ETSI TR 122 934 V12.0.0 (2014-10)

TECHNICAL REPORT

Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Feasibility study on 3GPP system to Wireless Local Area Network (WLAN) interworking (3GPP TR 22.934 version 12.0.0 Release 12)

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Contents

Foreword

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

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Introduction

This document studies the feasibility of interworking between 3GPP systems and Wireless Local Area Networks (WLANs). For the purpose of this document the term 3GPP - WLAN interworking refers to the utilisation of resources and access to services within the 3GPP system by the WLAN UE and user respectively. The intent of 3GPP - WLAN Interworking is to extend 3GPP services and functionality to the WLAN access environment. Thus the WLAN effectively becomes a complementary radio access technology to the 3GPP system.

The WLAN provides access to services located in WLANs and/or networks behind the WLAN. In 3GPP - WLAN interworking, 3GPP system functionalities can reside behind the WLAN or in parallel to the WLAN. In the case of 3GPP system functionalities located behind WLAN, the interworking between 3GPP system and WLAN may include:

- Enabling usage of 3GPP system functionalities between mobile terminals and 3GPP systems via the WLAN (e.g. providing SIP calls)

- Utilising 3GPP system functionalities to complement the functionalities available in the WLAN (e.g. providing charging means, authentication, authorization, and accounting functions)

In a case when the WLAN is seen as a parallel system to the 3GPP system, the interworking between the systems may include

- Creation of mechanisms for selecting and switching between the WLAN and 3GPP systems

Enabling any of these interworking cases may result in modifications or additions in 3GPP systems, in WLANs or both.

1 Scope

This document studies the feasibility of interworking between 3GPP systems and Wireless Local Area Networks (WLANs). This document identifies and describes:

- Scenarios for 3GPP - WLAN Interworking

- 3GPP - WLAN interworking service requirements

- Guidelines for standardisation of 3GPP-WLAN interworking

The document includes a number of different scenarios of 3GPP-WLAN interworking ranging from common billing to the provision of services seamlessly between the WLAN and the 3GPP system. In addition, 3GPP-WLAN interworking feasibility study includes the analysis of a number of environments where both the 3GPP system and WLAN may be deployed. Finally, this report outlines some of the different WLAN technologies that may be interworked with 3GPP systems.

It is beyond the scope of 3GPP to develop new system functionalities for WLANs that are not interworking with any 3GPP system functionality.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1]   3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2]   3GPP TS 21.133: "Security Threats and Requirements"

[3]   3GPP TS 22.001: "Principles of circuit telecommunication services supported by a Public Land Mobile Network (PLMN)".

[4]   3GPP TS 22.004: "General on supplementary services".

[5]   3GPP TS 22.057: "Mobile Execution Environment (MExE); Service description; Stage 1".

[6]   3GPP TS 22.060: " General Packet Radio Service (GPRS); Service description; Stage 1".

[7]   3GPP TS 22.071: " Location Services (LCS); Service description, Stage 1".

[8]   3GPP TS 22.078: "Customised Applications for Mobile network Enhanced Logic (CAMEL); Service definition - Stage 1".

[9]   3GPP TS 22.101: "Service principles".

[10]   3GPP TS 22.105 'Services and Service Capabilities'

[11]   Open Mobile Alliance (OMA): OMA-RD-Parlay_Service_Access-V1_0-20100427-A

[12]   3GPP TS 22.129: "Handover Requirements between UTRAN and GERAN or other Radio Systems"

[13]   3GPP TS 22.140: "Multimedia messaging service; Stage 1".

[14]   3GPP TS 22.141: " Presence Service; Stage 1".

[15]   3GPP TS 22.146: "Multimedia Broadcast/Multicast Service; Stage 1".

[16]   3GPP TS 22.177: " Speech-enabled services; Stage 1".

[17]   3GPP TS 22.226: 'Global Text Telephony, Stage 1.'

[18]   3GPP TS 22.228: " Service requirements for the Internet Protocol (IP) multimedia core network subsystem; Stage 1".

[19]   3GPP TS 22.233: 'Transparent end-to-end packet switched streaming service; Stage 1'

[20]   3GPP TS 22.240: "3GPP Generic User Profile (GUP) requirements; Stage 1".

[21]   3GPP TS 22.242: " Digital Rights Management (DRM); Stage 1".

[22]   3GPP TS 22.243: " Distributed speech recognition based automated voice services ".

[23]   ISO/IEC 8802-11 IEEE Std 802.11, 1999 Edition : "Information technology - telecommunications and information exchange between systems - local and metropolitan area networks - specific requirements. Part 11: wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications".

[24]   IEEE Std 802.11b-1999 (Supplement to ANSI/IEEE Std 802.11, 1999 Edition)

[25]   IEEE Std 802.11a-1999 (Supplement to ANSI/IEEE Std 802.11, 1999 Edition)

[26]   IEEE STD 802.1X: " Standards for Local and Metropolitan Area Networks: Port Based Access Control, June 14, 2001".

[27]   ETSI TR 101 683: "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; System Overview"

[28]   DTS/BRAN-0020003-2 Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Interworking between HIPERLAN/2 and 3rd Generation Cellular and other Public systems

[29]   MMAC HiSWANa Network Specification Ver. 2.0

[30]   Bluetooth Specification 1.1

[31]   RFC0791 - Internet Protocol

[32]   RFC2486 - The Network Access Identifier

3   Definitions, symbols and abbreviations

3.1   Definitions

APN: Access Point Name

Environment: The type of area to be covered by the WLAN network of a 3GPP - WLAN interworking; e.g. public, corporate and residential.

Home WLAN: The WLAN that is interworking with the HPLMN of the 3GPP - WLAN interworking user.

Interworking WLAN : WLAN that interworks with a 3GPP system**.**

Online Charging : See [1]

Offline Charging : See [1]

Serving WLAN : The interworking WLAN that the user is connected to, i.e. either a visited or a home WLAN.

Visited WLAN: An interworking WLAN that Interworks only with a visited PLMN.

WLAN coverage: an area where wireless local area network access services are provided for interworking by an entity in accordance with WLAN standards.

WLAN roaming: The ability for a 3GPP - WLAN interworking user (subscriber) to function in a serving WLAN different from the home WLAN

3GPP - WLAN Interworking: Used generically to refer to interworking between the 3GPP system and the WLAN family of standards**.**

3.2   Symbols

None

3.3   Abbreviations

AAA: Authentication, Authorisation and Accounting (See [1])

AP: Access Point. WLAN Access Points act as the 'Base Stations'

HIPERLAN/1: HIPERLAN/1 (High Performance Radio Local Area Network / 1) is a standard developed by ETSI for Wireless Networking to provide short-range wireless communications, with user date rates up to around 20 Mbit/s. It was designed to operate in the 5.15-5.35 GHz band in Europe.

HIPERLAN/2: HIPERLAN/2 is a standard developed by ETSI for Wireless Networking to provide higher speeds of up to 54 Mbit/s. It is designed to operate in Europe 5.15-5.35 GHz and 5.470-5.725 GHz

HiSWANa: HiSWAn a standard developed by MMAC for Wireless Networking to provide higher speeds of up to 54 Mbit/s. It is designed to operate in Japan in the 5 Ghz Waveband.

IPv4: Internet Protocol version 4.

IPv6: Internet Protocol version 6.

LAN: Local Area Network.

NAI: Network Access Identifier

SSID: Service Set Identifier (802.11b) or Service Set Identification (IEEE 802.11 wireless networks)

WLAN: Wireless Local Area Network.

802.11b: 802.11b is a standard developed by IEEE for Wireless Networking. It offers a range of data speeds up to 11 Mbit/s for short ranges. 802.11b operates in the 2.4GHz frequency bands (2.4-2.4835 GHz).

802.11a: 802.11a is a standard developed by IEEE for Wireless Networking. It offers a range of data speeds up to 54 Mbit/s for short ranges. 802.11a operates in the 5GHz frequency bands.

4   Background

4.1   WLAN technologies

There are several different technologies that fall into the WLAN category. An existing industry standard is IEEE 802.11b operating in the 2.4 GHz ISM band. A new entrant for this same band is Bluetooth. New technologies such as IEEE 802.11a and ETSI BRAN Hiperlan2 are being developed for 5GHz bands [23, 24, 25, 26, 27, 28, 29, 30].

Despite the different radio technologies, most WLANs are commonly used for transportation of IP packets. The specific WLAN technology used in each wireless IP network is not very visible for the layers above IP [31].

Service interworking between 3GPP systems and WLANs should reuse the established ways of using WLANs, i.e. transportation of IP packets. 3GPP - WLAN interworking should thus be built on top of harmonising layer(s) (e.g. IP) and not limited to any specific WLAN technology.
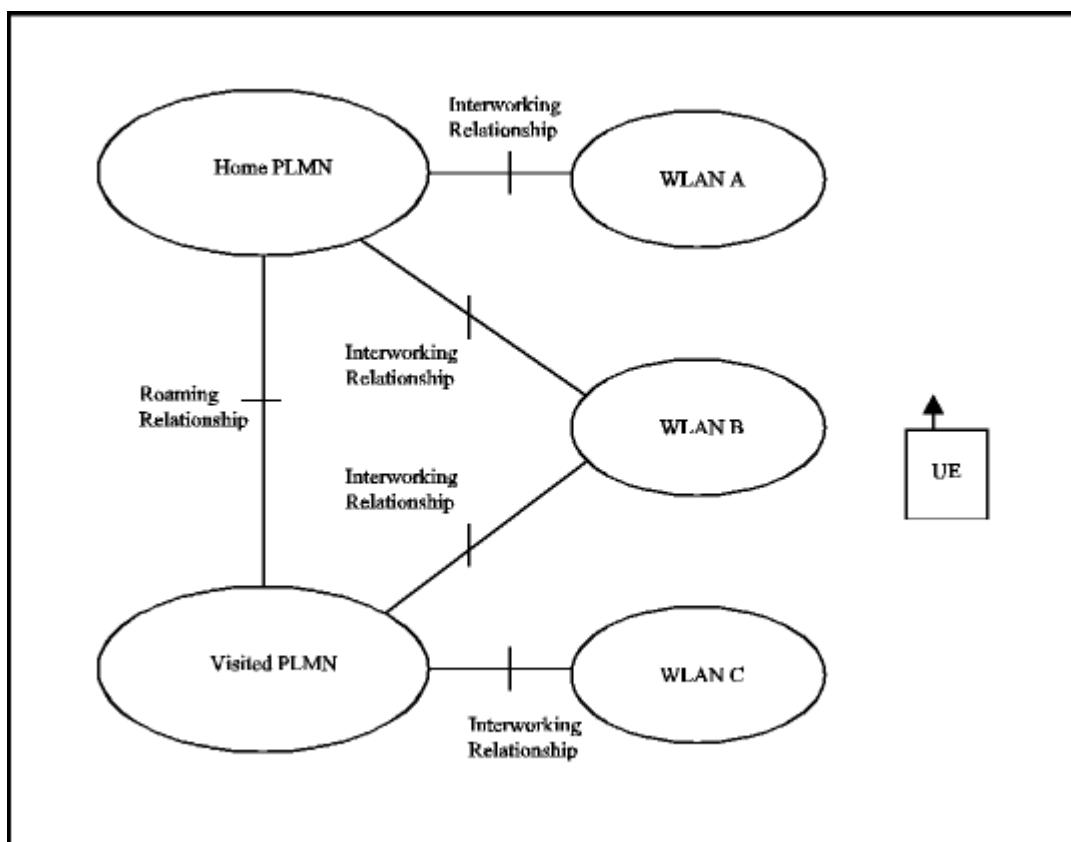
Defining 3GPP - WLAN interworking based IP allows easier phased introduction of more advanced interworking scenarios as well as parallel provisioning of different interworking scenarios by the same WLAN.

However, if some standard mechanisms for realising specific system functions within a WLAN exist, they should be considered to be reused for 3GPP system interworking to ensure compatibility with generic WLANs.

4.2   Interworking model

An Interworking relationship is defined as a technical arrangement between two platforms for realising the interworking functionality. Figure 4.1 shows different entities and illustrates the concept of many to many relationships between PLMNs and WLANs.
Seen from the user, WLAN A and WLAN B are home WLAN networks where as WLAN C is a visited WLAN.
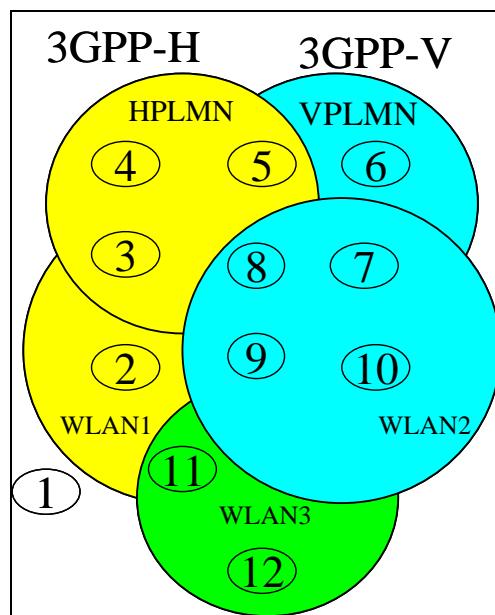
Figure 1: Interworking Model

4.3   Deployment and usage

It is recognised that WLANs are, and will continue to be deployed by independent (i.e.non 3GPP) operators and that these WLANs may or may not be interworked with a 3GPP system. Futher, these WLAN"s may overlap partially or completely with WLANs that are interworked with Home and/or Visited 3GPP systems. Lastly, WLANs interworked with Home and Visited 3GPP systems may also overlap each other, as well as the UTRAN for each 3GPP system. These situations create multiple permutations of coverage areas and service states which will need to be carefully understood and managed.

4.3.1   Network Coverage Areas and user states

The figure below illustrates a range of overlapping coverage areas. Different user states can be identified by different trajectories through the coverage areas. Table 1 describes a number of coverage areas that are derived from the Figure below.

Figure 2: User States

Assumptions: WLAN1(s) interworked with 3GPP-H (HPLMN); WLAN2(s) interworked with 3GPP-V(VPLMN); WLAN3(s) not interworked.

Table 1: Description of User States

State	Description	WLAN Coverage	3GPP PLMN Coverage
1	Switch on	No coverage	No coverage
2	Single network WLAN1 coverage	Coverage only available from WLAN1(s)	No coverage
3	Overlapping 3GPP & WLAN coverage	Single network coverage	Home network coverage
4	Single network 3GPP-H coverage (HPLMN)	No coverage	Home network coverage
5	Multiple networks 3GPP coverage	No coverage	Coverage from home network and other operator(s)
6	Network(s) 3GPP-V coverage (VPLMN)	No coverage	Coverage from visited network(s) only
7	Overlapping 3GPP & WLAN coverage	Coverage only available from WLAN2(s)	Coverage from visited network only
8	Multiple 3GPP & Multiple WLANs	WLAN1(s) & WLAN2(s) (NOTE 1):	Coverage from Home and Visited Networks
9	Multiple WLAN coverage	Coverage available from WLAN1(s) & WLAN2(s)	No coverage
10	Single WLAN2 network coverage	Coverage only available from WLAN2(s)	No coverage
11	Multiple WLAN coverage	Coverage available from WLAN1 & WLAN3	No coverage
12	WLAN(s) coverage not interworked	Coverage only available from WLAN3(s)	No coverage
NOTE 1 : May also include WLAN 3 (Not Illustrated)			

4.4   Environments

There are number of different possible operating environments where interworking of the 3GPP system and the WLANs may be desired. The 3GPP operates universally in Public, Corporate, or Residential environments. WLANs may also be deployed in any of these environments and it would be advantageous if the standards for 3GPP - WLAN interworking could accommodate all of these environments. Such capability would further enhance the ease of use for the mobile system user and virtually extend the effective coverage areas of each system.

The different environments may involve different administrative domains and wide diversity of WLAN technical capabilities. As an example, the security capabilities and policies may differ between public, corporate and residential WLANs. These differences may lead to different interworking methods between 3GPP and WLANs. Hence, it is to be recognised that 3GPP - WLAN interworking may not be possible in all cases for both technical and non-technical considerations.

The environments and some of their characteristics may be summarised as follows:

The 'Public' environment includes all areas where there is unrestricted public presence, including outdoor areas, streets, transportation centres, retail stores, hotels, restaurants and public spaces and lobbies in major civic buildings. Here, for example, the WLAN operator is expecting general access and will likely have a system policies and equipment suitable for 3GPP - WLAN interworking.

The 'Corporate' environment includes offices and factories where the users are restricted to employees of the business. Restricted visitor access may also be accommodated in this environment. The Corporate WLAN operator is providing service primarily for internal uses, and access to other networks may be screened (i.e. with a 'firewall'). There may be several WLANs deployed within the corporation, not all of which are to be interworked with 3GPP. Thus, interworking between Corporate WLAN and 3GPP may involve some different policies and techniques than for other environments.

The 'Residential' environment includes individual homes and apartments where the users are restricted to the residents and their guests. Here, the WLAN owner and user are most likely the same. However, in a multi-tenant building, there may be a single WLAN (i.e. owned by the landlord) serving many users. The interworking of residential WLAN with 3GPP may involve some different policies that for other environments.

4.5   User access to services

In terms of the user"s access to services, it is envisaged that the user will have access to the same set of services, irrespective of the radio access technology used (i.e. 3GPP UTRAN or WLAN). This may include access to a range of different services, including:

-    Access to corporate Intranet services;

-    Access to operator local services; and

-    Access to the public Internet.

Access to Interworked WLANs using 3GPP defined authentication means does not preclude a customer from accessing non Interworked WLANs via other authentication means..

4.6   Target user experience

In each of these user/network states, the target user experience is the same whether the user transitions to the new state from a previous state or whether he turns on his WLAN enabled client device in a particular state. These user experiences are summarised in the following table and assumes the user is primarily seeking data connectivity. Two modes of human computer interaction are described for each situation; manual mode is when the user is given complete discretion to choose, whereas automatic mode (note that these are not the same as 'automatic' and 'manual' PLMN selection modes described in section 6.3.1.1) is when the UE is more 'intelligent' using proximity or context to trigger changes to the bearer, application or service.

Table 2: Target User Experience

State	Description	User Interface	Comments
1	No coverage	Dial-up networking client (or equivalent), shows 'no network connection'	
2	Single network WLAN coverage	In manual mode, equipment notifies the user via the icon that network connectivity may be possible In automatic mode, equipment automatically attempts registration / authentication / encryption, and updates network connectivity icon appropriately.	In manual mode, icon/gui may regularly update to show whether network connectivity may be available Security icon may be displayed , for example a 'padlock'
3	Overlapping 3GPP & WLAN coverage	In manual mode, user should be made aware that several radio technologies are now available. In automatic mode 3GPP and/or WLAN is selected based on predetermined choices, (set by UE, the user, network, location or context).	Consideration needs to be given to interaction of Circuit Switched services (voice and data) with the packet side of the user equipment. For example for devices that cannot support voice at the same time as WLAN packet access.
4	Single network 3GPP coverage (HPLMN)	In automatic mode, user equipment, changes to 3GPP air interface. Registration / authentication / encryption are performed as required. Update of Security icon if security level is modified. Update of Charging policy if modified	State changes based on of 'network connectivity icon' to indicate a change in data rates Review Network Connectivity / Security / Charging policy 'status' and consider means of notification, which could be via icons. Users could specify which status indicators they are interested in, and how they would like them to be displayed
5	Multiple networks 3GPP coverage	Network selection is covered by 3GPP standards	
6	Single network 3GPP coverage (VPLMN)	Network selection is covered by 3GPP standards	
7	Overlapping 3GPP & WLAN coverage	Same as (3) with notification of WLAN roaming	A Method should be provided to allow the operator to provide the user with preferred bearer service depending on the context of use, including device, application, bearer, QoS amongst others
8	Multiple 3GPP & Multiple WLANs	In manual mode, user should be made aware that several radio technologies are now available. In automatic mode 3GPP and/or WLAN is selected based on predetermined choices, (set by UE, the user, network, location or context).	(Note 1)
9	Multiple networks WLAN coverage	In manual mode user is notified of available networks Not covered by standards; In automatic mode, connectivity is established via preferred network settings	
10	Single network coverage from WLAN interworking with VPLMN	In manual mode, equipment notifies the user via the icon(s) that network connectivity may be possible via a Visited network. In automatic mode, equipment automatically attempts registration / authentication /encryption, and updates network connectivity icon appropriately, indicating the use of Visited network (that is, Roaming situation).	Same as in State 2.
11	Multiple networks WLAN coverage	Same as (2)	
12	Not interworked WLAN3	User is notified of available coverage; experience dependent on relationship between WLAN3 and 3GPP HPLMN	
NOTE 1 : May also include WLAN(s) not interworked			

4.7   Terminal aspects

Two modes of user equipment are foreseen for the 3GPP - WLAN interworking:

- Single mode 3GWLAN , which is an independent WLAN UE. This terminal handles all the 3GPP - WLAN interworking services that are offered to the user through the interworked WLAN.

- Multimode 3GWLAN, which is a dual mode WLAN - 3GPP system UE. This terminal handles all the 3GPP - WLAN interworking services that are offered to the user through either the interworked 3GPP system or the interworked WLAN.

The single mode may be dominant for scenario 1 through 3. The multi mode terminal may be dominant for Scenario 4 and above.

5   Main concepts

This chapter describes an approach for a flexible, general, scalable and future proof 3GPP - WLAN interworking. The approach is flexible and scalable in the sense that it can be implemented in steps from a quite simple 3GPP - WLAN interworking, to fully seamless inter system operation. The approach is general in that there are no limitations on the WLAN that can be interworked. The approach is also future proof in that it ensures interworking with both current and future WLAN and 3GPP releases. The following section (5.1) defines a number of different scenarios for interworking that provide an indicative roadmap for development.
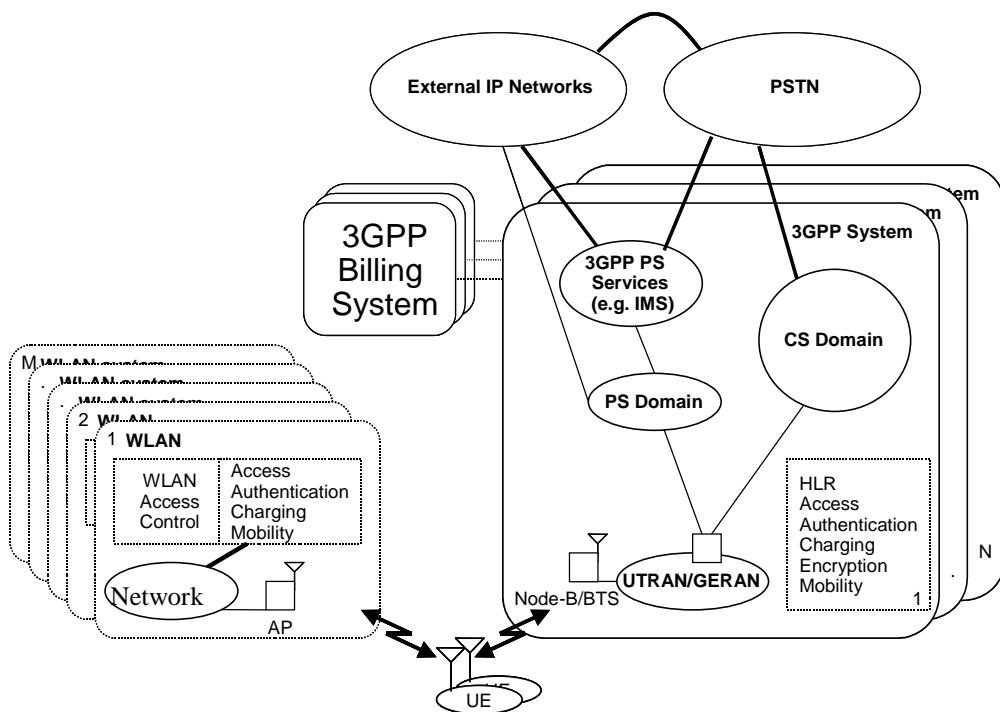
Interworking between 3GPP Systems and WLAN should be possible with minimum coordination of the respective standards. The goal is to avoid changes to WLAN standards and to minimise changes in existing 3GPP specifications.

Also, the goal is to allow 3GPP - WLAN interworking with Release 99, Release 4 and Release 5, however it is acknowledged that the actual fulfilment of this goal will vary from scenario to scenario.

5.1   Interworking scenarios

In this chapter six 3GPP - WLAN interworking scenarios are described. Each scenario realises an additional step in integrating WLAN in the 3GPP service offering and naturally includes the previous level of integration of the previous scenario.

3GPP -WLAN interworking scenarios may be considered with the aid of the simplified reference diagram in figure 1. This reference diagram illustrates the elements of the 3GPP system and WLANs being interworked. These may be interconnected in a variety of ways to develop the progressive scenarios outlined in this section.

Figure 3: 3GPP System - WLAN interworking simplified reference model

Scenario 1 - Common Billing and Customer Care

This is the simplest scheme of 3GPP -WLAN interworking. The connection between the WLAN and the 3GPP system is that there is a single customer relationship. The customer receives one bill from the mobile operator for the usage of both 3GPP and WLAN services. Integrated Customer Care allows for a simplified service offering from both the operator and the subscriber"s perspective. The security level of the two systems may be independent.

This scenario does not pose any new requirements on 3GPP specifications.

Use case: Jim Beam is a 3GPP subscriber who would like to access the WLAN service provided by his home operator. Jim wants the charges for the WLAN usage included on his 3GPP service bill. Jim"s home 3GPP operator provides him with a user name and password to access the WLAN. Jim has access to Internet services and resources from the WLAN but does not have access to 3GPP services or resources other than those he can normally access from the Internet.

Scenario 2 - 3GPP system based Access Control and Charging

This is the scenario where authentication, authorization and accounting are provided by the 3GPP system. The security level of these functions applied to WLAN is in line with that of the 3GPP system [2]. This ensures that the user does not see significant difference in the way access is granted. This may also provide means for the operator to charge access in a consistent manner over the two platforms.

Reusing the 3GPP system access control principles allows for additional benefits seen from a user and 3GPP system operator standpoint. First, the 3GPP system operator may easily allow subscribers within his existing 3GPP system customer base to access the WLAN with a minimum effort both for the subscriber and the operator. In addition, the maintenance of the subscriber may also be simplified.

No requirements are put upon the set of services to be offered in the WLAN part beyond those inherently offered by being addressable in an IP network..

Use case : Angus Lagavulin is 3GPP subscriber who needs a more secure way of accessing the WLAN than user name and password. Angus"s home 3GPP operator modifies his 3GPP user profile to include WLAN access and Angus purchases a WLAN NIC equipped with a UICC associated with his 3GPP account. Angus is authenticated on the WLAN from the credentials on the UICC but does not have access to 3GPP services other than those he can normally access from the Internet.

Jack Daniels is a 3GPP subscriber and wants to access 3GPP packet switched services and WLAN service without having to swap NIC"s in his laptop. Jack purchases a dual mode (3GPP/WLAN) NIC. Jack can access 3GPP and WLAN service using separate sessions without changing any hardware.

Scenario 3: Access to 3GPP system PS based services

The goal of this scenario is to allow the operator to extend 3GPP system PS based services to the WLAN. These services may include, for example, APNs, IMS based services, location based services, instant messaging, presence based services, MBMS and any service that is built upon the combination of several of these components [5, 6, 7, 8, 11, 13, 14. 15, 16, 17, 18, 19, 20, 21, 22]

Even though this scenario allows access to all services, it is an implementation question whether only a subset of the services is actually provided.

However, service continuity between the 3GPP system part and the WLAN part is not required.

Use case : Jose Cuervo is a 3GPP subscriber and wants to access to his 3GPP packet switched services, e.g MMS, that he cannot normally access through the Internet. Jose has a dual mode NIC in his laptop and is able to receive his MMS through the WLAN or 3GPP system.

Scenario 4: Service Continuity

The goal of this scenario is to allow the services supported in Scenario 3 to survive a change of access between WLAN and 3GPP systems. The change of access may be noticeable to the user, but there will be no need for the user/UE to re-establish the service. There may be a change in service quality as a consequence of the transition between systems due to the varying capabilities and characteristics of the access technologies and their associated networks. It is also possible that some services may not survive, as the continuing network may not support an equivalent service.

The criteria and decision mechanism for change of access network is under investigation.

Change in service quality may be a consequence of mobility between radio access technologies, due to varying capabilities and characteristics of radio access technologies.

   NOTE : The use of the term service continuity is different to the definition given in [12]

Use case : Jari Finlandia is a 3GPP subscriber who travels frequently and has a PDA equipped with a WLAN and 3GPP transceiver. Jari would like to be able to move freely about airports and hotels without having to establish a 3GPP session when he moves out or range of the WLAN. Jari"s PDA can switch between 3GPP and WLAN as required based on the parameters (e.g. QOS) in his profile on the same session. However, Jari may experience brief interruptions in data flow during the transitions between 3GPP and WLAN.

Scenario 5: Seamless services

The goal of this scenario is to provide seamless service continuity, as defined in [12],between the access technologies, for the services supported in Scenario 3.

By seamless service continuity is meant minimizing aspects such as data loss and break time during the switch between access technologies.

Use case : Seamus Bushmills is a 3GPP subscriber with a multimedia terminal that includes VoIP capability. Seamus spends a lot of time in places with WLAN service and would like to utilise WLAN for his multimedia calls when possible. However, Seamus is on the go and may need to leave the area with WLAN in the middle of a call. Seamus would like to maintain his multimedia and VoIP sessions when he leaves WLAN coverage without noticeable interruption. Seamus purchased a WLAN card for his terminal, and can switch between 3GPP and WLAN as necessary without interrupting the session.

Scenario 6: Access to 3GPP CS Services

This scenario allows access to services provided by the entities of the 3GPP Circuit Switched Core Network over WLAN. This scenario does not imply any circuit-switched type of characteristics to be included into WLAN.

It shall be possible to provide a technical implementation that would allow:

-   Access to services provided by the 3GPP CS core network entities over WLAN interface.

-   Seamless and user-transparent switching between access technologies for a connection carrying service provided by the entities of 3GPP CS core network

The table below defines the service and operational capabilities of each scenario.

Table 3 : Scenarios and their Capabilities

Scenarios: Service and operational Capabilities:	Scenario 1: Common Billing and Customer Care	Scenario 2: 3GPP system based Access Control and Charging	Scenario 3: Access to 3GPP system PS based services	Scenario 4: Service continuity	Scenario 5: Seamless services	Scenario 6: Access to 3GPP system CS based Services
Common billing	X	X	X	X	X	X
Common customer care	X	X	X	X	X	X
3GPP system based Access Control		X	X	X	X	X
3GPP system based Access Charging		X	X	X	X	X
Access to 3GPP system PS based services from WLAN			X	X	X	X
Service Continuity				X	X	X
Seamless Service Continuity					X	X
Access to 3GPP system CS based Services with seamless mobility						X

Service and operational Capabilities:

Common billing: The user will receive the bill for the services consumption on either platform in a coordinated way. However, it does not include any requirement to harmonize the tariff structure or level of services on the two platforms.

Common customer care: The user will not have to bother about which platform that might have caused his need to consult the customer care.

3GPP system based Access Control: The user faces control procedures (authentication and authorization) similar for WLAN as within the 3GPP domain.

3GPP system based Access Charging: This capability enables that the 3GPP charging mechanism can be reused for WLAN.

Access to 3GPP system PS based services from WLAN: The user is offered access to the same PS based services over WLAN as may be accessed via the 3GPP system.

Service continuity: services will survive the process of change of access network technology between WLAN and a 3GPP system.

Seamless service continuity: to provide seamless service continuity between the access technologies by minimizing aspects such as data loss and break time during the switch between access technologies.

Access to 3GPP system CS based Services with seamless mobility: to allow the operator to grant access to 3GPP system CS based services through the WLAN.

5.2 Ownership, operation, and trust

5.2.1 Ownership

Ownership of the WLAN to be interworked with a 3GPP network may be one or more of the following general classes

1) The WLAN owner is a 3GPP system operator.

2) The WLAN owner is a public network operator who is not a 3GPP system operator. This may include, for example, fixed network operators, operators of mobile networks other than 3GPP systems or public WLAN operators.

3) The WLAN owner is an entity providing WLAN access in a local area (i.e. building manager/owner or airport authority) but who is otherwise not a public network operator. In this class it may be considered that a primary purpose of the WLAN operations is to provide local services and internet access as well as WLAN interworking.

4) The WLAN owner is a business entity that may be providing a WLAN for its internal use that also wishes to allow interconnection, and possibly visitor use, for some or all of their WLANs. The entity may have more than one WLAN in operation in a location of which some may be interworked to 3GPP systems and some may not be interworked. In this class it may be considered that the primary purpose of the WLAN operations is for its own business and WLAN interworking is a secondary consideration.

This is not intended to be a restrictive list, but rather, illustrative of possibilities. There are many other possible combinations.

5.2.2 Operations

For 3GPP system subscribers, the operation of the interworked WLAN for creating charging records should follow the same principles as for other networks interworked with 3GPP systems. The end responsibility for billing, for example, should be with the subscriber"s home operator. To assist billing, the home operator should receive charging records associated with WLAN usage.

5.2.3 Internetworking trust

3GPP systems interworking with WLANs should consider the possibility of security weaknesses within the WLAN. The level of trust for physical communications and signalling in the network may be affected by the security of the servers, their operating software and the procedures used in the interworked WLAN. The level of trust of communication between the WLAN and the 3GPP system may be considered to have three levels -

1) The WLAN may be completely untrusted by the UE and the 3GPP system.

2) The WLAN contains elements that may be trusted by the UE and the 3GPP system. For example, the WLAN may include trusted servers that look after aspects of security and authentication interworking with the 3GPP systems (e.g. 802.1x, 802.11i). However, other elements of the network may be untrusted.

3) All of the elements of the WLAN may be fully trusted by the UE and the 3GPP system.

Mutual authentication between the UE and the WLAN/3GPP System should be used to assure the needed level of trust by both entities for interworking and access to services. In the case of an untrusted interworked network, this may limit the charging possibilities as, for example, some messages may be spurious. For a network with trusted servers and authenticated messages, the charging records may be considered trusted.

5.3   Service capability interworking

The following table provides the use cases for scenarios 3 to 6 with specific service capabilities [5, 6, 7, 8, 11, 13, 14. 15, 16, 17, 18, 19, 20, 21, 22].

Table 4 : Use Cases

Service capability	Use case	Service domain
SMS	A user should be able to send and receive SMS messages between themselves and terminals in the 3GPP system. The content, size restrictions, and notifications should be equivalent.	PS+CS
MMS	User connected via WLAN, should be able to send and receive MMS messages. The user interaction with the client application is the same as when they are connected via the 3GPP system.	PS
Presence	The user"s presentity should be able to interact with the Presence server. The user may want to set different access rules if they are connected via the WLAN. (Note : this is currently not supported by the presence service)	PS
IMS	The user should be able to access all IMS based services (e.g. IMS messaging and Group Management). The QoS provided by the WLAN may affect the services available	PS
LCS	The user should be able to use applications that make use of Location information, without the need to enter the location into the application manually. .	PS+CS
MBMS	MBMS is a bearer service used by 3rd party or operator provided applications. These applications should be available to the user in the WLAN.	PS
MexE	MexE provides an access independent standardised API which should work when the user is connected through WLAN.	PS+CS
OSA	An OSA application should be able to interact with a UE connecting via WLAN.	CS+PS
UE Management (UEM)	It should be possible for an operator to be able to provide a similar level of customer support regardless of how the user is connected to their services.	

6   Service Requirements

This chapter provides the service and operational requirements for each of the scenarios identified and for which high-level description is provided in chapter 5.

6.1   General Requirements

Interworking between WLAN and 3GPP systems could be implemented in different ways. The WLAN could be an integral part of the 3GPP system or the two systems could be separate. The WLAN could interwork with one or more 3GPP systems and that a 3GPP system could interwork with one or more WLANs.at the network side.

The following guidelines for deployment of WLAN - 3GPP Interworking are recommended.

-   The functional split between WLAN and 3GPP system should be clearly specified

-   Interworking between WLAN and 3GPP system should pose as few 3GPP specific requirements to WLANs as feasible

-    Interworking means between WLAN and 3GPP system should be able to support many-to-many relationship between the two systems (i.e. the specifications should allow that one WLAN can interwork with several 3GPP systems and one 3GPP system can interwork with several WLANs).

6.2   Interworking Scenario 1

There are no requirements affecting 3GPP specifications for Scenario 1.

6.3   Interworking Scenario 2

6.3.1   Service aspects

WLAN-3GPP system interworking service is defined as a wireless IP connectivity service where the radio access technology is of type WLAN.

The service is subject to a 3GPP system subscription.

The WLAN-3GPP system interworking service should support IPv4 and IPv6 based connectivity.

Quality of Service is out of the scope in this scenario 2 (see 5.1).

It should be possible to support the following categories of service

1)   General Internet services

2)   Access to intranets

6.3.1.1   Network Selection

The broad aims of 3GPP Network Selection are to:

-    Maximise availability of networks to the user

-    Support both manual and automatic network selection

-    In the case of automatic network selection:

    -    Prioritise the Home network

    -    Allow the operator to define a home, preferred or forbidden list of networks

It is recommended that similar concepts are developed for WLAN selection.

It is noted that through discrimination of the Network Operator Identifier (s) values being transmitted by the available access points, the user can determine which of available networks is the one they wish to use. It is also conceivable that a function similar to the preferred PLMN (Public Land Mobile Network) list could be implemented into a W LAN smart client.

6.3.1.2   System recognition

Integrated devices should be capable of recognizing the range of air interface options available, and communicating these choices to the end user. For example, the IEEE 802.11 standard supports Network Operator Identifier functionality. Network Operator Identifier is a network identity sent in 'text' over the 802.11 radio interface .This information could be used when system recognition and network selection takes place.

6.3.2   Access control

Access control for a 3GPP system subscriber accessing the WLAN -3GPP system interworking service shall be provided by the 3GPP system.

Successful 3GPP system based access control is a prerequisite for usage of the WLAN - 3GPP interworking service.

It shall be possible to reuse existing UICC cards, containing the SIM/USIM, for the access control.

NOTE: Additional methods of access control could be defined in the future.

3GPP compatible access control for users accessing WLAN may:

- Reuse existing 3GPP permanent subscriber databases (e.g. HLR)

To be WLAN compatible one major characteristic is assumed:

- Reuse of the standard WLAN radio interface mechanisms for authentication interworking with 3GPP compatible access control.

6.3.2.1 Authentication

Authentication procedures shall be able to prohibit user session establishment (and hence subsequent radio and network resource allocation) prior to successful authentication.

6.3.3 Security

The level of security of the 3GPP system shall not be compromised by deployment of the 3GPP -WLAN interworking system

Access control for users accessing WLAN shall have the same level of security as a 3GPP system authentication procedure.

The following objectives were identified in relation to user security features for 3GPP:

- User anonymity

- Authentication

- Encryption (user data and signalling)

- Integrity

- Strong security for authentication data

The following objectives were identified in relation to network operator security features for 3GPP systems:

Features:

- Establish basis to trust other network operators

- Maintain Roaming Agreement principle for WLAN interworking

- Allow 3GPP and WLAN Operators to use their own security algorithms

- Avoid transporting sensitive information related to inter-operator roaming over insecure networks.

- Avoid (detect and/or block) fraudulent user ambiguity (use of same subscription in multiple locations and/or sessions)

6.3.4 Roaming aspects

3GPP -WLAN interworking system should provide the ability for 3G subscribers to access the WLAN service and roam between 3GPP networks and WLANs. A 3GPP system operator should be able to have roaming with WLAN operators that are not also 3GPP system operators. This implies the pre-existence of a roaming mechanism and a service agreement between the different network operators involved.

UE shall be able to select the visited network when accessing the WLAN. The selection within the UE can be automated or done by the user.

6.3.5   Terminal aspects

6.3.5.1   General

3GPP system based access control requires the existence of similar level of security for the access control related functions within the user equipment as exists in 3GPP user equipment.

One identified option to realise this requirement is to have a UICC card containing SIM or USIM application in the UE.

Deployed WLAN devices (according WLAN standards, e.g. 802.11, HiperLan 2 etc), that meet interworking requirements, (e.g. security), shall be supported without upgrading the functionality.

User involvement in enabling scenario 2 interworking functionality in terminals shall be minimized (e.g. installation of software).

6.3.5.2   Accessing UICC data

One objective is to minimize complexity of administration for authentication and billing. The approach to this is to use the UICC.

Several options have been identified, which may require further study, including:

-     Dedicated UICC card reader within the WLAN card

-     External UICC Card reader

-     By WLAN device communicating with UICC (e.g. via Bluetooth or IrDA port)

Each of these should be considered in conjunction with the section on Security objectives section 6.3.3.

6.3.6   Naming and addressing

Usage of NAI format ensures that 3GPP based access control will be compatible with standard WLAN equipment and with IETF AAA protocols such as Diameter. This approach also enables smooth simultaneous usage of 3GPP based and non-3GPP based access control solutions over the same WLAN.

The user identification for 3GPP based access control shall be based on Network Access Identifier (NAI) format (user@realm) [32].

6.3.7   Charging and billing

Charging and billing in the 3GPP system shall not be compromised by the interworking with the WLAN. Other aspects regarding charging and billing shall be accommodated as for interworking between 3GPP systems.

6.3.7.1   Online charging support

3GPP -WLAN interworking system shall have the possibility to provide online charging.

As the charging information affects the service rendered, a mechanism shall be available to allow the 3GPP system to indicate to the WLAN that the service rendered should be terminated, interrupted or modified (for example for pre-paid users).

6.3.7.2   Offline charging support

Offline charging shall utilise the existing 3GPP system Charging Gateway, i.e. WLAN charging shall be based on charging records delivered to 3GPP Charging Gateway.

6.4 Interworking scenario 3

The goal of Scenario 3 is to make access to 3GPP system PS based services available to the user through the WLAN. The following service requirements apply to the interworking scenario 3.

6.4.1 Service aspects

The services available should include all services based on 3GPP System PS domain capabilities (e.g. IMS).

As the charging and QoS parameters may differ between the WLAN and 3GPP system, it shall be possible for the user to select which interface to use. This process may be automated by a function in the terminal.

The user"s actions related to service invocation should be the same when using either the WLAN or the 3GPP system.

Simultaneous usage of both radio access technologies will depend on the requirements of the user"s application, the capabilities of the UE and the coverage of the radio access technologies. The standards shall not preclude the simultaneous use of both WLAN and 3GPP radio access technologies.

For example, the following cases -

- The UE might use the WLAN for data services (internet access) together with the 3GPP system for a speech call.

- The UE and the WLAN and 3GPP systems might elect to use both access technologies simultaneously in order to balance traffic, system capabilities or for radio resource management.

6.4.1.1 IMS service aspects

WLAN should support all IMS capabilities

Support of real time IMS services will require QoS support in WLAN. If the WLAN technology does not offer sufficient support for QoS, best effort approach may be used to approximate the service.

> NOTE: Currently the IMS does not support parallel registrations. No use cases have yet been identified that would require parallel IMS registrations of the UE over WLAN and over UTRAN/GERAN.

6.4.1.2 LCS service capability interworking

The requirements for support of Location Based services via the WLAN are:

1 When a LCS client requests the location of a user access via a Interworking WLAN, then it shall be possible to determine the location of the device. The accuracy of the position may be limited to the known area of coverage of the Access Point.

2 The LCS client should not need to know which access technology is being used in order to obtain the location information

3 The security and privacy requirements as specified in TS 22.071 [7] shall be met

> NOTE: The position methods in the WLAN are outside the scope of 3GPP

6.4.2 Service access control

When enabling access to 3GPP services that require separate authentication and access control, such as IMS, the service authentication and access control mechanisms developed for that service must be used.

Access to IMS service over WLAN must comply with the separation of access and service authentication and thus IMS authentication is done separately and only after WLAN access authentication (see Scenario 2) has succeeded.

6.4.3 Security aspects

The security requirements established in sub-section 6.3.3 shall be applied for scenario 3.

6.4.4   QoS aspects

The 3GPP system end-to-end QoS principles should be applicable to WLAN.

It should be possible to charge based on the level of QoS provided and on the QoS subscription.

It should be possible to base QoS provisioning in WLANs on the user's subscription.

6.4.5   Roaming aspects

It should be possible to support roaming so that the same sets of services are accessible when roaming into a visited WLAN.

6.5   Interworking scenario 4

The following service requirements apply to the interworking scenario 4 for service continuity for transitions between 3GPP Systems and WLANs. These requirements cover only aspects of the transitions between 3GPP Systems and WLANs and do not include those that may be internal to the WLANs (as these are outside the scope of 3GPP).

NOTE : The use of the term service continuity is different to the definition given in [12]

6.5.1   Service aspects

The transition between access technologies may occur under two conditions -

1) It should be possible for the UE to make automatic transitions between the WLAN and the 3GPP system (e.g. when entering or leaving regions of system coverage) with no manual actions from the user required.

2) It should be possible for the user to manually activate the transition between the WLAN and the 3GPP system. To aid the user, it should be possible for the UE to indicate to the user the availability of systems, for example, when there is a change of coverage or at the user"s request.

The specifications shall cover service continuity for environments where the 3GPP Systems and the WLANs involved may be operated by the same network operator, different network operators or other entities with suitable interworking agreements. There may be more than one target 3GPP system or WLAN for transition, in addition to the serving system, in a given geographical area.

It should be possible for the user to be notified when a transition between the WLAN and the 3GPP system occurs, as there may be a change in the communication, the quality of service or the cost.

After the handover the user shall remain connected to the selected external network (e.g. internet, intranet) independently of the radio interface being used.

6.5.2   Service continuity cases

Service continuity shall support the following cases:

1.   Continuity of active 3GPP PS domain based services (e.g. IMS, PSS) when transitioning between 3GPP system and the WLAN.

2.   Continuity of WLAN services when transitioning between WLAN coverage areas. (Note: this case may involve a (temporary) transition through a 3GPP system.)

In these service continuity cases the transitions may be from 3GPP system to a WLAN, or from a WLAN to a 3GPP system. Service continuity need not be supported for services using resources specific to the source domain that cannot be maintained using resources in the target domain.

6.5.3   Charging and network management

Means shall be standardised that allow charging records to reflect the transistions between the WLAN and the 3GPP system. This includes the time and type in addition to the QoS variations.

A capability to provide network management information relating to frequency of occurrence and type of transition between radio access technologies should be defined.

6.5.4   Security

The security requirements established in sub-section 6.3.3 shall be applied for scenario 4.

The specifications shall assure that transition of radio access technology does not compromise the security of the network providing the new services, the (possibly different) network providing the original services, and the UE or the user"s application.

6.5.5   Performance requirements

6.5.5.1   Change of QoS

During transition between 3GPP Systems and WLANs, the change of service quality shall not cause a service to drop, although the user may notice some change in performance.

It may happen that a target network cannot support the requested QoS or service provided by the current serving network. If all services cannot be accommodated in the target system, a transition of radio access technology to a reduced set of services shall be possible. If the newly negotiated QoS is not acceptable, the UE/user may terminate the connection/context.

6.5.5.2   Requirements on multiple services

Means shall be defined to allow transition of multiple sessions/services between the 3GPP systems and the WLANs.

6.6   Interworking scenario 5

. During handover from a 3GPP System to a WLAN or from a WLAN to a 3GPP system, change of service shall be no greater than that which may occur during intra 3GPP System handover i.e. it shall not be noticeable to the user. A seamless change of service shall be possible when

-    the UE stays within limits for the service (i.e. pedestrian rate of motion) in both the WLAN and 3GPP System;

-    the UE remains during the time of handover within coverage of both systems.

6.7   Interworking scenario 6

No use cases have been identified for this scenario. Without such use cases it is not considered worthwhile doing any further development on this scenario in 3GPP.

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7   Summary and conclusion

The service scenarios outlined in this report provide a path for evolution from entry-level services to full availability of 3GPP services to the WLAN access user. Each of these scenarios provides an increasing level of service that is built upon the lower level scenarios. A deployment initially directed at one service scenario provides the basis for further development. Within a 3GPP network, there may be interworking with WLAN encompassing several service scenario levels. The services may thus be tailored to suit the network capabilities and the operating environment.

7.1 Impact on Specifications

The study has concluded that the stage 1 requirements for WLAN-3GPP Interworking can be included through changes to existing specifications. The following list summarises the impact on the specifications for each of the interworking scenarios.

NOTE 1: This is the initial list of impacted specifications. Further details on these impacts may be identified during the specification work.

1- Interworking scenario 1 : Common Customer Care and billing

There are no requirements affecting 3GPP specifications for Scenario 1.

2- Interworking scenario 2 :Common Access Control and charging

Section 6.3 identifies the requirements related to this scenario. The following specifications are expected to be impacted by this scenario.

- 3GPP TS 22.101, to include the general requirements and those on service aspects and roaming.

- 3GPP TS 22.011, to include the aspects on Network selection and system recognition.

- 3GPP TS 21.133, to include the security requirements

- 3GPP TS 22.115, to include the requirements on charging.

3- Interworking scenario 3 - Access to 3GPP system PS based services

Section 6.4 identifies the requirements related to this scenario. The services available should include all services based on 3GPP System PS domain capabilities. Section 5.3 lists the use cases for this and following scenarios with specific service capabilities.

The following specifications are expected to be impacted by this scenario.

- 3GPP TS 22.101, to include the service aspects.

- 3GPP TS 22.105, to include the QoS aspects

4- Interworking scenario 4 - Service continuity

Section 6.5 identifies the requirements related to this scenario. The services available will survive the process of change of access network technology between WLAN and a 3GPP system although there may be a change in service quality (e.g. data rate, delay may be different) as a consequence of the transition between systems due to the varying capabilities and characteristics of the access technologies and their associated networks.

The following specification is expected to be impacted by this scenario.

- 3GPP TS 22.129, to include the service continuity aspects

5- Interworking scenario 5 - Seamless services

Section 6.6 identifies the requirements related to this scenario. In this scenario, the continuity of services when transitioning between the 3GPP and WLAN access technologies is seamless (i.e. the user experiences no interruption of the available services during the transition).

The following specification is expected to be impacted by this scenario.

- 3GPP TS 22.129, to include the service continuity aspects

7.2 Phasing of the work

This report has identified 6 levels of interworking. As the level of interworking increases, so does the amount of specification work. It is proposed that Scenarios 2 to 5 be worked together, however, if a split in the feature is required at a later time then the split could be made between some of the scenarios.

7.3   Conclusion

This technical report has analysed various scenarios and service requirements for interworking 3GPP system and WLAN. From this study it is concluded that the feature, interworking between 3GPP system and WLAN requires specification work within 3GPP. The recommendation is that the work be started as a single feature and that phasing of the work occur at a later date if necessary. It is also recommended that the stage 1 requirements be added to existing specifications that have been identified.

Annex A:
Impacted Specifications

The following table analyses the requirements in each of the subsections and indicates if these requirements can easily be added to existing requirements.

Section No	Title	Analysis	TS and section number
6	Service Requirements	-	-
6.1	General Requirements	Basic high level requirements setting out the prinicples of the integration. Could be contained in a new subsection in 22.101	ST22.101, 4.8 (new)
6.2	Interworking Scenario 1	No requirements	
6.3	Interworking Scenario 2	-	-
6.3.1	Service aspects	Implies roaming to WLAN - this should be covered in TS 22.101. The remainder consider services aspects. Suggest a new section in TS 22.101	TS 22.101, section 17 TS 22.101 subsection 7.2.6 (new)
6.3.1.1	Network Selection	Recommends the concepts of 3GPP systems be met. These are defined in TS 22.011	TS 22.011
6.3.1.2	System recognition	Similar to previous section.	TS 22.011
6.3.2	Access Control		TS 21.133
6.3.2.1	Authentication		TS 21.133
6.3.3	Security		TS 22.101 and/or TS 21.133
6.3.4	Roaming aspects		TS 22.101 section 17
6.3.5	Terminal Aspects		TS 22.101 section 14?
6.3.5.1	General	Identifies option for UICC, add to TS	TS 22.101 section 13

		22.101 section 13. The secuirty aspects should be handled in TS	
6.3.5.2	Accessing UICC Data	May be able to add to TS 22.101, section 13.	TS 22.101 section 13?
6.3.6	Naming and Addressing	High level naming/numbering is handled in TS 22.101	TS 22.101, section 11
6.3.7	Charging and Billing	Basically requires WLAN to use the 3GPP charging records. Suggest this is covered in TS 22.101 section 16 and TS 22.115	TS 22.101 section 6 TS 22.115
6.3.7.1	Online charging support	See above	
6.3.7.2	Offline charging support	See above	
6.4	Interworking Scenario 3	-	
6.4.1	Service aspects	-	
6.4.1.1	IMS Service Aspects	These are high level services aspects and could be handled in TS 22.101 section 7.	TS 22.101, section 7
6.4.2	Service Access Control	Simply requires that the existing IMS capability is used - so no new requirement for the 3GPP system.	-
6.4.3	Security aspects	-	-
6.4.4	QoS aspects	Requires that the QoS principles be used	TS 22.105
6.4.5	Roaming aspects	Simply requires roaming support between interworked WLANs	TS 22.101 section 17
6.5	Interworking Scenario 4	Basically requires the ability to meet the intersystem requirements for 3GPP. This is simply another intersystem scenario.	TS 22.129
6.5.1	Service aspects	See comment for 6.5	
6.5.2	Service Continuity cases	See comment for 6.5	
6.5.3	Charging and Network		TS 22.105

	Management		
6.5.4	Security		TS 21.133
6.5.5	Performance Requirements	See comment for 6.5	TS 22.129
6.5.5.1	Temporary degradation of service	See comment for 6.5	TS 22.129
6.5.5.2	Requirements on multiple services	See comment for 6.5	TS 22.129
6.6	Scenario 5	See comment for 6.5	TS 22.129
6.7	Interworking Scenario 6	No requirements	-

Annex B:
Change history

<table>
<tr><th colspan="13">Change history</th></tr>
<tr><th>TSG SA#</th><th>SA Doc.</th><th>SA1 Doc</th><th>Spec</th><th>CR</th><th>Rev</th><th>Rel</th><th>Cat</th><th>Subject/Comment</th><th>Old</th><th>New</th><th>Work Item</th></tr>
<tr><td>SP-17</td><td>SP-020572</td><td></td><td>22.934</td><td></td><td></td><td>Rel 6</td><td></td><td>Presented to SA #17 for approval</td><td>2.0.0</td><td>6.0.0</td><td>WLAN</td></tr>
<tr><td>SP-18</td><td>SP-020665</td><td>S1-022261</td><td>22.934</td><td>001</td><td></td><td>Rel-6</td><td>F</td><td>WLAN: Clarification of support of APNs for Scenario 3, 4 and 5</td><td>6.0.0</td><td>6.0.0</td><td>WLAN</td></tr>
<tr><td>SP-18</td><td>SP-020665</td><td>S1-022328</td><td>22.934</td><td>002</td><td></td><td>Rel-6</td><td>B</td><td>WLAN-LCS interworking requirement</td><td>6.0.0</td><td>6.1.0</td><td>WLAN</td></tr>
<tr><td>SP-21</td><td>SP-030463</td><td>S1-030716</td><td>22.934</td><td>003</td><td>-</td><td>Rel-6</td><td>C</td><td>Deletion of Software SIM concept</td><td>6.1.0</td><td>6.2.0</td><td>WLAN</td></tr>
<tr><td>SP-21</td><td>SP-030463</td><td>S1-030761</td><td>22.934</td><td>004</td><td>-</td><td>Rel-6</td><td>C</td><td>Service Capability Interworking</td><td>6.1.0</td><td>6.2.0</td><td>WLAN</td></tr>
<tr><td>SP-36</td><td></td><td></td><td>22.934</td><td></td><td></td><td>Rel-7</td><td></td><td>Updated from Rel-6 to Rel-7</td><td>6.2.0</td><td>7.0.0</td><td></td></tr>
<tr><td>SP-42</td><td>-</td><td>-</td><td></td><td></td><td></td><td>Rel-8</td><td></td><td>Updated from Rel-7 to Rel-8</td><td>7.0.0</td><td>8.0.0</td><td></td></tr>
<tr><td>SP-46</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Updated to Rel-9 by MCC</td><td>8.0.0</td><td>9.0.0</td><td></td></tr>
<tr><td>SP-49</td><td>SP-100575</td><td>S1-102057</td><td>22.934</td><td>0005</td><td>-</td><td>Rel-9</td><td>D</td><td>Removal of references to 3GPP OSA</td><td>9.0.0</td><td>9.1.0</td><td>TEI9</td></tr>
<tr><td>2011-03</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Update to Rel-10 version (MCC)</td><td>9.1.0</td><td>10.0.0</td><td></td></tr>
<tr><td>2012-09</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Updated to Rel-11 by MCC</td><td>10.0.0</td><td>11.0.0</td><td></td></tr>
<tr><td>2014-10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Updated to Rel-12 by MCC</td><td>11.0.0</td><td>12.0.0</td><td></td></tr>
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History

Document history		
V12.0.0	October 2014	Publication