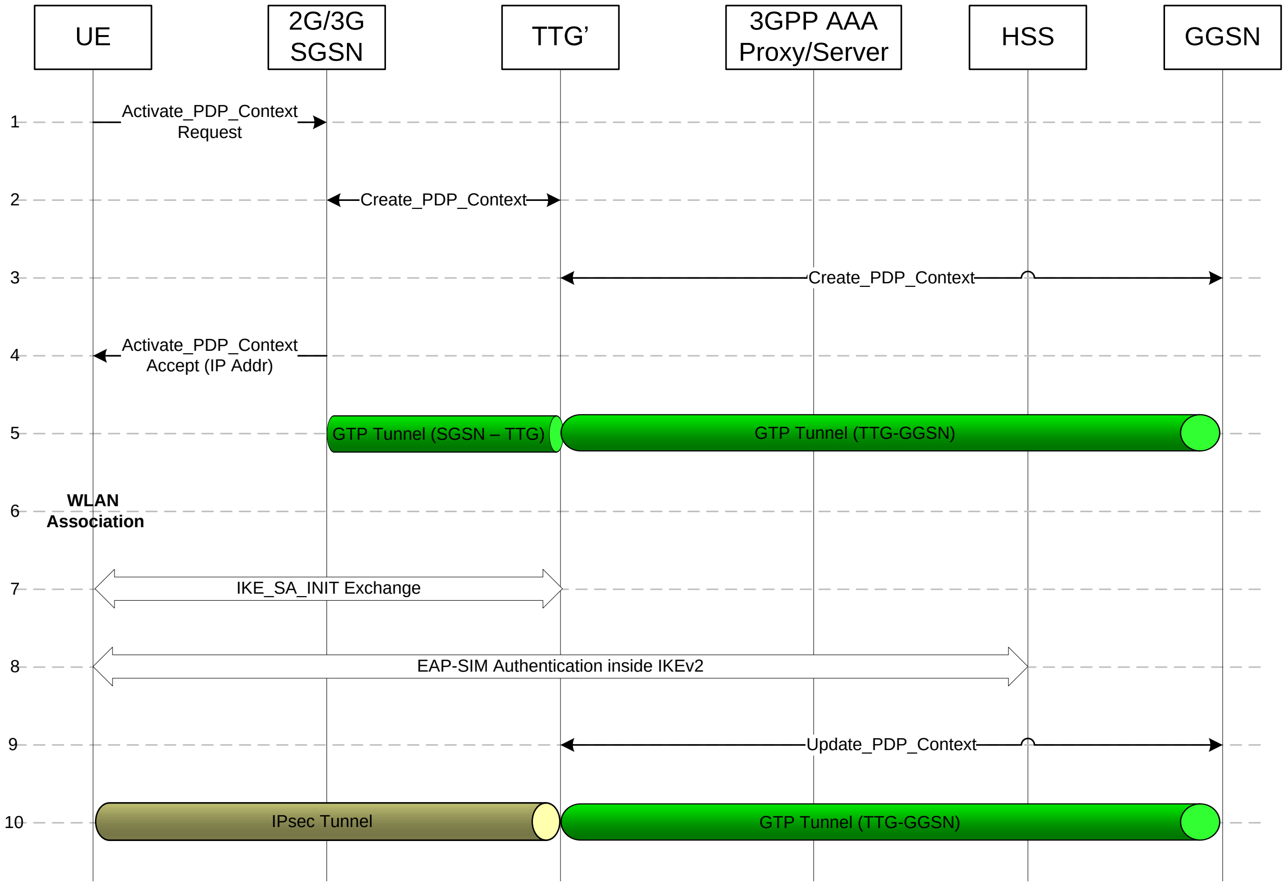

Figure 6.2.7 Pre-SAE 3GPP to WLAN handover (Gi Services)

1. The user is in pre-SAE 3GPP system coverage and requests the PDN or Operator IP service by sending 'Activate PDP context request' to SGSN.

2. The TTG' is resolved as a GGSN, and the SGSN creates the PDP context toward the TTG. The TTG' acts as a GGSN here.

3. TTG' resolves the GGSN address through which the service is to be provided and proxies the create_PDP_context request/response to and from the GGSN. The TTG' acts as a SGSN here.

4. The SGSN sends the response to the client with the assigned IP address, after it receives the 'create_PDP_context_ack' from the TTG.

5. There are two GTP legs – one between SGSN and TTG' and the other between TTG' and GGSN. Note that the optimization can be achieved using the user and control plane separation, already defined in GPRS specification. Note that if the TTG' is used in the operator's network, the TTG' will terminate the GTP tunnel for GPRS connection and route the traffic to the PDN.

6. User is associated with WLAN.

7. The 3GPP-WLAN tunnel setup procedure starts by exchanging IKE_SA_INIT between the client and the TTG. The TTG' is operating as specified in TS 23.234 and TS 33.234, and terminates the IKE and IPSec exchanges.

8. To authenticate and authorize the tunnel, the EAP-SIM procedure is performed inside the IKEv2 per TS 33.234. The EAP-SIM authentication involves the client, TTG, AAA server, and HLR/HSS. Note that the TTG' can assign the same IP address that was used for GPRS session to the WLAN session. This is possible since the TTG' already has the knowledge of the user session.

9. When the authentication is successful, the TTG' can now switch the access network from the pre-SAE 3GPP system to WLAN. Since there is already a GTP leg between the TTG' and GGSN to carry the traffic, there is no need for the TTG' to perform any further procedures toward the GGSN. However, for accounting purposes (to let the GGSN know that the access network has been changed from pre-SAE 3GPP to WLAN), the TTG' may optionally send the Update_PDP_context to the GGSN. Only the RAT (Radio Access Type) needs to be updated.

10. Now the traffic is switched by the TTG' from GPRS to the WLAN. The IPSec tunnel has been established between the client and the TTG, and one GTP tunnel is used between the TTG' and the GGSN. Note that if the TTG' is used in the operator's network, the TTG' will terminate the IPSec tunnel for WLAN connection and route the traffic to the PDN.

Also note that the all the traffic is terminated at the GGSN, so the existing GGSN service, e.g. APN based services and content/event based billing, can be provided without any implications.

6.3 Comparisons

7 Conclusion

Editor's note: depending on the progress and status of the SAE WI, the output of the SI may be considered to be either incorporated into SAE TS 's or TS23.234.

Annex x: Change History

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2007-3	SA2 ad-hoc C				TR skeleton (S2-071558) includes the approved documents: S2-071627, S2-071560, S2-071628, S2-071629.	0.0.1	0.0.2