Wi-Fi Roaming Guidelines
Version 9.0
19 November 2014

This is a Non-binding Permanent Reference Document of the GSMA

Security Classification: Non-confidential
Access to and distribution of this document is restricted to the persons permitted by the security classification. This document is confidential to the Association and is subject to copyright protection. This document is to be used only for the purposes for which it has been supplied and information contained in it must not be disclosed or in any other way made available, in whole or in part, to persons other than those permitted under the security classification without the prior written approval of the Association.

Copyright Notice
Copyright © 2015 GSM Association.

Disclaimer
The GSM Association (“Association”) makes no representation, warranty or undertaking (express or implied) with respect to and does not accept any responsibility for, and hereby disclaims liability for the accuracy or completeness or timeliness of the information contained in this document. The information contained in this document may be subject to change without prior notice.

Antitrust Notice
The information contained herein is in full compliance with the GSM Association’s antitrust compliance policy.
Table of Contents

1 Introduction 4
   1.1 Scope 4

2 Abbreviations and Terminology 4

3 References 10

4 EPC Overview (Informative) 11
   4.1 EPC Access Overview 11
      4.1.1 EPC-integrated Wi-Fi Overview 11
      4.1.2 EPC Specific Nodes 12

5 Access Interface 13
   5.1 Interactions between AAA & HSS 13
      5.1.1 Trusted/Untrusted Wi-Fi IP Access Network Detection 14
   5.2 Wi-Fi Access Network Selection 14
      5.2.1 Untrusted Wi-Fi Access Selection 14
      5.2.2 ANDSF Support 14
   5.3 EPC-integrated Wi-Fi Access Authentication and Security 15
   5.4 Identities 16
   5.5 IP Address Allocation 16
      5.5.1 IP Address Allocation in Untrusted Wi-Fi Access 16
      5.5.2 IP Address Allocation in Trusted Wi-Fi Access 16
   5.6 PDN Connectivity Service 17
      5.6.1 Untrusted Access 17
      5.6.2 Trusted Access 19

6 Functional Description & Procedures of EPC-Integrated Wi-Fi 21
   6.1 Overview 21
   6.2 Mobility Management 21
   6.3 Local Breakout 22
   6.4 Non-seamless Wi-Fi Offload 22
   6.5 Multi Access PDN Connectivity 22

7 Roaming Interface 22
   7.1 NNI Overview 22
   7.2 IPX Specifics 22
   7.3 SWd 23
   7.4 Other Functions 24

Annex A Pre-Release 11 Wi-Fi Roaming Guidelines (a.k.a. The Previous Version of IR.61) 25
   A.1 Basic Information 25
      A.1.1 Scope 25
   A.2 Roaming Network Architecture 26
      A.2.1 3GPP-WLAN Interworking Overview 28
   A.3 Access Interface 29
      A.3.1 MT Association to the Wi-Fi 29
      A.3.2 Web Based login 30
      A.3.3 802.1X AND EAP-SIM, EAP-AKA OR EAP-AKA’ Login 32
### A.3.4 HS2.0 Based Network Discovery 36
### A.3.5 Service Provider Advertisement and Selection 36
### A.3.6 WLAN 3GPP IP Access End-To-End Tunnelling 38
### A.4 Inter-Service Provider Interface (NNI) 38
### A.4.1 Radius Roaming Network 39
### A.5 NOTES: 46
### A.5.2 Radius Attributes for EAP-AKA AND EAP-AKA’ Application 49
### A.6 Co-Existence and Migration 49
### A.6.1 Web Based Authentication and 802.1x Authentication 49

#### Annex B Document Management 53

- **B.1** Document History 53
- **Other Information** 54
- **Feedback** 54
1 Introduction

1.1 Scope

The main purpose of this document is to describe Wi-Fi Access to the Evolved 3GPP Packet Switched domain also known as the Evolved Packet Core (EPC) as specified in 3GPP specifications such as TS 23.402 and TS 24.302. The document is based on 3GPP Release 11 and later.

The document concentrates on the roaming scenarios but includes also some text regarding the non-roaming scenarios to give the full picture, including mobility between E-UTRAN and pre-E-UTRAN 3GPP radio access technologies, policy control and charging, and authentication.

Main focus of the current version of the document are S2b and S2a interfaces using GTP. Out of scope are S2c interface and usage of PMIP (for both S2b and S2a).

NOTE: The case of Non-seamless offload (i.e. data traffic directly to a data network without passing through EPC) is FFS.

The earlier IR.61 (version 6.0) is moved as such to the Annex A, thus if the reader is not interested in EPC integrated Wi-Fi roaming (s)he can still find the common guidelines for the pre-Release 11 Wi-Fi roaming including:

- Access interfaces including connection procedures (also according to HotSpot 2.0 specification) and authentication
- Inter-operator interfaces for RADIUS authentication and accounting procedures (recommendations for charging principles, billing and settlement are handled in detail by BARG and TADIG)
- 3GPP Release-7 Interworking WLAN related Domain name System (DNS) naming conventions, DNS deployment considerations and guidance for Public Land Mobile Network (PLMN) selection
- 3GPP Release-7 Interworking WLAN related Network Access Identifies naming conventions

Please refer to the introductory note of Annex A for the status of I-WLA in 3GPP.

2 Abbreviations and Terminology

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Independence</td>
<td>The WLAN UE is able to establish WLAN 3GPP IP Access connectivity and access 3GPP PS services without prior authentication to WLAN 3GPP Direct Access.</td>
<td></td>
</tr>
<tr>
<td>Accounting</td>
<td>The process of collecting resource usage measurements and apportioning charges for joint service between interworking and/or co-operating service/network providers.</td>
<td></td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Billing</td>
<td>A function whereby Call Detail Records generated by</td>
<td>A function whereby Call Detail Records generated by the charging function are transformed into bills requiring payment.</td>
</tr>
<tr>
<td>Customer</td>
<td>A business entity or an individual with a direct contractual</td>
<td>A business entity or an individual with a direct contractual relation to receive the Service from the Home Wi-Fi Service Provider.</td>
</tr>
<tr>
<td>Home Wi-Fi</td>
<td>The network operated by the Home Wi-Fi Service Provider.</td>
<td>The network operated by the Home Wi-Fi Service Provider.</td>
</tr>
<tr>
<td>RADIUS Roaming Proxy (WLAN Roaming Proxy)</td>
<td>RADIUS Roaming Proxy (or WLAN Roaming Proxy) shall mean a component transporting RADIUS messages from visited Wi-Fi Service Provider to Home Wi-Fi Service Provider (and vice versa). This component typically also carries out some security functions. The interface between RADIUS Roaming Proxies is an inter-operator interface described in this document.</td>
<td>RADIUS Roaming Proxy (or WLAN Roaming Proxy) shall mean a component transporting RADIUS messages from visited Wi-Fi Service Provider to Home Wi-Fi Service Provider (and vice versa). This component typically also carries out some security functions. The interface between RADIUS Roaming Proxies is an inter-operator interface described in this document.</td>
</tr>
<tr>
<td>Roaming Agreement</td>
<td>Agreement between two parts to enable end users of each to utilize the other parts network using their Home account service provider authentication parameters.</td>
<td>Agreement between two parts to enable end users of each to utilize the other parts network using their Home account service provider authentication parameters.</td>
</tr>
<tr>
<td>Roaming Partner</td>
<td>The WO who has entered into a Roaming Agreement with another WO.</td>
<td>The WO who has entered into a Roaming Agreement with another WO.</td>
</tr>
<tr>
<td>Roaming Service</td>
<td>Roaming Service in this document means provision of Internet service over WLANs for customers of another WO, also known as the Roaming Partner. The Roaming Service enables customers from Roaming Partners to access at least their subscribed services through each other’s network by using the same authentication credentials as in its Home WLAN</td>
<td>Roaming Service in this document means provision of Internet service over WLANs for customers of another WO, also known as the Roaming Partner. The Roaming Service enables customers from Roaming Partners to access at least their subscribed services through each other’s network by using the same authentication credentials as in its Home WLAN</td>
</tr>
<tr>
<td>Settlement</td>
<td>Settlement</td>
<td>Settlement</td>
</tr>
<tr>
<td>User</td>
<td>The individual receiving the Service.</td>
<td>The individual receiving the Service.</td>
</tr>
<tr>
<td>Visited Wi-Fi</td>
<td>The network operated by the Visited Wi-Fi Service Provider.</td>
<td>The network operated by the Visited Wi-Fi Service Provider.</td>
</tr>
<tr>
<td>Non-seamless WLAN Access/Offload</td>
<td>NOTE: This is to use the same terminology as 3GPP and also to avoid any confusion with “WiFi Direct” feature now supported by some UEs.</td>
<td>NOTE: This is to use the same terminology as 3GPP and also to avoid any confusion with “WiFi Direct” feature now supported by some UEs.</td>
</tr>
<tr>
<td>WLAN 3GPP IP Access</td>
<td>The WLAN UE is allowed to access 3GPP PS based services provided via WLAN. The data traffic gets always routed PLMN.</td>
<td>The WLAN UE has an access to an IP network directly from a WLAN AN without passing data to a PMN (e.g. EPC) via a tunnel. It is a non-EPC based solution.</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>3GPP AAA-Proxy</td>
<td>3GPP defined RADIUS and Diameter AAA proxy for the 3GPP Rel-6</td>
<td></td>
</tr>
<tr>
<td>3GPP AAA-Server</td>
<td>3GPP defined RADIUS and Diameter AAA server for the 3GPP Rel-6</td>
<td></td>
</tr>
<tr>
<td>802.1X PAE</td>
<td>IEEE 802.1X Port Access Entity</td>
<td>The logical port controlling the flow of user data on an 802.1X enabled Access Point till authentication is complete.</td>
</tr>
<tr>
<td>AC</td>
<td>Access Controller</td>
<td></td>
</tr>
<tr>
<td>Alternative NAI</td>
<td>Alternative Network Access Identifier</td>
<td>A NAI that shall have the form of: <code>&lt;any_non_null_string&gt;@unreachable.3gppnetwork.org</code></td>
</tr>
<tr>
<td>ANDSF</td>
<td>Access Network &amp; Discovery &amp; Selection Function</td>
<td>3GPP framework comprising of a network entity (ANDSF Server) and a UE entity (ANDSF Client) that supports operator’s policies for network selection and traffic steering between 3GPP and non-3GPP accesses (e.g. WLAN).</td>
</tr>
<tr>
<td>AP</td>
<td>Access Point</td>
<td>Interface between the radio network part and the wired network part of a WLAN network, offering wireless connectivity to MTs</td>
</tr>
<tr>
<td>BARG</td>
<td>Billing, Accounting, and Roaming Group</td>
<td>Working Group within GSMA.</td>
</tr>
<tr>
<td>Decorated NAI</td>
<td>Decorated Network Access Identifier</td>
<td>A NAI that shall have the form ‘Homerealm!username@visitedrealm’</td>
</tr>
<tr>
<td>Diameter</td>
<td>Authentication, Authorization and Accounting (AAA) protocol</td>
<td></td>
</tr>
<tr>
<td>EAP</td>
<td>Extensible Authentication Protocol</td>
<td>A protocol to transfer authentication information between a MT and a Home WO AAA-server.</td>
</tr>
<tr>
<td>EAP-AKA</td>
<td>Extensible Authentication Protocol using a USIM profile</td>
<td>Extensible Authentication Protocol with Universal Mobile Telecommunications System (UMTS) Authentication and Key Agreement (AKA) mechanism method as standardized in RFC 5448</td>
</tr>
<tr>
<td>EAP-SIM</td>
<td>Extensible Authentication Protocol using a SIM profile</td>
<td>Authentication method used with EAP to support authentication using a SIM, as standardized in RFC 4186</td>
</tr>
<tr>
<td>EAP-TLS</td>
<td>Extensible Authentication Protocol using a certificate</td>
<td>Authentication method used with EAP to support authentication through Transport Layer Security, in which secure digital certificates are used to mutually identify a user and a server’s identity, as standardized in RFC 5216</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>EAP-TTLS</td>
<td>Extensible Authentication Protocol using Username/Password</td>
<td>Authentication method used with EAP to support authentication through Tunnelled Transport Layer Security, in which secure digital certificates are used to identify a server’s identity (and optionally, a device’s or user’s identity), establish a tunnel, and then allow for user identification over the encrypted tunnel, as standardized in RFC 5281 tools. <strong>NOTE:</strong> that there is often an inner EAP method used with EAP-TTLS, such as MSCHAPv2 (see RFC 2759).</td>
</tr>
<tr>
<td>EPC</td>
<td>Evolved Packet Core</td>
<td>EPC is an end-to-end packet core architecture for 4G Long-Term Evolution (LTE) that provides a converged voice and data networking framework to connect users to an LTE network</td>
</tr>
<tr>
<td>ePDG</td>
<td>Evolved Packet Data Gateway</td>
<td>IPsec GW that connects UE to Untrusted Non-3GPP network</td>
</tr>
<tr>
<td>EPS</td>
<td>Evolved Packet System</td>
<td></td>
</tr>
<tr>
<td>Fast Re-authentication NAI</td>
<td>Fast Re-authentication Network Access Identifier</td>
<td>A NAI that is optionally used only during the EAP-SIM/AKA/AKA’ fast re-authentication procedure. The NAI shall have the form of: <code>&lt;any_string&gt;@realm</code> or just <code>&lt;string&gt;</code></td>
</tr>
<tr>
<td>FQDN</td>
<td>Fully Qualified Domain Name</td>
<td>An unambiguous domain name that specifies the node’s position in the DNS tree hierarchy absolutely</td>
</tr>
<tr>
<td>Home Wi-Fi SP</td>
<td>Home Wi-Fi Service Provider</td>
<td>The Party contracting to provide the Service to its own Customers and authenticates and charges the customer.</td>
</tr>
<tr>
<td>HS2.0</td>
<td>HotSpot 2.0</td>
<td>WFA standardized protocol for the automated network discovery in Wi-Fi networks</td>
</tr>
<tr>
<td>IARP</td>
<td>Inter-APN Routing Policy</td>
<td>Operator rules determining which traffic should be routed across which PDN connection and which traffic should be non-seamlessly offloaded to WLAN</td>
</tr>
<tr>
<td>IKEv2</td>
<td>Internet Key Exchange version 2</td>
<td>Version 2 of the Internet Key Exchange protocol, which is used to negotiate a Security Association at the outset of an IPsec session.</td>
</tr>
<tr>
<td>IPSec</td>
<td>IP Security</td>
<td>A suite of protocols for securing IP communications by authenticating and/or encrypting each IP packet in a data stream.</td>
</tr>
<tr>
<td>IREG</td>
<td>International Roaming Experts Group</td>
<td>Working Group within GSMA.</td>
</tr>
<tr>
<td>MAC</td>
<td>Message Authentication Codes</td>
<td>These are unique cryptographic values computed and attached to each protocol message to provide message authenticity.</td>
</tr>
<tr>
<td>MAP</td>
<td>Mobile Application Part</td>
<td>Mobile related SS7 application protocol that is used in the GSM Core Network to talk to the AuC/HLR.</td>
</tr>
<tr>
<td>MNO</td>
<td>Mobile Network Operator</td>
<td></td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>MT</td>
<td>Mobile Terminal</td>
<td>End system equipment providing the interface towards human beings through a set of applications. NOTE: The MT includes, among other things, the functions and protocols necessary to provide and handle the communication to the WLAN network, as well as against other networks, services, and applications.</td>
</tr>
<tr>
<td>MTP</td>
<td>Message Transfer Part</td>
<td>Layer 1,2,3 of the SS7 stack</td>
</tr>
<tr>
<td>PCRF</td>
<td>Policy Charging and Rules Function</td>
<td>LTE network functionality that supports service data flow detection, policy enforcement and flow-based charging</td>
</tr>
<tr>
<td>PDG</td>
<td>Packet Data Gateway</td>
<td>A 3GPP flavoured IKEv2 IPsec gateway</td>
</tr>
<tr>
<td>PDN Gateway</td>
<td>Packet Data Node GW</td>
<td>Gateway acts as the interface between the LTE network and other packet data networks</td>
</tr>
<tr>
<td>PGW</td>
<td>PDN Gateway</td>
<td>Gateway acts as the interface between the LTE network and other packet data networks</td>
</tr>
<tr>
<td>PLMN</td>
<td>Public Land Mobile Network</td>
<td></td>
</tr>
<tr>
<td>PSPL</td>
<td>Preferred Service Providers List</td>
<td>A prioritised list of service providers preferred by the UE’s (3GPP) home operator for WLAN roaming.</td>
</tr>
<tr>
<td>Root NAI</td>
<td>Root Network Access Identifier</td>
<td>A NAI, that shall have the form ‘username@realm’.</td>
</tr>
<tr>
<td>SA</td>
<td>Security Association</td>
<td>An establishment of shared security information between two network entities to support secure communication.</td>
</tr>
<tr>
<td>SCCP</td>
<td>Signalling Control Connection Part</td>
<td>Control part of SS7 protocol that manages Signalling Transfer Points (STPs)</td>
</tr>
<tr>
<td>S-GW</td>
<td>Serving Gateway</td>
<td>Routes data packets through the access network.</td>
</tr>
<tr>
<td>SS7</td>
<td>Signalling System 7</td>
<td>Circuit Switched Network Signalling Protocol for connection management.</td>
</tr>
<tr>
<td>TADIG</td>
<td>Transferred Account Data Interchange Group</td>
<td>Working Group within GSMA.</td>
</tr>
<tr>
<td>TCAP</td>
<td>Transfer Capabilities Application Part</td>
<td>Mobile related SS7 protocol that is used in the GSM Core Network to talk to the AuC/HLR.</td>
</tr>
<tr>
<td>TFT</td>
<td>Traffic Flow Template</td>
<td></td>
</tr>
<tr>
<td>TWAG</td>
<td>Trusted WLAN Access Gateway</td>
<td>Gateway that interfaces P-GW using S2a.</td>
</tr>
<tr>
<td>TWAN</td>
<td>Trusted WLAN Access Network</td>
<td>Trusted WLAN network that does not require the use of IPsec with the UE. The detailed functional split within a TWAN is out of scope of 3GPP. Whether a Non-3GPP access is trusted or not to EPC is left for the (AAA server of the) Home operator to decide.</td>
</tr>
<tr>
<td>TWAP</td>
<td>Trusted WLAN AAA Proxy</td>
<td>Relays AAA information between TWAN and 3GPP AAA Server (or Proxy in case of roaming) using the STa (Swd) interface.</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Visited Wi-Fi</td>
<td>Visited Wi-Fi Service Operator</td>
<td>The Party providing the Roaming Service to the Customer of the other Party.</td>
</tr>
<tr>
<td>Service Operator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WAG</td>
<td>WLAN Access Gateway</td>
<td>A 3GPP flavoured Access Controller</td>
</tr>
<tr>
<td>W-APN</td>
<td>WLAN APN</td>
<td>WLAN equivalent for GPRS Access Point Name (APN)</td>
</tr>
<tr>
<td>WFA</td>
<td>Wi-Fi Alliance</td>
<td></td>
</tr>
<tr>
<td>Wi-Fi SP</td>
<td>Wi-Fi Service Provider</td>
<td>Owner and/or Provider of Wi-Fi network infrastructure. This entity could be a Mobile Network Operator (MNO) or a Wireless Internet Service Provider (WISP).</td>
</tr>
<tr>
<td>WISP</td>
<td>Wireless LAN Internet Service</td>
<td></td>
</tr>
<tr>
<td>Provider</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
<td>Usually referred to the IEEE 802.11 product family.</td>
</tr>
<tr>
<td>WLANSP</td>
<td>WLAN Selection Policies</td>
<td>Operator rules that determine which WLAN AP to select</td>
</tr>
<tr>
<td>WLAN UE</td>
<td>WLAN User Equipment</td>
<td>A terminal with WLAN capability</td>
</tr>
<tr>
<td>WLCP</td>
<td>WLAN Control Plane (protocol)</td>
<td>Control (only) protocol between UE and TWAG to (dynamically) setup / release a PDN connection when under trusted WLAN access.</td>
</tr>
<tr>
<td>WPA</td>
<td>Wi-Fi Protected Access</td>
<td>This is a Wi-Fi Alliance promoted WLAN device security feature set. It includes IEEE 802.1X support, Support for portions of the IEEE 802.11i draft specification namely TKIP and optional AES cipher suite support.</td>
</tr>
<tr>
<td>WPA2</td>
<td></td>
<td>Wi-Fi Protected Access II</td>
</tr>
</tbody>
</table>
3 References

<table>
<thead>
<tr>
<th>Document</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC 2865</td>
<td>Remote Authentication Dial In User Service (RADIUS)</td>
</tr>
<tr>
<td>RFC 2866</td>
<td>RADIUS Accounting</td>
</tr>
<tr>
<td>RFC 2869</td>
<td>RADIUS Extensions</td>
</tr>
<tr>
<td>RFC 2607</td>
<td>Proxy Chaining and Policy Implementation in Roaming</td>
</tr>
<tr>
<td>RFC 5247</td>
<td>PPP Extensible Authentication Protocol (EAP)</td>
</tr>
<tr>
<td>RFC 4186</td>
<td>EAP SIM Authentication</td>
</tr>
<tr>
<td>RFC 3579</td>
<td>Radius support for Extensible Authentication Protocol</td>
</tr>
<tr>
<td>RFC 3580</td>
<td>IEEE 802.1X RADIUS Usage Guidelines</td>
</tr>
<tr>
<td>RFC 1851</td>
<td>The ESP Triple DES Transform</td>
</tr>
<tr>
<td>RFC 2401</td>
<td>Security Architecture for the Internet Protocol</td>
</tr>
<tr>
<td>RFC 4372</td>
<td>The Chargeable User Identity</td>
</tr>
<tr>
<td>RFC 4284</td>
<td>Identity Selection Hints for the Extensible Authentication Protocol (EAP)</td>
</tr>
<tr>
<td>RFC 4282</td>
<td>The Network Access Identifier</td>
</tr>
<tr>
<td>RFC 4306</td>
<td>Internet Key Exchange (IKEv2) Protocol</td>
</tr>
<tr>
<td>RFC 5448</td>
<td>EAP-AKA and EAP-AKA’ Authentication</td>
</tr>
<tr>
<td>RFC 5216</td>
<td>The EAP-TLS Authentication Protocol</td>
</tr>
<tr>
<td>RFC 5281</td>
<td>The EAP-TTLS Authentication Protocol</td>
</tr>
<tr>
<td>RFC 5580</td>
<td>Carrying Location Objects in RADIUS and Diameter</td>
</tr>
<tr>
<td>PRD AA.80</td>
<td>Agreement for IP Packet eXchange (IPX) Services</td>
</tr>
<tr>
<td>PRD IR.21</td>
<td>Roaming Database, Structure and Updating Procedures</td>
</tr>
<tr>
<td>PRD IR.33</td>
<td>GPRS Roaming Guidelines</td>
</tr>
<tr>
<td>PRD IR.34</td>
<td>Inter-PLMN Backbone Guidelines</td>
</tr>
<tr>
<td>PRD IR.40</td>
<td>Guidelines for IPv4 Addressing and AS Numbering for GPRS Network Infrastructure and Mobile Termin</td>
</tr>
<tr>
<td>PRD IR.67</td>
<td>DNS Guidelines for Operators</td>
</tr>
<tr>
<td>PRD IR.88</td>
<td>LTE and EPC Roaming Guidelines</td>
</tr>
<tr>
<td>3GPP TS 23.003</td>
<td>Numbering, addressing and identification</td>
</tr>
<tr>
<td>3GPP TS 23.402</td>
<td>Architecture enhancements for non-3GPP accesses</td>
</tr>
<tr>
<td>3GPP TS 24.244</td>
<td>Wireless LAN Control Plane protocol for trusted WLAN access to EPC</td>
</tr>
<tr>
<td>3GPP TS 24.302</td>
<td>Access to the 3GPP Evolved Packet Core (EPC) via non-3GPP access networks</td>
</tr>
<tr>
<td>3GPP TS 24.312</td>
<td>Access Network Discovery and Selection Function (ANDSF) Management Object</td>
</tr>
<tr>
<td>3GPP TS 24.234</td>
<td>WLAN User Equipment (WLAN UE) to network protocols (See introductory NOTE in Annex A)</td>
</tr>
</tbody>
</table>
4 EPC Overview (Informative)

4.1 EPC Access Overview

3GPP Rel-8 introduced the Enhanced Packet Core (EPC) as part of EPS and the integration of non-3GPP accesses into EPC. It supports also local breakout for the services.

General guidelines for the EPC roaming environment using 3GPP accesses are described in IR.88.

4.1.1 EPC-integrated Wi-Fi Overview

Integration of Wi-Fi Access into EPC enables Mobile Services to be available through Wi-Fi. Release-11 and later makes it possible to use mobile services, like IMS-based voice and video, MMS and SMS over IP over the Wi-Fi Access.

Wi-Fi Access is divided into two scenarios, one for Trusted Wi-Fi Access and one for Untrusted Wi-Fi Access. In case of Trusted Wi-Fi Access, the Wi-Fi connects directly to the PDN Gateway via S2a interface, using GTP.

In Untrusted Wi-Fi Access an additional IPsec tunnel is established between UE and ePDG using SWn interface. After successful IPsec tunnel setup, ePDG forwards the user traffic to PDN GW via S2b interface using GTP. In roaming scenario, the HSS/3GPP AAA Server in HPLMN makes the decision of whether a Wi-Fi Access is used as Trusted or Untrusted Wi-Fi Access. The HSS/3GPP AAA Server may take the VPLMN's policy and capability returned from the 3GPP AAA Proxy and roaming agreement into account.

Figure 1 illustrates the overall roaming architecture for EPC when using the interfaces S5, S2a and S2b as specified in 3GPP TS 23.402. SWd is required as a roaming interface. For EPC/LTE roaming interfaces, please refer to IR.88.
4.1.2 EPC Specific Nodes

Following list shortly describes key EPC components.

- PDN Gateway EPC includes e.g. GPRS Tunneling Protocol for the control plane and the user plane to provide PDN connectivity to UEs using Wi-Fi Accesses if GTP-based S2b is used.
- ePDG is placed at the border between the Untrusted Wi-Fi Access and the PLMN. It is used e.g. to create an IPsec tunnel to the UE and is connected to the PDN Gateway when using Untrusted Wi-Fi Access. It uses S2b interface.
- For S2a, the functional structure of the trusted WLAN access network is summarised in Figure X. In this case there is no need for an IPSec tunnel between the UE and Trusted WLAN Access Gateway (TWAG): It leverages the appropriate security provided by IEEE 802.11-2007 (802.11i, AES) over the air interface (SWw) between UE and the WLAN Access Network. The TWAP (Trusted WLAN AAA Proxy) relays AAA information between TWAN and 3GPP AAA Server (and via a 3GPP Proxy AAA when roaming). The internal structure and interfaces of the Trusted Non-3GPP Access Network (here Fixed BB Access for WLAN support) are out of scope of 3GPP.
PCRF is a Policy Charging and Rules Function. Its responsibilities are e.g. to provide QoS information to the PDN Gateway, to manage and control sessions and to determine charging policy for packets.

5 Access Interface

5.1 Interactions between AAA & HSS

The interaction between 3GPP AAA server and HSS in the HPLMN via SWx reference point for Wi-Fi Access is described in 3GPP TS 23.402 chapter 7. It defines the Location Management procedures, Subscriber Profile Management procedures as well as Authentication Procedures.

NOTE: multiple PDN as described in chapter 7.6 in TS 23.402 is FFS

NOTE: bearer modification as described in chapter 7.11 in TS 23.402 is FFS

Location Management procedures are common to all Wi-Fi Accesses, whether Trusted or Untrusted, and are independent of the mobility protocol used.

The Subscriber Profile management is invoked by the HSS when the subscriber profile has been modified and needs to be sent to the 3GPP AAA Server. This may happen due to a modification of user profile data in the HSS.

The 3GPP AAA Server may also request the user profile data from the HSS. This procedure is invoked when for some reason the subscription profile of a subscriber is lost or needs to be updated.

The authentication procedures between HSS and 3GPP AAA Server are described in 3GPP TS 33.402 chapter 8.

NOTE: fast re-authentication is FFS

The authentication procedures define the process in which the 3GPP AAA Server interacts with the HSS to acquire necessary data (i.e. Authentication Vectors for EAP-AKA, RFC 4187 or EAP-AKA', RFC 5448) from the HSS to successfully authenticate the user for accessing the Wi-Fi system.
For supporting multiple PDN connections, all PDN connections shall be setup either as Trusted or as Untrusted, i.e. it shall not be possible to use procedure to access one PDN using the Wi-Fi Access Network via Trusted Wi-Fi Access, while using procedure to access to another PDN using the same Wi-Fi Access as Untrusted Wi-Fi Access.

5.1.1 Trusted/Untrusted Wi-Fi IP Access Network Detection

During initial attach or handover attach a UE must discover the trust relationship (whether it is a Trusted or Untrusted Wi-Fi Access Network) of the Wi-Fi Access Network in order to know which Wi-Fi Access procedure to initiate. The trust relationship of a Wi-Fi Access Network is made known to the UE either

1. If the Wi-Fi Access supports 3GPP-based access authentication, the UE discovers the trust relationship during the 3GPP-based access authentication. Or
2. The UE operates on the basis of pre-configured policy in the UE.

5.2 Wi-Fi Access Network Selection

5.2.1 Untrusted Wi-Fi Access Selection

The UE and the network must support access selection as specified in TS 24.302 chapter 5

NOTE: For support and status of I-WLAN refer to Annex A introductory note.

5.2.2 ANDSF Support

The Access Network Discovery and Selection Function (ANDSF) may be used to support access Wi-Fi selection and traffic steering over WLAN and 3GPP accesses.

The ANDSF is a framework consisting of a UE client and a network (EPC) server defined by 3GPP. It is specified in 3GPP TS 23.402, TS 24.302 and TS 24.312. With 3GPP Release 12, ANDSF provides a complete and consistent set of rules for both WLAN selection and Traffic Steering.

The simplified architecture of this framework is illustrated below. The interface between the UE and ANDSF server (S14) is based on OMA-DM (Device Management) and runs on an IP based network and reachable via 3GPP or WLAN access. ANDSF is applicable for both S2a and S2b.

![Figure 3: ANDSF Architecture](image-url)

ANDSF (Release 12) supports the following:
- WLAN access selection (and PMN selection) consisting of:
  - WLAN Selection Policies (WLANSNP) which are operator rules that determine which WLAN AP to select.
  - The Preferred Service Providers List (PSPL) which contains a prioritised list of service providers preferred by the UE's (3GPP) home operator for WLAN roaming. The PSPL is provided by the HPLMN through H-ANDSF (or can be statically provisioned in the UE).

- Traffic steering: this has been enhanced by the introduction of:
  - Inter-APN Routing Policy (IARP) which are operator rules determining which traffic should be routed across which PDN connection and which traffic should be non-seamlessly offloaded to WLAN (NSWO).
  - 3GPP RATs (E-UTRAN, UTRAN and GERAN) in Inter-System Routing Policies (ISRNP) allowing better rule granularity than the Release 11 "Wi-Fi" and "3GPP" choice

In brief, with 3GPP Release 12, ANDSF provides a complete and consistent set of rules for both WLAN selection and Traffic Steering and this for both S2a and S2b.

**NOTE:** Alternatives to ANDSF (e.g. static provisioning or “RAN rules” based) is FFS.

**NOTE:** The 3GPP Rekease 12 work on 3GPP / WLAN Radio inter-working (consideration of e.g. access load, signall strength / quality) is also relevant for network selection / traffic steering decisions and can be described when the related is sufficiently advanced and stable. In this work, the ANDSF is optional in the sense that two solutions will be specified: one with ANDSF and one without (“RAN rules”).

### 5.3 EPC-integrated Wi-Fi Access Authentication and Security

EPC-integrated Wi-Fi Access authentication defines the process that is used for Access Control (i.e. to permit or deny a subscriber to attach to and use the resources of a EPC-integrated Wi-Fi Access). Access authentication signalling is executed between the UE and the 3GPP AAA server/HSS. The authentication signalling may pass through AAA proxies and the UE must support both EAP-AKA and EAP-AKA'.

3GPP based access authentication is executed across a SWa/STA reference point as depicted in the EPC architecture diagram. The following principles shall apply in this case:

- Transport of authentication signalling shall be independent of the Non-3GPP IP Access technology.
- The 3GPP based access authentication signalling shall be based on IETF protocols, (e.g., Extensible Authentication Protocol (EAP) as specified in RFC 3748).

SWa interface must be used to connect the Untrusted Wi-Fi Access with the 3GPP AAA Server/Proxy and transport access authentication, authorization and charging-related information in a secure manner (see Figure 1).

STA interface connects the Trusted Wi-Fi Access with the 3GPP AAA Server/Proxy and transports access authentication, authorization, mobility parameters and charging-related information in a secure manner (see Figure 1).
The details of the access authentication procedure are defined in 3GPP TS 33.402 chapter 6.1, 6.2, 6.3 and chapter 8 and 3GPP TS 24.302 chapters 6.4 and 6.5.

For a UE supporting S2b:

- Full EAP-AKA authentication procedure as described in 3GPP TS 33.402 and RFC4187 shall be supported;
- Profile of IKEv2 as specified in 3GPP TS 33.402 shall be used;
- Profile of IPsec as specified in 3GPP TS 33.402 shall be used;
- Fast re-authentication procedure as described in 3GPP TS 33.402 shall be supported;
- UE shall support to initiate rekeying of both IKE_SA and IPSEC_SA. This should be triggered by a configurable timer;
- UE shall support to receive from ePDG rekeying of both IKE_SA and IPSEC_SA; and
- NAT traversal of IKEv2 and IPsec packets must be supported.

Depending on operator policy, fast re-authentication shall be possible to be used in these scenarios:

- UE has a SWu tunnel for one APN. The UE moves to 3GPP for some time and then moves back to Wi-Fi and re-establishes SWu tunnel.
- UE has at least one existing PDN connection and wants to setup a new one.

5.4 Identities

In order to access the 3GPP Evolved Packet Core from Wi-Fi Accesses, and get Authentication, Authorization and Accounting services from the Evolved Packet Core, the NAI RFC 4282 based user identification defined in TS 23.003 shall be used.

5.5 IP Address Allocation

This following descriptions are about allocation of IP address for the data plane.

5.5.1 IP Address Allocation in Untrusted Wi-Fi Access

When an Untrusted Wi-Fi Access is used the following IP addresses are allocated to the UE

- An IP address, which is used by the UE within the Untrusted Wi-Fi Access Network to get IP connectivity towards the ePDG
- One or more IP address(es), which is used by the UE towards the external PDNs via the allocated PDN GW(s).

5.5.2 IP Address Allocation in Trusted Wi-Fi Access

When using Single-connection mode and Multi-connection mode, the UE sees the PDN Connection as a point-to-point link similar to how it is in 3GPP access. Shared link parameters such as netmask and default router IP address are not used.

In Transparent Single-connection Mode (3GPP Release 11 and above), TWAG shall act as DHCPv4/v6 server for the UE.

In Single-connection mode and Multi-connection mode (3GPP Release 12):

- To support IPv4 connectivity, the IPv4 address shall be allocated and sent to the UE during PDN connection establishment.
To support IPv6 connectivity, the PGW handles the RS/RA messages and to support IPv6 parameter configuration the UE may use stateless DHCPv6. The PGW acts as DHCPv6 server.

5.6 PDN Connectivity Service

5.6.1 Untrusted Access

5.6.1.1 ePDG Discovery

If the UE is not roaming or cannot determine if it is roaming, the UE shall create a FQDN with the HPLMN ID as specified in 3GPP TS 23.003. If it is known the UE is roaming and VPLMN ID is known, the UE shall create a FQDN with the VPMLN ID. DNS queries for ePDG selection are sent to the DNS server provided on the Wi-Fi Internet connection.

It should be possible to configure the UE with static ePDG IP addresses or FQDN; the latter must be resolvable via the Internet.

If the ePDG selection fails using the FQDN created using HPLMN ID (in the non-roaming case) or VPLMN ID (in the roaming case) then the UE can use the configured ePDG IP addresses or FQDN.

The UE shall keep using the same ePDG as long as it is reachable. If ePDG fails or its connectivity is lost, the UE can start using another ePDG IP address (either configured or provided by the DNS).

5.6.1.2 Connectivity Services

For Wi-Fi Access to the EPC the PDN connectivity service is provided by IKEv2 and IPsec connectivity between the UE and the ePDG concatenated with S2b bearer(s) between the ePDG and the PGW. During this connection procedure the UE and the ePDG must perform support mutual authentication for the IPsec tunnel establishment between the UE and the ePDG (SWu reference point). The Tunnel authentication is executed across a SWm reference point as depicted in the EPC architecture diagram, see Figure 4.
The UE must establish a separate SWu instance (i.e. a separate IPsec tunnel) for each PDN connection.

One default S2b bearer must be established on the S2b interface when the UE connects to a PDN, and that remains established throughout the lifetime of the PDN connection to provide the UE with always-on IP connectivity to that PDN. Additional dedicated S2b bearers may be established on S2b for the same PDN connection depending on operator policy. The PGW establishes dedicated S2b bearers on S2b for the same PDN connection based on PCC decisions as specified in 3GPP TS 23.203.

The ePDG must release the SWu instance when the default S2b bearer of the associated PDN connection is released.

The S2b bearer is realized by the following elements:

- A GTP tunnel on S2b transports the packets of an S2b bearer between the ePDG and a PDN GW;
- The ePDG stores the mapping between uplink packet filters it receives from the PGW (e.g. in the Create Bearer Request message) and the corresponding S2b bearer;
- The PDN GW stores the mapping between downlink packet filters and an S2b bearer.

In support for the UE connectivity with the PDN:

- A SWu instance (i.e. a IPsec tunnel) transports the packets of all S2b bearer(s) for the same PDN Connection between the UE and the ePDG.

The ePDG shall route uplink packets to the different bearers based on the uplink packet filters in the TFTs assigned to the bearers in the PDN connection, in the same way as a UE does for uplink traffic under 3GPP access. If no match is found, the uplink data packet shall be sent via the bearer that does not have any uplink packet filter assigned. If all bearers (including the
default bearer for that PDN) have been assigned an uplink packet filter, the ePDG shall discard the uplink data packet.

The PDN GW shall route downlink packets to the different bearers based on the downlink packet filters in in the TFTs assigned to the S2b bearers in the PDN connection, in the same way as the PDN GW does on GTP-based S5/S8 bearers (see 3GPP TS 23.401 clause 4.7.2.2).

5.6.1.3 UE initiated disconnect
The UE initiated disconnect procedure shall be used by UE in the following scenarios:

- The UE is turned off and has one or more active SWu connections to ePDG;
- Wi-Fi connection is turned off and the UE has one or more active connections to ePDG that according to the UE/operator policy should not be handed over to cellular (i.e. depending on policies, see section 6.5); and
- Wi-Fi connection is turned off and UE has one or more active connections to ePDG and no cellular coverage.

For each PDN connection the UE should disconnect, it shall send a IKE Informational request with Delete Payload, which contains the SPI of the IKEv2 SA corresponding to the WLAN UE session to be disconnected.

5.6.1.4 Network initiated disconnect
The UE shall be able to receive an IKEv2 Informational request with Delete Payload, which contains the SPI of the IKEv2 SA corresponding to the WLAN UE session to be disconnected. The UE shall reply with an IKEv2 Information response.

NOTE: The network that initiates the disconnect can be triggered by many reasons like subscription changes, maintenance in network etc.

5.6.2 Trusted Access
The PDN connectivity service (Figure Y, from TS 23.402) is provided by the point-to-point connectivity between the UE and the TWAG concatenated with S2a bearer(s) between the TWAG and the PDN GW.

The bearer model of GTP based S2a interface is similar to that of GTP based S5/S8 interface and GTP based S2b interface. The TWAN handles the uplink packets based on the uplink packet filters in the TFTs received from the PDN GW for the S2a bearers of the PDN connection, in the same way as an ePDG does for GTP based S2b interface.
The trusted access can be used in the following modes:

- **Non-Seamless offload mode** (as from Release 11): this mode does not make use of a P-GW (EAP-AKA’ however supported) and the traffic is routed directly to an external data network via the TWAG. It can also be considered as a specific case of a Single-connection mode.

- **Transparent connection mode** (as from Release 11): single connection to P-GW using S2a but without mobility support between 3GPP and WLAN. Selective offload (e.g. moving one PDN out of two from one access to another) is not possible. This nomadic PDN connectivity enables to have a consistent 3GPP service (re-use of P-GW functionalities) while using a WLAN.

- **Single-connection mode** (as from Release 12): support of a single connection at a time (non-seamless or with a single PDN connectivity). The use of the Single-Connection mode and the associated parameters of the connection can be negotiated during authentication over TWAN. Seamless mobility between accesses in this mode is possible.

- **Multi-connection mode** (as from Release 12): support of multiple connections simultaneously. One connection may be used for Non-Seamless offload and one or more simultaneous connections may be used for PDN connectivity. The use of the Multi-Connection mode can be negotiated during authentication over TWAN and a requested PDN connection can be setup with the WLCP (WLAN Control Plane protocol, as per 3GPP TS 24.244). This mode therefore enables the support of MAPCON (Multi-Access PDN Connectivity) where selective offload is possible (e.g. two PDN connections (e.g. IMS, Internet) over 3GPP and only one (e.g. Internet) needs to be moved to WLAN based on operator policy / rules). Seamless mobility in this mode between accesses is possible.

The above modes are managed in a consistent manner using ANDSF Release 12 and must all be supported by the network. UE-Network negotiation for the chosen mode is done during EAP-AKA’ procedure. For the case of Non-seamless offload see section 6.4.
Seamless mobility (IP address preservation) is possible for trusted access using S2a as from Release 12 and this is possible with both Single-connection and Multi-connection modes. Mobility of a PDN connection between 3GPP and WLAN is not possible with Release 11 as no modifications to the UE was allowed for that release. This restriction has been removed for Release 12.

**NOTE:** It is been recommended by the GSMA / WBA Roaming Task Force to IREG (PACKET#66, July 2013) to support seamless mobility (IP address preservation). Delivery of voice and real time services over Wi-Fi will be the key drivers. Furthermore, besides the recommendation of using GTP as protocol to reach P-GW from a WLAN gateway, usage of Trusted WLAN Access was also mentioned as a priority.

**NOTE:** Though Release 12 is not completed yet (Stage 3), the Stage 2 for Trusted access / S2a (GTP) is stable. However, this PRD can be revisited appropriately if needed after Stage 3 completion. Furthermore QoS support for Trusted WLAN Access will also be introduced in Release 12 and this will need to be incorporated in this PRD. QoS support for real-time services as voice and video telephony is required to maintain an appropriate user experience over WLAN, in particular for seamless mobility support.

## 6 Functional Description & Procedures of EPC-Integrated Wi-Fi

### 6.1 Overview

The EPC supports the use of Wi-Fi Access Networks. The PDN GW is an anchoring point of services (for all accesses), 3GPP services are available through Wi-Fi and there is a local breakout available. Also mobility between 3GPP Access Networks and Wi-Fi is possible.

### 6.2 Mobility Management

Depending on operator policy the EPC network must support network-based mobility management mechanism based on GTP over S2b and (with 3GPP Release 12) over S2a reference points as specified in 3GPP TS 23.402. Connection modes supporting mobility using S2a are described in section 5.6.2.

The mobility management procedures are specified to handle mobility between 3GPP and Wi-Fi Accesses. This applies to UEs either supporting simultaneous radio transmission capability or not supporting it. EPC-based mobility between GERAN/UTRAN Access and Wi-Fi Access requires S4-based SGSNs.

**NOTE:** the handover indication as specified in 3GPP TS 23.402 chapter 8.6 is only supported in GTPv2.

For multiple PDN-GWs connecting to the same PDN, all the PDN GWs shall support the same mobility protocols.

A UE supporting S2b shall

- support seamless handover from LTE to Wi-Fi as described in 3GPP TS 23.402;
- support seamless handover from Wi-Fi to LTE as described in 3GPP TS 23.402;
6.3 Local Breakout
The EPC supports local breakout of traffic whether a roaming subscriber is accessing the EPC via a 3GPP or Wi-Fi Network according to the design principles described in TS 23.402 7.2.4, 7.4.3 and 7.4.4.

6.4 Non-seamless Wi-Fi Offload
Policies for non-seamless Wi-Fi offload must be either pre-defined by the home operator and reside on the UE or be provided via ANDSF according to Release 12 3GPP TS 23.402, that

- state if and when a certain APN can be moved to Wi-Fi using SWu taking into account 3GPP location (e.g. PLMN, tracking area and cell id), Wi-Fi location (i.e., SSID) location and if UE is roaming or not; and

determine which traffic should be routed across different PDN connections and which traffic should be non-seamlessly offloaded to Wi-Fi.

6.5 Multi Access PDN Connectivity
The network must support Multi Access PDN Connectivity (MAPCON) as specified in 3GPP TS 23.402 and TS 24.302. A UE supporting simultaneous radio transmission capability can use MAPCON to offload one or more PDN connections to Wi-Fi while keeping other PDN connections on cellular access.

MAPCON policies must be either pre-defined by the home operator and reside on the UE or be provided via ANDSF according to Release 12 3GPP TS 23.402.

NOTE: It is recommended to have MAPCON policies which keep at least one APN/PDN connection on LTE. This avoids frequent attach procedures, reducing the signaling load in the network (for a typical traffic model) and enables a quicker handover from Wi-Fi to LTE. Also, the UE must stay attached to LTE if CS fallback is used.

7 Roaming Interface

7.1 NNI Overview
EPC integrated Wi-Fi roaming reuses the general IP based NNI structure currently utilized by other systems and services, such as VoLTE roaming and IMS interconnection.

As the EPC integrated Wi-Fi roaming uses the Local Breakout model in order to be aligned with general model selected for the VoLTE roaming, the interfaces carrying signalling over NNI form the main consideration for this document.

General requirements for IP addressing and routing are contained within IR.33, IR.34 and IR.40. General DNS guidelines are described in IR.67.

7.2 IPX Specifics
Generally speaking, the IPX (IP eXchange) as defined by IR.34 is the preferred inter-Service Provider IP network for GSMA. Thus it should also be utilized for purpose of the EPC integrated Wi-Fi roaming.

For further details on IPX, please see GSMA PRDs such as IR.34 and AA.80.
7.3 SWd

SWd runs between 3GPP AAA Proxy and 3GPP AAA Server. The main purpose of this interface is to transport AAA signalling between home and visited networks. General interface description can be found in TS 23.234, whereas the actual SWd protocol is specified in TS 29.273.

The SWd interface uses Diameter protocol as defined in RFC 3588. IR.88 describes how Diameter is utilized in the EPC roaming environment, giving guidance for example on routing and identity related topics. Generally speaking the functionality of SWa, STa, SWm and S6b applies also to SWd. There is no specific Diameter application defined for SWd but it proxies the applications of the interfaces listed above.

As shown in the Figure 3 below, the 3GPP AAA Proxy in the Visited SP acts as a Diameter proxy agent and forwards Diameter commands between the roaming Diameter client and the Diameter server located in the Home SP. As described in IR.88, Diameter traffic over NNI is strongly preferred to utilize DEA (Diameter Edge Agent) nodes at the border of the Service Provider core network to support scalability, resilience and maintainability.

Figure 6: SWd Interface Overview

SWd is used for the following purposes:

- Carrying data for authentication signalling between 3GPP AAA Proxy and 3GPP AAA Server;
- Carrying data for authorization signalling between 3GPP AAA Proxy and 3GPP AAA Server;
- Carrying charging signalling per user;
- Carrying keying data for the purpose of radio interface integrity protection and encryption;
- Carrying authentication data for the purpose of tunnel establishment, tunnel data authentication and encryption, for the case in which the ePDG is in the VPLMN;
7.4 Other Functions

Access Control:

Without an explicit agreement from the HPLMN, the VPLMN must block the access of inbound roamers into their Wi-Fi Access network. This is compulsory to ensure roamers will not experience any service disruption because the necessary technical requirements have not been implemented and tested with the HPLMN.
Annex A  Pre-Release 11 Wi-Fi Roaming Guidelines (a.k.a. The Previous Version of IR.61)

A.1  Basic Information

NOTE: 3GPP SA decided in March 2014 that ongoing WLAN related work in Release 12 shall not take I-WLAN into account (i.e. new WLAN related functionalities may not be backward compatible with existing I-WLAN ones) and that functional modifications of I-WLAN shall be stopped from Release 12 onwards. 3GPP SA will further analyse the specification documentation aspects of this decision, and whether I-WLAN specifications are still needed in Release 12 and will provide further guidance on these matters in June 2014. However, the I-WLAN work (based on 3GPP Release 6/7) from the “legacy IR.61” is annexed here and not deleted (at least for now) as it may be deployed and used by some operators. The 3GPP I-WLAN specifications referenced in this annex (TS 24.234, TS 29.234 and TS 33.234) are all concerned (along with a some others) by the above 3GPP SA decision. *This aspect will be revisited later.*

A.1.1  Scope

The main purpose of this document is to specify a common technical solution for Roaming Service between Wi-Fi Service Providers (SP) from an inter-operator perspective. As a new item it includes WFA relevant aspects of Hotspot 2.0 (HS2.0) implementation to provide automatic network discovery to access roaming Wi-Fi networks. HS2.0 specifies usage of the EAP-methods, too.

It shall cover the following aspects:

- Access interfaces including connection procedures (also according to HS2.0 specification) and authentication
- Inter-operator interfaces for RADIUS authentication and accounting procedures (recommendations for charging principles, billing and settlement are handled in detail by BARG and TADIG)
- 3GPP Release-7 Interworking WLAN related Domain name System (DNS) naming conventions, DNS deployment considerations and guidance for Public Land Mobile Network (PLMN) selection
- 3GPP Release-7 Interworking WLAN related Network Access Identifies naming conventions

The scope of this document is to describe an interoperable way to implement RADIUS based Wi-Fi roaming. Also, within the scope of this document is to describe an interoperable and upwards compatible way to implement 3GPP rel-7 WLAN 3GPP Internet Protocol (IP) Access and 3GPP WLAN Direct Access based roaming that can be deployed before 3GPP Release 7 specifications conforming implementations. 3GPP has implemented inter-operator interface based on AAA protocol (Diameter or Remote Authentication Dial In User Service (RADIUS), however, this document only considers the RADIUS case). This means that also UMTS Subscriber Identity Module ((U)SIM based authentication can be implemented without using
Mobile Application Part (MAP) between operators. GSM Association acknowledges the value of using (U)SIM in Wi-Fi environment.

It is understood that, the current solutions for authentication are Web based login using Username and Password and also the login using Extensible Authentication Protocol (EAP)-SIM or Extensible Authentication Protocol Method for UMTS Authentication and Key Agreement (EAP-AKA or EAP-AKA’) over 802.1X. These solutions use RADIUS as the backend protocol. This document discusses roaming using Web based Username/Password (some implementations may use One Time Passwords for example via help of SMS) or EAP-SIM, EAP-AKA and EAP-AKA’ over 802.1X procedures in detail but also touching other EAP methods. This document also includes recommendations how the relevant aspects of HS2.0 specification should be implemented in this environment.

The importance of (U)SIM-based authentication in a Wi-Fi environment is being addressed by the GSM Association through its strong support for EAP-SIM, EAP-AKA and EAP-AKA’ inter-operator roaming. Preference has also been given to EAP-SIM EAP-AKA and EAP-AKA’ by 3GPP, which is defining an inter-working architecture for 3GPP and WLANs.

A.2 Roaming Network Architecture

The Wi-Fi reference roaming architecture described here defines open interfaces for Access and Inter-Service Provider roaming. This architecture when implemented enables users to globally access Wi-Fi as long as roaming agreements are in place between the Service Providers (MNOs providing Wi-Fi or any other Wi-Fi SP).

![Figure 7: WLAN Roaming Reference Architecture.](image-url)

Two sets of interfaces are required to support the roaming, one between the MT (Mobile Terminal) and the Visited Wi-Fi Network (Ww and Wa interfaces) and another set between Visited Wi-Fi Service Network and Home Wi-Fi Service Network (Wd interface), defined by
The first set of interfaces, as a minimum, is required to provide authentication of the user. User authentication mechanism is a Web based login, using Username/Password over a Secure Sockets Layer (SSL) link with a Web Server hosted by the Visited Wi-Fi SP Network or alternatively EAP-SIM, EAP-AKA or EAP-AKA’ that allows the use of a SIM or USIM for authentication using the IEEE 802.1X EAP framework. Also, it is recommended that other EAP based mechanisms such as EAP-Transport Layer Security (TLS) and EAP- Tunnelled Transport Layer Security (TTLS) are supported in the Access networks, so that they can support those EAP-TLS/TTLS roaming users.

The second set of interfaces is between the Visited Wi-Fi SP Network and the Home Wi-Fi SP Network. This set of interfaces shall perform at least two functions: Authentication and Accounting. In addition, Authorization may also be supported for Username/Password Roaming or SIM/USIM based Roaming using EAP-SIM, EAP-AKA, EAP-AKA’ including other EAP framework methods the protocols are following:

- Authentication protocols and frameworks: EAP-SIM, EAP-AKA, EAP-AKA’, EAP-TLS and EAP-TTLS, EAP, HS2.0, IEEE 802.1X, RADIUS
- Accounting protocols: RADIUS
- Authorization protocols: RADIUS

RADIUS accounting messages shall always be transferred between Home Wi-Fi SP and Visited Wi-Fi SP especially for fraud monitoring and other requirements. Further details are within IETF RFC 2866.

An inter-Service Provider Network is needed when Wi-Fi Roaming between Service Providers is used. This is due to the fact that the RADIUS Roaming Proxy (3GPP AAA Proxy) in the Visited network needs to be able to connect to RADIUS Server in the Home network, since the RADIUS Server located in the Home network is always responsible for example actually authenticating the user, regardless of whether they are roaming or not. This inter-Service Provider interface (NNI) is always based on IP.

IP Exchange (IPX) is the preferred solution for the IP based inter-Service Provider network (between RADIUS Servers) roaming between Service Providers which are MNOs, as it is for other inter-Service Provider IP traffic purposes, for example LTE roaming and MMS interworking. For traffic between Wi-Fi SPs, or between Wi-Fi SP and MNO Wi-Fi SP, alternative solutions such as IPSec could be used. Issues such as quality of service, security, and control of interworking networks, overall reliability and issuing of new network features are easier handled inside IPX than when using public Internet to relay RADIUS based roaming traffic between Service Providers. It should be noted that this does not in any way prevent Service Providers from using public Internet as an inter-Service Provider network, if needed. Security issues related to RADIUS based roaming need to be addressed (for example RFC 2607).
A.2.1 3GPP-WLAN Interworking Overview

The 3GPP-WLAN Interworking and roaming architecture briefly described here defines open interfaces for the Inter-Service Provider roaming. This architecture, when implemented, enables users to globally access 3GPP-WLANs as long as roaming agreements are in place between the Service Providers (Mobile Network Operator (MNO) provided Wi-Fi or any other Wi-Fi Service Provider).

A.2.1.1 Roaming Network Architecture

Figure 5 illustrates the 3GPP-WLAN roaming reference model as defined in 3GPP TS 33.234. The figure contains both WLAN 3GPP Direct Access and WLAN 3GPP IP Access scenarios. WLAN 3GPP IP Access specific components are inside the grey area. The Home network is responsible for access control. Charging records can be generated in the Visited and/or the Home 3GPP networks. The 3GPP Authentication, Authorization and Accounting (AAA) proxy relays access control signalling and accounting information to the Home 3GPP AAA Server using the Wd reference point. The 3GPP network interfaces to Wi-Fi Access Networks via the Wa reference point.

This document concentrates to the following reference points:

- **Wd** – this inter-operator reference point is between the 3GPP AAA Proxy and 3GPP AAA Server, possibly via intermediate networks. The interface is RADIUS or Diameter based. The prime purpose of this reference point is to transport authentication, authorization and related information in a secure manner. EAP-SIM EAP-AKA and EAP-AKA’ as well other EAP framework method authentications shall be transported over the Wd reference point from Visited Wi-Fi SP Network to the Home Wi-Fi SP network.
- **Wa** – This reference point is between the WLAN AN and 3GPP AAA Proxy. This interface is almost the same as Wd interface.
- **Ww** – This reference point is between the WLAN UE and WLAN AN. It contains e.g. 802.1X protocol and functionalities according to HS2.0.

In addition to the interfaces listed above this document also discusses related functionality such as network nodes wherever required.
A.3 Access Interface

This section describes how the roaming user connects to the Wi-Fi and the related procedures and the messaging flow. The Authentication and the Authorization process on the Access interface involves the following steps:

1. 802.11 Association (Open Authentication)
2. 802.1X Authentication process with EAP-SIM, EAP-AKA or EAP-AKA’
3. 802.1X Authentication process according to HS2.0 specification including EAP-methods.

A.3.1 MT Association to the Wi-Fi

For association to the Wi-Fi, the minimum requirement is knowledge of the Visited Wi-Fi Network Service Set Identifier (SSID). There are four basic methods for this association to occur:

1. Manual configuration of the MT with the right SSID
2. Media sensing, browsing and selecting the right SSID
3. Automatic network discovery based on HS2.0 specification
4. Automatic network discovery based on 3GPP Service Provider Advertisement and Selection

A.3.2 Web Based login

A.3.2.1 Sign-on Procedure
The user performs a login to the Wi-Fi Service using the login page provided by the Web browser. The user must provide the Username, which is of the form of a Network Access Identifier (NAI) as defined in RFC 4282. This NAI shall be of the form: Username@Realm.

Where the Username identifies a unique user in the domain described by the Realm. The Realm should be a fully qualified domain name, which signifies the Home Wi-Fi SP. After the Username@realm entry, a password is entered for authentication process. The login page shall not display the password entered.

The Visited Wi-Fi SP can also provide a dropdown box for choosing the Home operator. In this case, the user enters the Username part of the NAI and chooses the Home operator brand name from a list in a dropdown box on the login page (brand name will be given to a roaming partner in IR.21). The Visited Network then concatenates the correct Realm to the Username (thus creating a complete NAI).

A.3.2.2 Secure Login
The Web based login shall use SSL for secure transmission of the user credentials.

A.3.2.3 Protocol Implementation
The Web based login described above is implemented by the Access controller (AC). When the user first tries to browse the Internet, performing a Hypertext Transfer Protocol (HTTP) Get, using the Wi-Fi, the browser is redirected to the login page. The user enters the Username/Password and this is sent using a Hypertext Transfer Protocol Secure (HTTPS) Put to the AC. The AC has a RADIUS client on the backend which transports the Username/Password in the Access request to the Home Wi-Fi SP Radius Server. The rest of the key messages are shown in Figure 6. In some cases Wi-Fi SPs are using WFA specified WISPr mechanism to ease username/password roaming.
**NOTE:** All RADIUS accounting messages are acknowledged even though this is not presented in Figure 6.

There is no mandatory behaviour for the HTTPS login response. Depending on business considerations the Visited Wi-Fi SP Network may decide to push as a HTTPS response to the logon procedure one or multiple pages. Those pages could be any of the following:

- Simple login result page
- Portal page from either the Visited network, Home operator, or hotspot location
- Any other page

**A.3.2.4 Log-Out**

There should be a method for explicit disconnect by the user on a page displayed by the Visited Wi-Fi SP after a successful authentication. This can be for example, a clearly labelled log-out button on a session window provided by the visited Wi-Fi SP.

There is a requirement for Immediate Service Termination functionality by the Home Wi-Fi SP, for example in case of fraud. As there are no standardized ways to implement this functionality (RFC3579 is informational). The recommended mechanism to control user sessions is using Session-timeout parameter to limit their maximum length. The Home Wi-Fi SP should decide the used Session-timeout value.
A.3.3 802.1X AND EAP-SIM, EAP-AKA OR EAP-AKA’ Login

A.3.3.1 SIM/USIM Based Login
There are various user scenarios for SIM/USIM based logins. Authentication can be used in the handheld devices, in 3G laptops (also certain Universal Serial Bus (USB) modems support this feature) and in tablets equipped with 3G. The amount of similar devices is rapidly increasing; consumers expect to connect everywhere and require the same access to the Wi-Fi networks similar to the cellular networks meaning that that is transparent as much as possible. That is increasing the Wi-Fi usage and simultaneously offloading traffic from cellular networks to the Wi-Fi networks.

A.3.3.2 802.1X Authentication
When the users with the Mobile Terminals roam into the Wi-Fi Hotspot they expect to get authenticated by the GSM Home Network using SIM/USIM credentials they possess. The Wi-Fi service based on 802.11 uses 802.1X as the flexible authentication and security framework for supporting multiple authentication credential types including SIM/USIM. EAPOL defined within 802.1X provides this flexibility by allowing EAP based authentication methods to be used transparently over the radio link. The Wi-Fi AP that supports RADIUS also allows EAP messages to be carried transparently to the Home SP Network.

A.3.3.3 EAP-SIM, EAP-AKA and EAP-AKA’ Authentication
This section describes (U)SIM based Wi-Fi authentication using the EAP-SIM protocol IETF RFC4186 or the EAP-AKA and EAP-AKA’ protocol, IETF RFC 5448. The use of EAP-SIM provides the following features:

- Allows re-use of the existing GSM authentication infrastructure for Wi-Fi authentication
- Mutual authentication of the Mobile Terminal and the Network
- Dynamic session key establishment for use in link layer (WPA or WPA2) encryption
- Basic IMSI privacy protection
- An optimized re-authentication procedure
Figure 10: SIM Based Login Message Flow Overview

Figure 7 captures the high-level message flows between the various entities in the visited Wi-Fi Network and the Home Wi-Fi Network RADIUS Server. The IEEE 802.1X Protocol runs between the Mobile Terminal and the Access Point for the purposes of authentication. The Port Access Entity (PAE) implemented on the Access Point is responsible for blocking all user traffic except EAP packets until authentication completes. The AP also has a RADIUS client function which is responsible for initiating the RADIUS protocol which finally terminates on the Home Wi-Fi Network RADIUS Server. This RADIUS client is implemented based on the "IEEE 802.1X RADIUS usage guidelines", RFC3580, and is responsible for interpreting and appropriately forwarding the EAP packets between the AP and the Home SP Wi-Fi Network. The Visited SP Wi-Fi Network RADIUS Server/Proxy does not modify the EAP message passing through it. However the Visited SP Wi-Fi Network RADIUS Server/Proxy is
responsible for routing the EAP packets to/from the appropriate Home SP Wi-Fi Network RADIUS Server.

Once the Mobile Terminal associates with the Access Point, the EAPOL-Start message is optionally sent by the MT to trigger the 802.1X authentication process based on EAP. The EAP Identity Request is sent to the MT which responds with EAP Identity Response which carries the NAI (username@realm). The Username can be IMSI or a temporary pseudonym and the ‘realm’ will be a fully qualified domain name that identifies the home Wi-Fi SP Network. The usage and format of NAIs for 3GPP-WLAN Interworking have been defined in the 3GPP TS23.003. Within IR.61 scope the definitions standardized in the 3GPP TS23.003 should be followed.

The home Wi-Fi SP Network RADIUS Server recognizing the Username will attempt to start the EAP-SIM exchanges using the RADIUS Access Challenges/Requests. Following the successful authentication using EAP-SIM the RADIUS Access Accept message sent from the server will result in an EAP Success message to the Client by the AP. This RADIUS message also carries EAP-SIM derived keying material for the session, which needs to be provided to the AP. The MT also derives keying material as part of EAP-SIM authentication. Ciphering keys are set-up using this keying material on the MT and the AP as part of completing the 802.1X key setting procedures. Please refer to the IEEE 802.1X and 802.11i specifications for details on the key setting procedure. The 802.1X PAE now opens the WLAN for user data traffic that is ciphered using the keys setup earlier.

The Accounting Start message needs to be sent by the AP to the Home Wi-Fi SP Network RADIUS Server for indicating the start of the accounting session. When the Mobile Terminal Disassociates, or terminates the login session, the AP needs to send the Accounting Stop message to indicate the session termination to the Home Wi-Fi SP Network RADIUS Server. Interim Accounting messages are also sent during the session for fraud monitoring and other purposes. These Accounting Messages are defined in RFC 2869.

The EAP-AKA and EAP-AKA', IETF RFC 5448, network access authentication principle is identical to the EAP-SIM. Access network nodes (including WLAN Access Points) and intermediate networking nodes do not need to be upgraded for the EAP-AKA or EAP-AKA' if the EAP-SIM is already supported. However, support for the AKA or AKA' is required from both terminal and backend AAA-server.

A.3.3.4 NAIs for EAP-SIM/AKA/AKA' Authentication

EAP-SIM, EAP-AKA and EAP-AKA' use a set of different identities during the authentication. These identities, full identity, pseudonym identity and re-authentication identity are expressed in form of Network Access Identities (NAI). The following sub-clauses describe all these identities as they are defined in the 3GPP TS23.003. The username part of the NAI contains the identity of the subscriber and the realm part is used for AAA routing. The GSMA PRD IR.67 contains more information concerning the realms used within 3GPP-WLAN Interworking.

A.3.3.4.1 Root NAI

The NAI used within the Release-7 3GPP-WLAN Interworking during full authentication is the Root NAI. The format of the root NAIs are shown below:
For example, for EAP-SIM authentication: If the IMSI is 234150999999999 (MCC =234, MNC =15), the root NAI then takes the form 1234150999999999@wlan.mnc015.mcc234.3gppnetwork.org.

A.3.3.4.2 Fast Re-authentication NAI Root NAI
Fast re-authentication is an optional but important optimization to EAP-SIM/AKA/AKA’ and defined in the respective IETF RFCs 4186,5448 and 3GPP TS23.003. The Fast re-authentication provides authentication that does not require new vectors from the HLR/HSS, which makes it a relevant optimization considering the possible reduction on the HLR/HSS load.

A WLAN UE should honour and utilize the fast re-authentication identity returned by the Home AAA-server. If the 3GPP AAA server does not return a complete NAI including both username and realm parts, the Fast Re-authentication NAI shall consist of the Username part of the fast re-authentication identity as returned from the 3GPP AAA server and the same realm as used in the permanent user identity. If the 3GPP AAA server returns a complete NAI as the re-authentication identity, then this NAI shall be used.

A.3.3.4.3 Pseudonym Length
3GPP TS33.234 defines the algorithm for the pseudonym generation and encoding to be used with EAP-SIM/AKA/AKA’. These are additional clarifications to the respective EAP-SIM, EAP-AKA’ and EAP-AKA, RFCs. IETF RFCs allow identity and pseudonym lengths up to 253 octets whereas the 3GPP defines the maximum 63 octets (including the possible realm part of the identity). Because of the backwards compatibility reasons with some RADIUS implementations 63 octets maximum length should be used. Furthermore, some WLAN UEs may restrict the length of the NAI to less than 253 octets, thus 63 octets from this point of view is also a safe value.

A.3.3.5 Support of Other EAP Methods
HS2.0 specifies the usage of the other EAP-methods. Each Wi-Fi SP Network should be capable to transmit EAP-TLS and EAP-TTLS requests to the customer’s Home SP Network (note: this does not mean that each SP should support EAP-TLS/TTLS authentication for their own customers, but just to support forwarding these requests to the correct Wi-Fi SP according to roaming agreements). The functionality of Hotspot 2.0 also makes it possible to deploy roaming to Wi-Fi networks on a large scale.

Accounting messages for EAP-TLS and EAP-TTLS are the same as on EAP-SIM/AKA/AKA’.
A.3.4  **HS2.0 Based Network Discovery**

The HotSpot 2.0 specification provides automatic network discovery for Wi-Fi networks, a functionality that is presented and familiar from the mobile networks and it is based on 802.11u specification. This functionality automates correct SSID discovery and simplifies authentication thus increasing the Wi-Fi usage and data offloading. It also uses EAP methods for the authentication and uses WPA2-Enterprise for the encryption of the data.

A.3.4.1  **Network selection**

The functionality is based on the AP advertising/broadcasting roaming partners NAI Realm list that the AP/Service Provider has a roaming agreement. The functionality is like in the mobile networks.

Even though HS2.0 supports all kinds of NAI Realms, it is recommended that MNOs use 3GPP defined Home Network Realm for WLAN usage (FQDN: wlan.mnc<MNC>.mcc<MCC>.3gppnetwork.org) as per TS 23.003 Section 14.2, since generation of this Home Network Realm can be automatically created from the (U)SIM card in the mobile device.

A.3.4.2  **EAP support**

The HS2.0 specification includes support for EAP-SIM, EAP-AKA and EAP-AKA' as well EAP-TTLS and EAP-TLS. The specification mandates a Hotspot 2.0 SP (MNO) having SIM/USIM infrastructure to support SIM/USIM credentials and their associated EAP methods and shall support at least one of the following: username/password or certificate credentials and their associated EAP method.

**NOTE:** HS2.0 mandates all HS2.0 operators to provide EAP-TLS or EAP-TTLS for their own customers. MNOs cannot commit to this since this is business related decision and the choice is up to MNO what to support/provide for their own customers.

A.3.5  **Service Provider Advertisement and Selection**

Figure 8 provides a logical overview what kind of use scenarios 3GPP-WLAN SP/network advertisement and selection is supposed to support. Basically the WLAN UE may authenticate back to home SP Network either directly or via some visited SP Network.
Figure 11: PLMN and Network Advertising and Selection Scenario

3GPP-WLAN Interworking Network selection consists of two procedures: the Interworking WLAN Access Network selection procedure, and the PLMN selection procedure. These procedures are applicable to initial network selection at WLAN UE switch on and following recovery from lack of WLAN radio coverage. In order to ensure that the result of network selection is the association with an Interworking WLAN that has direct connection to HPLMN, both procedures are linked to each other. Two 3GPP-WLAN Interworking network selection modes are defined: automatic and manual. Other network selection modes may be supported but they are implementation dependent.

During the WLAN access network selection procedure the WLAN UE uses at least passive scanning to find all available SSIDs. WLAN UE may also support and use active scanning. The result of passive and active scanning is a list Available SSIDs, which is then used to assist the subsequent PLMN selection procedure.

The Network discovery and selection procedure is executed between WLAN UE and the local AAA for the purpose of sending the WLAN UE the Supported PLMNs list for Wi-Fi access. The WLAN UE should support the Network discovery procedure as specified in the IETF RFC4284. The automatic network discovery procedure is greedy and the WLAN UE always tries to authenticate directly to HPLMN. Whenever a direct connection to HPLMN is found the WLAN UE exits the network selection procedure. If no direct connection is found the WLAN UE should use the highest priority VPLMN that provides connectivity to the HPLMN. In practise terminal and infrastructure vendors have been very slow in adopting 3GPP defined network discovery and selection functionality. Everything is still practically based on lists of SSIDs.

Should the WLAN UE want to find all PLMNs supported by all reachable WLAN ANs, then the WLAN UE must use the manual network selection procedure. During the manual network selection procedure the WLAN UE uses an AlternativeNAI instead of the Root NAI. The WLAN
UE initiates the EAP network discovery with every Wi-Fi network it can hear and attach to. The AlternativeNAI triggers the network discovery procedure and is used for the manual selection procedure. The AlternativeNAI MUST have the Realm part "unreachable.3gppnetwork.org" (as mandated by GSMA).

User and the operator should have a possibility to prioritize the order the WLAN UE selects WLAN networks and eventually selects the used PLMN. This is achieved through the use of:

- User defined list of preferred SSIDs and PLMNs (if Visited PLMNs are supported)
- Operator defined list of preferred SSIDs and PLMNs (if Visited PLMNs are supported)

The priority order is 1) user defined list, 2) operator defined list and 3) WLAN UE defined order (based on the implementation).

A.3.6 WLAN 3GPP IP Access End-To-End Tunnelling

The end-to-end tunnel in WLAN 3GPP IP Access is currently Internet Protocol Security (IPSec) and Internet Key Exchange (IKEv2) described in IETF RFC4306, based Virtual Private Network (VPN)-tunnel. The tunnel end-points are the UE and the Packet Data Gateway (PDG) in Home Wi-Fi Service Provider (also Visited Wi-Fi Service Provider case has been specified), and its purpose is to provide the user with a secure data access to the 3GPP-WLAN core network for accessing 3GPP PS based services (for example IMS). The tunnel establishment is initiated by the WLAN UE, specifically speaking a VPN client running in the WLAN UE, to the VPN gateway running in the PDG. A PDG is located using Wireless Access Point Names (W-APN) in a same way APNs are used in the mobile networks. The WLAN UE is authenticated during the IKEv2 negotiation using EAP-SIM/AKA/AKA'. After the IKEv2 IPSec tunnel establishment the user plane IP traffic from the WLAN UE gets securely routed through the PDG towards the external network pointed by the W-APN.

The WLAN UE constructs a FQDN using the W-APN Network Identifier and (V)PLMN ID as the Operator Identifier and performs a DNS query to resolve it. The DNS response will contain one or more IP addresses of equivalent PDGs that support the requested W-APN in the (V)PLMN according to standard DNS procedures. If the (V)PLMN does not support the W-APN, then the DNS query returns a negative response. The detailed DNS related information is documented in GSMA PRD IR.67.

3GPP has specified that there can be operator defined number of IPSec SAs per IKE SA. This information is configured into each PDG. The subscriber may have several simultaneous active tunnels set up (that is multiple IKE SAs). The maximum number of IKE SAs can be specified by the operator in the subscriber profile data.

A.4 Inter-Service Provider Interface (NNI)

Subscribers roaming in Wi-Fi Networks are authenticated and authorized using the Inter-Service Provider interface between the Visited Wi-Fi SP Network and the Home Wi-Fi SP Network. Another Inter-operator interface is responsible for the Data clearing or specifically the charging and settlement functionality. The Authentication, and Authorization Inter-operator interface is based on RADIUS as shown in the Figure 9. RADIUS is used to transfer the Authentication and Authorization information between the Visited Wi-Fi Network and the Home
Wi-Fi SP Core Network where the AAA Server resides. These transfers are made based on Roaming Agreements signed between the Wi-Fi SPs.

The AAA information in the roaming case may be routed from the Visited Wi-Fi SP Network to Home Wi-Fi SP Network directly or using a single RADIUS proxy or a network of such proxies that work in tandem. Such a RADIUS proxy network is often used in complex Wi-Fi Network deployments across several geographies for optimal AAA routing purposes. It is possible for the same business entity to support the WLAN Roaming Proxy function using RADIUS proxies and the Data clearing functions.

**Figure 12: Inter-Operator Interfaces for AAA, Charging and Settlement**

**A.4.1 Radius Roaming Network**

RADIUS Roaming Network is used for passing authentication, authorization and accounting data, AAA.

- AAA server requirements:
- AAA servers shall be capable of RADIUS Proxy.
- AAA servers shall be capable of identifying realms in a Username string and taking proxy action based on the realm.

Figure 10 gives an overview of how RADIUS Roaming Traffic is routed to different Roaming Partners based on Realms using IPX. Local user database in Figure 10 is an informative entity used only when inter-operator roaming is not used, that is user local access Wi-Fi service. It is therefore not directly related to actual inter-operator roaming.
Figure 13: Logical overview from a provider’s perspective how connection is made to the Roaming Partner networks. Service Provider X can represent any of the Roaming Partners.

Figure 10 also demonstrates how Roaming Partners actually connect to each other via Inter-Service Provider Network, e.g. IPX. During the Roaming login, user inserts their Username (with realm) & password and authentication request is proxied to Service Provider Y. User is then authenticated using the Service Provider Y’s user database. Necessary RADIUS messages are transferred between RADIUS Roaming Proxies using the IP based inter-Service Provider network, e.g. IPX.

An IPX network is used for transporting RADIUS authentication and accounting messages for Wi-Fi roaming services.

A.4.1.1 Authentication and Authorisation

RADIUS Server controlling the Visited SP Wi-Fi will recognize the Realm and proxy the RADIUS Access-Request towards the identified Home Wi-Fi RADIUS Server based on Realm. Username and password are RADIUS parameters.

Local validation is ignored and Access-request is routed to the Home SP Wi-Fi SP authentication server.

The Home Wi-Fi Service receives the Access-request and authenticates the user, e.g. using PAP either EAP-SIM/AKA authentication.

Following authentication, during Home SP Wi-Fi RADIUS Server authenticates the user and sends an Access-Response to the Visited Wi-Fi SP RADIUS server. It should be noted, that...
Home Wi-Fi SP carries out subscriber specific barring or prevention of Wi-Fi access. If the Home Wi-Fi SP sends a successful RADIUS Authentication Accept to Visited Wi-Fi SP, then the Visited Wi-Fi SP can assume that this subscriber is allowed to use the Wi-Fi service.

If the authentication was successful, the Visited Wi-Fi SP RADIUS Server enables session.

The Home Wi-Fi SP sends a subscriber identity to a Visited SP using Radius Chargeable User Identity attribute defined in IETF RFC 4372. It may include IMSI, Username or any other identity that is used for the billing purposes and is agreed with Roaming Partners.

A.4.1.2 Accounting and Log-out

When a new session starts, the following actions are performed:

1. Visited Wi-Fi SP RADIUS Server starts session statistics recording and sends RADIUS Accounting Start message to the Home Wi-Fi SP.
2. During connection the Visited Wi-Fi SP RADIUS Client checks if the connection is disconnected e.g. by radio connectivity loss or user inactivity timer expiry. If this occurs, RADIUS Accounting Stop message must be sent to the Home Wi-Fi Service.
3. Interim accounting messages shall be supported according to the requested time interval set by the Home Wi-Fi SP (e.g. to support prepaid and prevent fraud). It is recommended in RFC2869 that the interim time interval should not be smaller than 600 seconds. Time interval can be a part of IR.21 (or part of Wi-Fi Roaming Agreement).
4. A Log-out session window is provided by the Visited Wi-Fi SP.
5. When the user log-offs, the connection is terminated and the Visited Wi-Fi Service Provider’s RADIUS Client completes session statistics recording and sends RADIUS Accounting Stop message to the Home Wi-Fi SP.

A.4.1.3 RADIUS Attributes for Web Based Login

Basic RADIUS authentication and authorization is defined in RFC 2865. RADIUS accounting is defined in RFC 2866, while RADIUS extensions are defined in RFC 2869. The following list defines the minimum preferred RADIUS attribute set for the RADIUS servers and roaming proxies used in GSMA Wi-Fi roaming concept:
<table>
<thead>
<tr>
<th>Required Attribute</th>
<th>#</th>
<th>Type</th>
<th>Auth Request</th>
<th>Auth Response</th>
<th>Acct’ing start</th>
<th>Acct’ing stop</th>
<th>Acct’ing interim</th>
<th>Comment</th>
</tr>
</thead>
</table>
| User-name          | 1 | String | x            | x             | x              | x             | x              | - Users NAI (includes Username and realm)  
- This is given by the user over SSL.  
- Authentication reply can be used to override the Username given by user |
| User-password      | 2 | String | x            |               |                |               |                | This is given by the user over SSL |
| NAS-IP-Address     | 4 | Ipaddr | x            | x             | x              | x             | x              | IP address of the Access Controller (the address of RADIUS client). This address is not necessarily a public IPv4 address (see Note (1)). This address has typically an operator internal significance. Within one WLAN session the NAS IP address shall remain constant. |
| Class              | 25 | String | X            | x             | x              | x             | x              | Class attribute is used to link authentication and accounting sessions in RADIUS server.  
This Attribute is sent by the Home RADIUS server to the client in an Access Response and MUST be unmodified by the RADIUS client in Visited Network as part of all the Accounting-Start packets.  
May be also used for e.g. fraud detection. |
<p>| Session-timeout    | 27 | Integer | X            |               |                |               |                | Forced logout once timeout period reached (seconds). Can be used e.g. for pre-paid subscribers, to limit the potential financial loss from fraud cases, and to enable terminating ongoing accounting sessions in error cases (See note 2). |
| Acct-status-type   | 40 | Integer | x            | x             | x              |               |                | 1=start, 2=stop, 3=Interim update |</p>
<table>
<thead>
<tr>
<th>Required Attribute</th>
<th>#</th>
<th>Type</th>
<th>Auth Request</th>
<th>Auth Response</th>
<th>Acct’ing start</th>
<th>Acct’ing stop</th>
<th>Acct’ing interim</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acct-Input-Octets</td>
<td>42</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volume of the downstream traffic of the user.</td>
</tr>
<tr>
<td>Acct-Output-Octets</td>
<td>43</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volume of the upstream traffic of the user.</td>
</tr>
<tr>
<td>Acct-Session-ID</td>
<td>44</td>
<td>String</td>
<td></td>
<td>X</td>
<td>x</td>
<td></td>
<td></td>
<td>A session ID given by a NAS for a unique accounting correlation ID (between accounting start, interim and stop). Accounting and authentication messages related to a certain WLAN session will use the same session ID.</td>
</tr>
<tr>
<td>Acct-session-time</td>
<td>46</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>WLAN session duration in seconds</td>
</tr>
<tr>
<td>Acct-Input-packets</td>
<td>47</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Number of packets (downstream)</td>
</tr>
<tr>
<td>Acct-output-packets</td>
<td>48</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Number of packets (upstream)</td>
</tr>
<tr>
<td>Acct-terminate-cause</td>
<td>49</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1=explicit logoff, 4=idle timeout, 5 =session timeout, 6=admin reset, 9=NAS error, 10=NAS request, 11 =NAS reboot</td>
</tr>
<tr>
<td>Acct-Input-Gigawords</td>
<td>52</td>
<td>Integer</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>Indicates how many times the Acct-Input-Octets counter has wrapped around its 4 byte length (i.e. Acct-Input-Gigawords &gt; 0 when volume of the downstream traffic of the user exceeds 4 GB). Attribute present if needed</td>
</tr>
<tr>
<td>Acct-Output-Gigawords</td>
<td>53</td>
<td>Integer</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Indicates how many times the Acct-Output-Octets counter has wrapped around its 4 byte length (i.e. Acct-Output-Gigawords &gt; 0 when volume of the upstream traffic of the user exceeds 4 GB). Attribute present if needed</td>
</tr>
<tr>
<td>Event time stamp</td>
<td>55</td>
<td>Integer</td>
<td></td>
<td>X</td>
<td>x</td>
<td></td>
<td></td>
<td>Number of seconds elapsed since January 1 1970. UTC time.</td>
</tr>
<tr>
<td>Required Attribute</td>
<td>#</td>
<td>Type</td>
<td>Auth Request</td>
<td>Auth Response</td>
<td>Acct’ing start</td>
<td>Acct’ing stop</td>
<td>Acct’ing interim</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------</td>
<td>-----------</td>
<td>--------------</td>
<td>---------------</td>
<td>----------------</td>
<td>---------------</td>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>NAS-port-type</td>
<td>61</td>
<td>Integer</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>15=Ethernet, 19=802.11</td>
</tr>
<tr>
<td>Acct-Interim-Interval</td>
<td>85</td>
<td>Integer</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Interval (seconds) to send accounting updates given by Home operator. Needed e.g. if pre-paid is implemented between operators.</td>
</tr>
<tr>
<td>Operator-Name</td>
<td>126</td>
<td>String</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>This attribute defines the operator identity with which the roaming user’s Home Operator has the roaming agreement. The operator identity can be e.g. used for Inter Operator Tariffing purposes. IETF RFC 5580 See Appendix A for more information about this vendor specific attribute.</td>
</tr>
<tr>
<td>Location-Information</td>
<td>127</td>
<td>String</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>This attribute defines the location of the operator the roaming user’s Home operator has a roaming agreement with. Mandatory information in this attribute includes: ISO 3166 country code. The location information can be e.g. used for the end user roaming billing taxation, and roaming awareness purposes. See Appendix A for more information about this vendor specific attribute.</td>
</tr>
<tr>
<td>Location-Data</td>
<td>128</td>
<td>String</td>
<td>X</td>
<td></td>
<td>X</td>
<td>x</td>
<td></td>
<td>This attribute defines the name for the location of the operator the roaming user’s Home Operator has a roaming agreement with. Locations are names as “Airport”, “Hotel”, “Mall” and so on. Refer the IETF DRAFT draft-ietf-simple-rpid-02.txt for the exact presentation of this attribute. See Appendix A for more information about this vendor specific attribute.</td>
</tr>
<tr>
<td>Vendor Specific Attribute</td>
<td>26, 15297,196</td>
<td>String</td>
<td>X</td>
<td></td>
<td>X</td>
<td>x</td>
<td></td>
<td>This attribute defines the Visited Operator identity with which the roaming user’s Home operator has the roaming agreement. This attribute is used to identify the intermediating operator if there is no direct roaming relationship between the Visited Network Operator and the Home Network Operator. The</td>
</tr>
<tr>
<td>Required Attribute</td>
<td>#</td>
<td>Type</td>
<td>Auth Request</td>
<td>Auth Response</td>
<td>Acct'ing start</td>
<td>Acct'ing stop</td>
<td>Acct'ing interim</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---</td>
<td>------</td>
<td>--------------</td>
<td>---------------</td>
<td>----------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>---------</td>
</tr>
<tr>
<td>Visited-Operator-ID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Operator-Visited identity can be e.g. used for Inter Operator Tariffing purposes. See Appendix A for more information about this vendor specific attribute.</td>
</tr>
</tbody>
</table>
A.5 NOTES:

If a NAS-IP-Address is a private address; correlation of RADIUS-Accounting messages is not possible. Therefore this address should be a public one. However, an operator most likely has several access controllers and also several NAS-IP-Addresses. Thus achieving roaming awareness (i.e. from which Visited Wi-Fi SP the RADIUS Accounting message came via just this attribute is not practical. A Wi-Fi Service Operator would have to keep up to date lists of all the NAS-IP-Addresses of all its Roaming Partners. Furthermore, this attribute does not explicitly define the location of the Wi-Fi User, as there can be several hotspots under one Access Controller. A way to transport location information and to achieve better roaming awareness is for further study.

By using session timeout limiting the maximum length of a user session and thus limit the maximum loss that can occur after a user account is terminated because of fraud.

Also if for some reason no Acct-stop message is received from the Visited Wi-Fi SP in the Home Wi-Fi SP, there are two different possibilities to control it:

It is possible to terminate the accounting session if it is longer than the session timeout interval, therefore no accounting sessions are left open indefinitely. Leaving accounting sessions open may prevent users from logging in again if the Home WO does not allow more than one session per subscription. The session-timeout also limits the maximum loss for the customers if the Wi-Fi connection is left open and idle timeout mechanisms are not working ideally (e.g. when Users mobile terminal/client software is keeping the Wi-Fi connection alive).

Interim accounting timers are recommended and offer a more flexible way to control the session if some messages get lost. Recommended interval for sending Interim accounting messages is 20 minutes. However, if they are not supported by one of both Wi-Fi Roaming Partners, the solution is then applicable for managing the session when RADIUS messages get lost. Even if Acct-Interim messages are used, the Visited Wi-Fi SP should accept the Session-Timeout attribute sent by the Home Wi-Fi SP and use it to limit the maximum session length.

A.5.1.1 RADIUS Attributes for EAP-SIM, EAP-AKA’ and EAP-AKA Usage

Basic RADIUS authentication & authorization is defined in RFC 2865. RADIUS accounting is defined in RFC 2866, while RADIUS extensions are defined in RFC 2869. EAP-SIM, EAP-AKA and EAP-AKA’ using 802.1X are defined in RFC 3579, RFC 3580 and RFC4372. 3GPP 29.234 defines how the attributes are used in the GSMA Wi-Fi roaming.

A.5.1.2 Configuration

Configuration parameters:

RADIUS IP (public IPv4 address)
Within the first phase it is expected that static mappings are used to find RADIUS Roaming Proxies, thus DNS is not utilized.
Shared Secret encryption is limited to the password. For this reason the Shared Secret must be delivered to each Roaming Partner. If an IPX is used as inter-operator network, then Shared Secret could offer enough security, since the IPX is a private network.

However, if an inter-operator network is based on public Internet, inter-connection MUST be protected by an IPSec VPN tunnel, in addition to the RADIUS Shared Secret encryption, since VPN offers a higher level of security.

RADIUS Message Encryption
It is beneficial to secure RADIUS messages between Home Wi-Fi SP and Visited Wi-Fi SP. If IPX is used as an inter-operator network, then Shared Secret could offer enough security since IPX is a private network. However, if public Internet is used as an inter-operator network, then it IPSec ESP VPN with 3DES encryption is recommended to secure RADIUS messages. Options are not limited to that, for example DES could be used instead of 3DES, if 3DES is not allowed due to regulations.

Actual parameters of VPN should be bilaterally agreed on, however, both parties need to have identical configurations. Because of this, it is recommended that the parameters given in Table 5.1.6 be used to facilitate setting up IPSec connections and IKE if dynamic keying is to be used.

NOTE: This VPN is deployed only between RADIUS Roaming Proxies of Visited Wi-Fi SP and Home Wi-Fi SP, thus RADIUS Message Encryption is not related to any kind of VPN used between MT and e.g. corporate network.

Ports(UDP)
Recommended standard is port 1812 and 1813.
The user needs to provide the Username, which is of the form of a Network Access Identifier (NAI) as defined in RFC 4282. This NAI shall be of the form: `Username@Realm`.

The Username in NAI identifies a unique user in the domain described by the Realm. The Realm shall be a fully qualified domain name signifying the Home Wi-Fi SP.

### A.5.1.4 Roaming Implementation

This informative section lists issues that are needed in order to implement Wi-Fi Roaming using RADIUS:

In case of Web-based login, Wi-Fi services shall be open and WEP encryption not to be used.

Inform each Roaming Partner about:

- Shared Secret
- RADIUS Roaming Proxy/DNS
- Ports (UDP)
- Realms

The firewalls shall be open for each connection between two IP-addresses and ports.

**NOTE:** That only public IPv4 addresses should be used in roaming proxies.

RADIUS Servers have to be configured so that remote RADIUS Servers are clients for the local RADIUS Server. Shared secrets for each connection have to be defined.
GSM Association Non-confidential

Official Document IR.61 - Wi-Fi Roaming Guidelines

RADIUS Roaming Proxy features should be configured so that certain Realm is mapped to the certain IP-address/port.

Usernames and passwords for the testing have to be delivered for each Roaming Partner.

Define Test Instructions: Perform tests according to Test Instructions.

A.5.2 Radius Attributes for EAP-AKA AND EAP-AKA’ Application

The required RADIUS attributes for EAP-AKA and EAP-AKA’ authentication are exactly the same as for the EAP-SIM.

A.6 Co-Existence and Migration

A.6.1 Web Based Authentication and 802.1x Authentication

Web based login using username/password authentication is considered as an existing solution for the Wi-Fi authentication when the target solution today is an EAP based authentication solutions. It is important still that it is possible for existing solutions to work as long as justified from a business perspective beside the target solution. Going even further HS2.0 brings a new target, reusing EAP methods with new automated network discovery functionality.

To support EAP-SIM/AKA/AKA’/TLS/TTLS based roaming, it is expected that the Visited Wi-Fi Service Provider supports 802.1X and WPA (Wi-Fi Protected Access) or WPA2. WPA is a standards-based specification that provides an interoperable security solution for accessing Wi-Fi services. WPA2 is also a standards-based specification that provides enhanced security than WPA presenting Advanced Encryption Standard (AES) encryption.

To support relevant aspects of HS2.0 from roaming point of view does not bring anything new to the existing roaming interface. The new features are between Mobile Terminal and a Wi-Fi access point. The main HS2.0 features required to the Mobile device are support for automatic network selection based on 802.11u and support for WPA2-Enterprise data encryption. HS2.0 also includes the fall-back functionality, in case that device is equipped with HS2.0 capabilities but the networks are not. In that case user must use other methods to find correct SSID.

A.6.1.1 Web Based Authentication Using Home Wi-Fi SP Login Page

The web based username/password authentication shall be supported in the Visited SP Network as described in Chapter 4. However, there can be roaming cases where enabling additionally the use of Home Wi-Fi SP login page in Visited Wi-Fi SP Network can be necessary. Some operators may require the functionality for their login method to work (for example some implementations that send One Time Passwords via SMS). Additionally in this solution, the login and help/other informational pages can be displayed in a language chosen by Home Wi-Fi SP.

While displaying the Home Wi-Fi SP login page in the Visited Wi-Fi SP Network should not be mandated, it can be bilaterally agreed on within the Roaming Agreements. Described below is a recommendation how to implement a redirection to a Home Wi-Fi SP login page in a way that ensures maximal interoperability and minimal effect on the roaming infrastructure. The described mechanism can be implemented without changing the Visited
Wi-Fi SP Network RADIUS elements. This is because the mechanism works on the http(s) level, the RADIUS message flow does not change.

The proposed roaming functionality requires some modifications both to Home and Visited Wi-Fi SP Network’s web login page hosting elements. It also introduces WWW-proxy server to Visited Wi-Fi SP Network that forwards the parameters used in Visited login page’s http(s) post operation to the access controller. The Home Wi-Fi SP Network needs to implement a WWW server that hosts their login page(s) and can use the parameters from the Visited Wi-Fi SP Network.

A.6.1.2 Sign-on Procedure

After being redirected to the Visited Wi-Fi SP login page, the user selects his Home Wi-Fi SP (for example from a drop-down list). The user is then directed to the Home Wi-Fi SP login page. The user performs a login to the Wi-Fi using that page. The user needs to provide the Username, Password, and the realm as described in chapter 4.

A.6.1.3 Secure Login

The Web based login shall use SSL for secure transmission of the user credentials.

A.6.1.4 Protocol Implementation

The Web based login described above is implemented by the Access Controller (AC), Visited Wi-Fi SP WWW-proxy, and Home Wi-Fi SP WWW-server.

When the user first tries to browse the Internet, performing an HTTP Get, the browser is redirected to the Visited Wi-Fi SP login page. The Home operator choice is forwarded to the Visited Wi-Fi SP WWW-proxy-server in a HTTP(S) Get. The Visited WWW-proxy forwards it as an HTTP(S) Post to Home SP WWW-server. The Visited Wi-Fi SP adds hidden attributes to the HTTP(S) Post that inform the Home network about the correct address to which the final html-form should be submitted. The Home WWW-Server is capable of changing its login page’s variable names using the hidden attributes. Because the variables must be the same in both Visited and Home Wi-Fi SP Networks, a recommended format is presented in Table 6.1.4.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable’s function</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Username</td>
<td>Stores the variable name for the username-attribute. The username-attribute also contains the realm.</td>
<td>$username = “user@realm”</td>
</tr>
<tr>
<td>Password</td>
<td>Stores the variable name for the password-attribute</td>
<td>$password = “pwd”</td>
</tr>
<tr>
<td>loginPostURL</td>
<td>Stores the address to which the HTML-Form is submitted</td>
<td>$loginPostURL = “192.168.1.1/cgi-bin/login”</td>
</tr>
</tbody>
</table>

Table 1: Recommended Format for Parameters

Using the variables above, the Home Wi-Fi SP Network modifies its login page’s parameters to use the Visited Wi-Fi SP Network’s login page’s parameters. The user enters a Username/Password-pair to the Home Wi-Fi SP login page and this is sent using the
received attributes via an HTTP Post to the Visited Wi-Fi Service Provider’s AC. The resulting RADIUS message flow is as described in chapter 4.

NOTE: All RADIUS accounting messages are acknowledged even though this is not presented in Figure 11.

There is no mandatory behaviour for the HTTP login response. Depending on business considerations the Visited Wi-Fi SP Network may decide to push as a HTTP response to the logon procedure one or multiple pages. Those pages could be any of the following:

- Simple login result page
- Status
- Portal page from either the Visited network, Home operator, or hotspot location or
- Any other page

The Visited Wi-Fi SP is the master of the user’s session and status. Therefore it is up to the Visited Wi-Fi SP how this information is displayed to the user.

A.6.1.5 Home Wi-Fi SP Information-Page (optional)

If bilaterally agreed on, the Home operator can provide an additional info-page for its users.

The info-page could inform the user about, but not limited to, the following items:

- Context Help
- User Information
The info page should be called by a HTTP-Get request with the following parameters:

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable’s function</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Username</td>
<td>Stores the username of the user requesting status information.</td>
<td>$username = &quot;user@realm&quot;</td>
</tr>
<tr>
<td>LogoutPostURL</td>
<td>Stores the address to which the HTML-Form is submitted</td>
<td>$logoutPostURL = &quot;192.168.1.1/cgi-bin/login&quot;</td>
</tr>
</tbody>
</table>

Table 2: Recommended Format for Info Page Parameters
### B.1 Document History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Brief Description of Change</th>
<th>Approval Authority</th>
<th>Editor / Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0.1</td>
<td>June 6th, 2002</td>
<td>First draft created in WLAN TF (&quot;version A&quot;)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.2</td>
<td>June 7th, 2002</td>
<td>Version after WLAN TF Stockholm meeting (&quot;version B&quot;)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.3</td>
<td>July 4th, 2002</td>
<td>Version after WLAN TF conference call (4th of July) (&quot;version C&quot;)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.4</td>
<td>August 22nd, 2002</td>
<td>Version after WLAN TF conference call (&quot;version D&quot;), presented to IREG plenary in Singapore</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.5</td>
<td>September 19th, 2002</td>
<td>Version based on discussions and agreements in WLAN TF //IREG Singapore meeting (&quot;version E&quot;)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.6</td>
<td>September 27th, 2002</td>
<td>Version approved by WLAN TF in Portland (&quot;version F&quot;), presented to Packet WP in Madrid (November 2002)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.7</td>
<td>January 17th, 2003</td>
<td>Version after Packet WP ad-hoc in Düsseldorf</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>0.0.8</td>
<td>February 11th, 2003</td>
<td>Version after Packet WP Yokohama meeting (IREG Doc 026/03 Rev 1)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>3.0.0</td>
<td>April 23rd, 2003</td>
<td>Approved by EMC</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>3.0.1</td>
<td>November 3rd, 2003</td>
<td>Incorporated PACKET Doc 074_03 (NCR 001 on IR.61)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>3.0.2</td>
<td>October 24th, 2003</td>
<td>Incorporated IREG Doc 46_028 (NCR 002 on IR.61)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>3.0.3</td>
<td>October 24th, 2003</td>
<td>Incorporated IREG Doc 46_029 (NCR 003 on IR.61)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>3.1.0</td>
<td>August 25th, 2004</td>
<td>Incorporated IREG Doc 47_019 (SCR 005 on IR.61) and IREG Doc 47_016 (NCR 004 on IR.61)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>June 25th, 2007</td>
<td>Incorporated IREG Doc 52_038 (3GPP Release-6 WLAN interworking)</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>February 15th, 2012</td>
<td>DAG documents 088_028rev1, 88_029rev1, 88_030rev1, 88_031rev1, 88_032 and 88_033 incorporated</td>
<td>EMC/IREG</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>2013</td>
<td>DAG Docs 99_016, 99_017</td>
<td>DAG99</td>
<td>Marko Onikki TeliaSonera</td>
</tr>
<tr>
<td>7.0</td>
<td>2014</td>
<td>Incorporated CR1001 (Support for EPC integrated Wi-Fi)</td>
<td>IREG</td>
<td>Marko Onikki TeliaSonera</td>
</tr>
<tr>
<td>8.0</td>
<td>July 28th, 2014</td>
<td>Incorporated CR1002 and CR1003</td>
<td>IREG</td>
<td>Marko Onikki TeliaSonera</td>
</tr>
<tr>
<td>9.0</td>
<td>November 19th, 2014</td>
<td>Incorporated CR1004</td>
<td>IREG</td>
<td>Marko Onikki TeliaSonera</td>
</tr>
</tbody>
</table>
Other Information

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Owner</td>
<td>IREG</td>
</tr>
<tr>
<td>Editor / Company</td>
<td>Marko Onikki / TeliaSonera</td>
</tr>
</tbody>
</table>

Feedback

It is our intention to provide a quality product for your use. If you find any errors or omissions, please contact us with your comments. You may notify us at prd@gsma.com

Your comments or suggestions & questions are always welcome.