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Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Quality of Service (QoS) and policy aspects of 3GPP - Wireless Local Area Network (WLAN) interworking (Release 7)

Keywords
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Foreword

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

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Version x.y.z

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  - 1 presented to TSG for information;
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- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

Some 3GPP PS based services (e.g. VoIP over IMS, PS streaming, etc) require strict QoS provisioning. In order to support such services over I-WLAN, QoS Provisioning in 3GPP-WLAN Interworking is required.

IEEE 802.11 WLAN standards are currently not supporting QoS mechanisms, therefore QoS provisioning was not considered in Rel-6 work for 3GPP-WLAN Interworking. As IEEE is currently finalizing QoS amendments to 802.11 WLAN standards, QoS-related aspects of the 3GPP-WLAN architecture should be studied.

In the context of end-to-end QoS provisioning being studied in TR 23.802, provisioning of QoS within I-WLAN as an IP-CAN is important. It shall be defined if and how QoS provisioning in I-WLAN can interact with the end-to-end QoS framework.

Flow based charging and service/subscription based policy control are studied in TR 23.803 as generic features to support the access to PS based services from different IP-CANs. In order to leverage the generic charging and service/subscription based policy control within I-WLAN as another IP-CAN, the Gateway element in case of 3GPP-WLAN Interworking has to provide the needed functionalities, e.g. for Policy Enforcement.

The followings are objectives of the document.

- investigate the necessity and reliability of the applicable QoS mechanism between the WLAN UE and PDG, and the possible impacts to the 3GPP-WLAN interworking entities;
- ensure that the architecture for 3GPP/WLAN Interworking defined by TS 23.234 is supported by the following QoS-related mechanisms being developed in 3GPP:
  a. E2E QoS architecture being studied in TR 23.802;
  b. Policy and charging evolution capabilities being studied in TR 23.803.

2 References

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

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

[1] 3GPP TS 23.234: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3GPP system to Wireless Local Area Network (WLAN) interworking; System description".

[2] 3GPP TS 22.234: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Requirements on 3GPP system to Wireless Local Area Network (WLAN) interworking".

[3] 3GPP TR 23.803: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Evolution of Policy Control and Charging".

[4] 3GPP TS 23.125: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Overall High Level Functionality and Architecture Impacts of Flow Based Charging".

[5] 3GPP TS 23.008: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Organization of subscriber data".

[6] 3GPP TS 23.107: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Quality of Service (QoS) concept and architecture".

[7] IEEE 802.1D, 1998 Edition (ISO/IEC 15802-3:1998), "IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Media access control (MAC) Bridges".

[8] IEEE 802.11e [draft].

[9] 3GPP TS 23.203: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Policy and Charging Control Architecture".

[10] 3GPP TR 21.905: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Vocabulary for 3GPP Specifications".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the definitions given in TR 21.905 [10] and the following definitions apply:

3GPP WLAN QoS profile: 3GPP defined QoS profile for I-WLAN access.

WLAN AN QoS profile: WLAN AN specific QoS definition, e.g. a level, class, profile, or priority.

3.2 Abbreviations

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

WMM Wi-Fi Multimedia
CoS Class of Service

4 Architectural requirements and considerations

4.1 Basic assumptions

During the specification of the support of QoS provided by the WLAN AN, the following principles shall be considered:

- the 3GPP I-WLAN architecture shall be independent from the used WLAN technology, which specification is out of the scope of 3GPP. The QoS support for I-WLAN architecture shall be defined in a general way that is applicable for legacy and future WLAN QoS mechanisms. i.e. 3GPP shall not define WLAN QoS mechanisms and interworking with specific WLAN QoS mechanisms;
- the existing interfaces and procedures should be extended to support QoS within the 3GPP I-WLAN architecture;
- whenever possible existing standardized techniques (e.g., IEEE and IETF specifications) should be re-used.

4.2 Architectural requirements

To support interworking with QoS provided by the WLAN AN, following enhancements of the architecture defined in TS 23.234 [1] are necessary:

- the 3GPP WLAN QoS profile and WLAN AN QoS profiles shall be WLAN technology independent. The WLAN AN QoS profiles should use existing standardized specifications, if possible;
- the AAA Server shall be the single point to authorize WLAN AN QoS profiles for both WLAN direct IP Access and WLAN 3GPP IP Access;
- the 3GPP WLAN QoS profile shall be specified within the subscriber data of the HSS (defined in TS 23.008 [5]). The 3GPP WLAN QoS profile contains the subscribed WLAN AN QoS profiles and optionally additional parameters;
- authorization of the WLAN AN QoS profile in case of WLAN 3GPP IP Access shall be able to take into account the Policy Control and Charging (PCC) functionality;
- a mechanism shall be defined, which allows that the WLAN AN's QoS capabilities (e.g. the supported WLAN AN QoS profiles) are provided by the WLAN AN to the 3GPP AAA Server during initial WLAN direct IP Access authorization;
- the authorized WLAN AN QoS profile shall be sent from the 3GPP AAA Server to the WLAN AN during WLAN 3GPP IP Access authorization and re-authorization;
- a mechanism for authorization of change of WLAN AN QoS profile after initial authorization between WLAN AN and 3GPP AAA Server/Proxy shall be considered;
- charging signalling sent between WLAN AN and 3GPP AAA Proxy/Server shall contain information about the used WLAN AN QoS profiles.

5 QoS provisioning for I-WLAN

5.1 Architecture for QoS support

5.1.1 General

Figure 5.1 shows the considered QoS architecture for WLAN Direct IP Access.

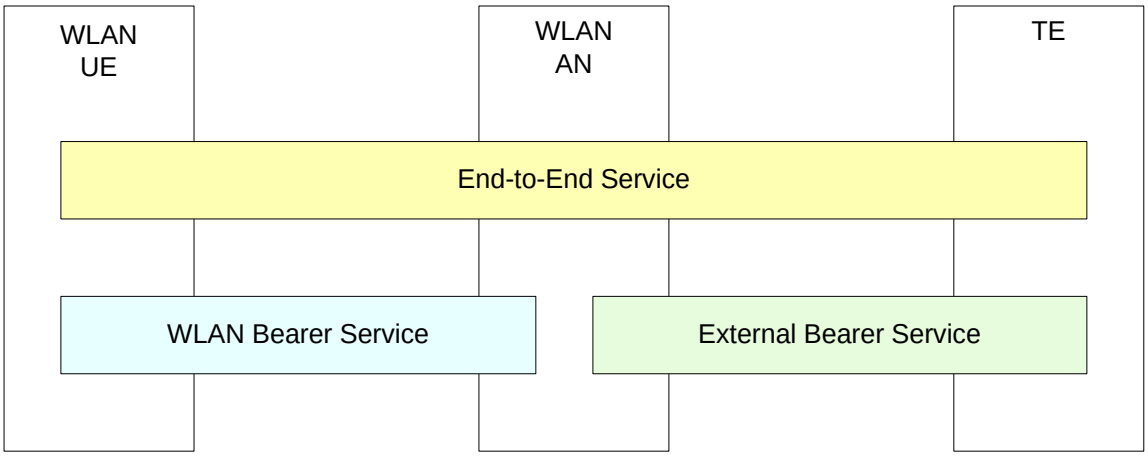

Figure 5.1: QoS Architecture for WLAN Direct IP Access

Figure 5.2 shows the considered QoS architecture for WLAN 3GPP IP Access.

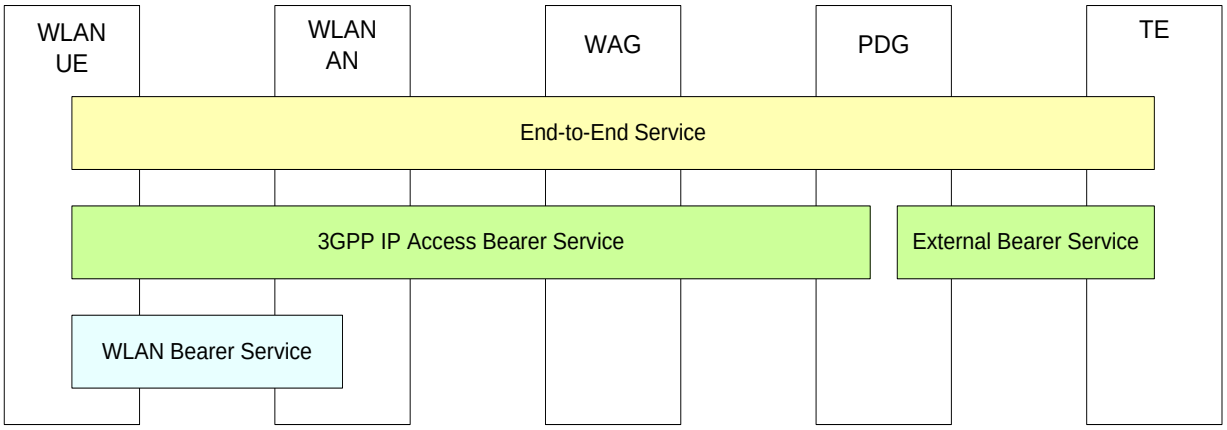

Figure 5.2: QoS Architecture for WLAN 3GPP IP Access

The End-to-End Service provides transport of the signalling and user data between the WLAN UE and another (external) TE (or correspondent node) passed over different bearer services of the network. In case of WLAN Direct IP Access, it consists of WLAN Bearer Service and External Bearer Service. In case of WLAN 3GPP IP Access, it consists of 3GPP IP Access Bearer Service and External Bearer Service.

The External Bearer Service is not further elaborated here as this bearer may be using several network services, e.g. another UMTS Bearer Service (TS 23.107 [6]). The 3GPP IP Access Bearer Service provides transport of signalling and user data between WLAN UE and PDG and supports I-WLAN QoS.

WLAN Bearer Service supports WLAN AN specific bearer capability between WLAN UE and WLAN AN.

5.1.2 Use of CoS based DiffServ for providing QoS over I-WLAN using 3GPP IP Access

When using 3GPP IP Access, a tunnel from UE to PDG is established for carrying 3GPP PS domain services traffic. This tunnel traverses over inter PLMN backbone (e.g. GRX) in the case of a roaming user. While accessing home network services, one or more tunnels will be setup that will carry traffic for all home network services that are being accessed irrespective of the level of QoS required for an individual service. It is possible that data for more than one IP flows and for different services is carried in one tunnel. Since the data within these tunnels (including the inside IP headers) is likely to be encrypted, it may not be possible to separate out individual IP flows and service traffic based on QoS at intermediate nodes.

A possible way to provide QoS in such a situation would be the use of DiffServ by the UE and PDG to appropriately colour the DiffServ bits in the external IP header based on the service that the individual packet belongs to. The DiffServ therefore will implement different classes of traffic to provide different levels of QoS. Such use of DiffServ mechanism works well with WMM guidelines from WiFi Alliance and GSMA's specifications on GRX (IR 34). WMM also provides a mapping from 802.11e priority categories to 802.1D priority levels. This mechanism is shown in Figure 5.3. See Annex A for further details on these specifications.

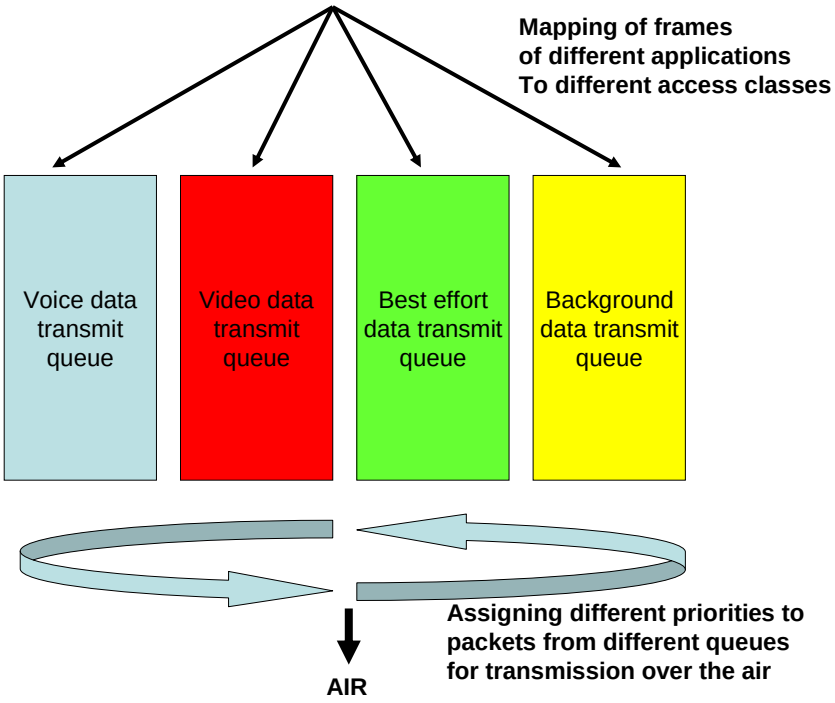

Figure 5.3: QoS Mapping

Once the QoS provisioning has been accomplished during the authentication phase, based on the information included in Table 1 and Table 2 of Annex A, it is possible to map different types of QoS traffic from the home network to DSCP and then onwards to 802.1D tags and 802.11e classes in the WLAN. Similarly UE can appropriately mark the traffic in the reverse direction.

The provisioned QoS profile may include for example information on bandwidth allowed to the user and maximum DSCP allowed for the user. The points of enforcement of bandwidth policies within 3GPP system are FFS. Entities within WLAN can implement similar enforcement. Also the entities responsible for proper DSCP marking are the end points of the tunnel (namely the UE and the PDG). If there is an inconsistent marking of QoS request from UE between layer 2 and layer 3 (for fraudulent reasons or due to error), the inconsistency will be resolved in the favour of layer 3 marking once the packet enters the 3GPP system. This will be consistent with the 3GPP flow based charging architecture that operates at layer 3.

5.2 Procedures

5.2.1 QoS Provisioning Call Flow

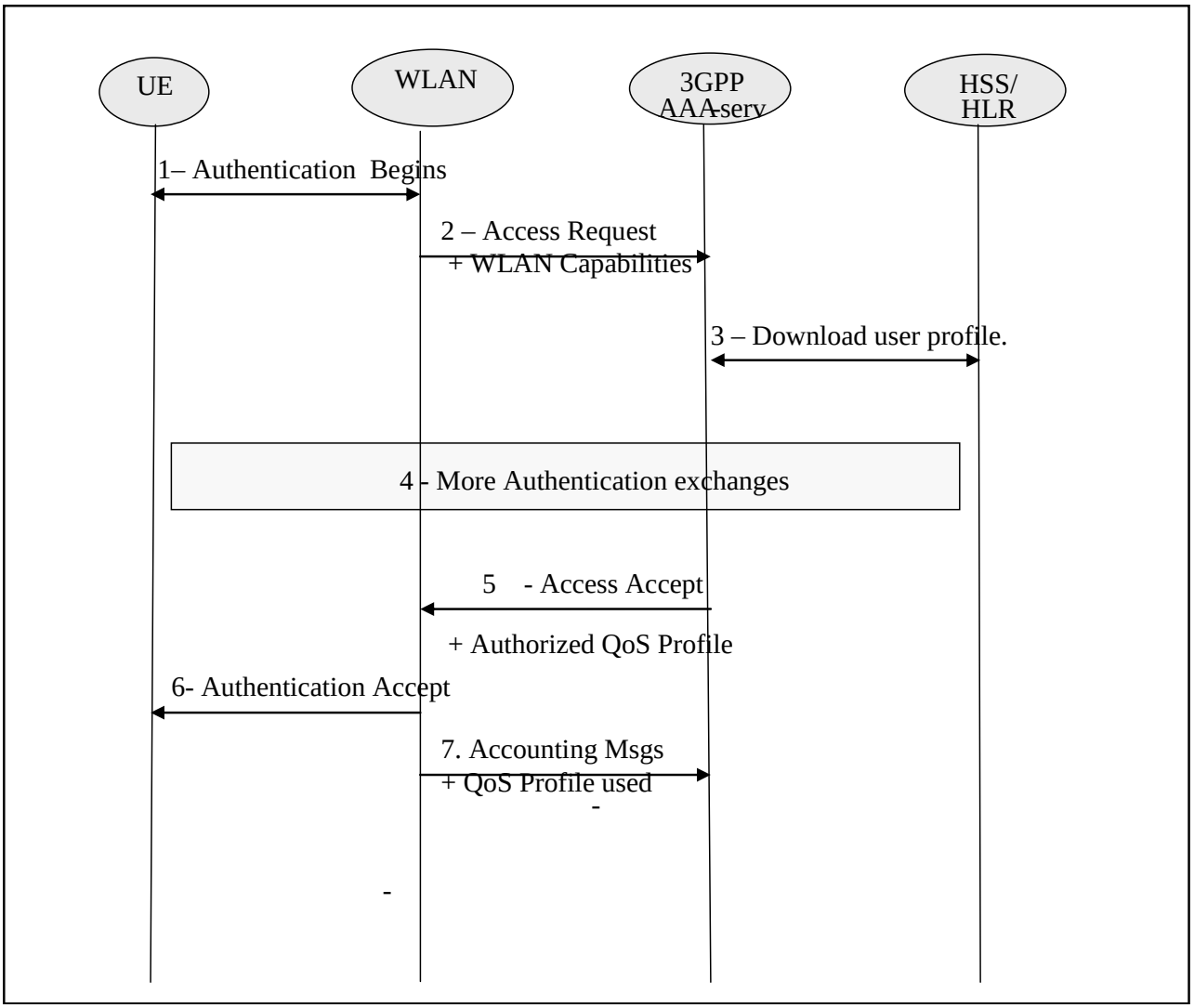

Figure 5.4: Call flow for QoS provisioning

1. UE starts the Authentication process for WLAN access.

NOTE 1: This authentication process is not for accessing 3GPP PS domain services.

2. WLAN sends out its capabilities along with the user Access Request to 3GPP AAA server. Standardized techniques for capabilities exchange are FFS, e.g., based on draft-lior-radext-end-to-end-caps-00.txt, draft-lior-radius-bandwidth-capability-01

3. User QoS profile is downloaded into AAA Server from HLR/HSS

4. Authentication message exchanges occur per TS 33.234

5. The user request for access is accepted and Access Accept message along with the authorized QoS profile is sent by 3GPP AAA server to WLAN. Standardized techniques for including the QoS profile in AAA messages is FFS.

6. WLAN informs the UE of successful authentication

7. The accounting messages from WLAN include the QoS profile being used. Standardized techniques for including the QoS profile in AAA messages is FFS.

NOTE 2: While roaming, AAA proxy in the visited network will be in the path of AAA messages and will therefore have access to the authorized QoS profile in case of a successful authentication.

5.2.2 <Procedure X>

Editor's note: Further procedures may be added.

5.3 New functions in network elements and reference points

5.3.1 Additional functions in the 3GPP AAA Server/Proxy

[Editor's Note: This section describes which additional functions are needed in the 3GPP AAA Server/Proxy to have QoS support for the I-WLAN architecture.]

In case of WLAN Direct IP Access the following functions are needed:

- retrieves subscriber profile, including subscriber's QoS authorization information, from the HLR/HSS of the 3GPP subscriber's home 3GPP network;
- authorizes 3GPP WLAN QoS profile. The authorized QoS is based on the best match of subscriber's QoS profile with the WLAN AN capabilities/policies. The authorization information may pass through AAA Proxies to the WLAN AN;
- other functions are FFS.

In case of WLAN 3GPP IP Access the following additional functions are needed:

- other functions are FFS.

5.3.2 Additional functions in the WLAN AN

[Editor's Note: This section describes which additional functions are needed in the WLAN AN to have QoS support for the I-WLAN architecture.]

In case of WLAN Direct IP Access the following functions are needed:

- may send out its QoS capabilities/policies along with the user Authentication Request to the 3GPP AAA server;
- shall apply QoS mechanisms according to the authorized QoS profile (from the 3GPP AAA Server);
- may apply DiffServ QoS mechanism to uplink/downlink IP packets. Additionally WLAN specific QoS mechanisms may be supported. The DiffServ QoS parameters are mapped into the WLAN QoS parameters;
- shall include the used QoS profile into accounting messages, in case QoS mechanisms have been used.

In case of WLAN 3GPP IP Access the following additional functions are needed:

-

5.3.3 Additional functions in the WAG

[Editor's Note: This section describes which additional functions are needed in the WAG to have QoS support for the I-WLAN architecture.]

In case of WLAN 3GPP IP Access the following additional functions are needed:

- in case of applying DiffServ in the I-WLAN, the WAG shall support DiffServ QoS mechamism to uplink/downlink IP packets.

NOTE: The WAG is only part of the WLAN 3GPP IP Access architecture.

5.3.4 Additional functions in the PDG

Editor's Note: This section describes which additional functions are needed in the PDG to have QoS support for the I-WLAN architecture.

In case of WLAN 3GPP IP Access the following additional functions are needed:

- enforces the authorized 3GPP QoS profile;
- for end-to-end QoS, the PDG operates as a QoS edge router between I-WLAN and external network. That is, the PDG shall have functionality of translation between I-WLAN QoS mechanism and external network QoS mechanism. In case of applying DiffServ in the I-WLAN, the PDG shall support DiffServ edge function;
- to allow for policy control (e.g. service based QoS control or gating) according to PCC, the PDG shall support the PCEF functionality specified in TS 23.203 [9].

NOTE: The PDG is only part of the WLAN 3GPP IP Access architecture.

5.3.5 Additional functions in the WLAN UE

[Editor's Note: This section describes which additional functions are needed in the WLAN UE to have QoS support for the I-WLAN architecture.]

In case of WLAN Direct IP Access the following functions are needed:

- applies DiffServ mechanisms by marking the DS field of IP packets according to the application QoS requirements. The DS field of IP packets are mapped into WLAN QoS parameters, when WLAN QoS mechanisms are applied.

In case of WLAN 3GPP IP Access the following additional functions are needed:

- in case of applying DiffServ in the I-WLAN, WLAN UE marks the DS field of IP packets according to the application QoS requirements. The DS field of IP packets are mapped into the WLAN QoS parameters.

Editor's Note: It is FFS what is the relation of the DS field of the inner and the outer IP header.

5.3.6 Additional functions in the HSS

Contains 3GPP WLAN QoS profiles authentication and subscription data for the 3GPP subscribers.

5.3.7 Additional functions of the Wd/Wa reference points

[Editor's Note: This section describes which additional functionality of Wa/Wd reference points is needed to have QoS support for WLAN Direct IP Access]

In case of WLAN Direct IP Access the following functions are needed:

- carrying data for QoS capabilities/policies within authentication request from WLAN AN to 3GPP AAA Proxy and 3GPP AAA Server;
- carrying data for QoS profile authorization signalling between WLAN AN, 3GPP AAA Proxy and 3GPP AAA Server;
- carrying used QoS profile within charging signalling per WLAN user.

In case of WLAN 3GPP IP Access the following additional functions are needed:

-

5.3.8 Additional functions of the Wm reference point

- Carrying messages for user authorization, including QoS authorization information, between PDG and 3GPP AAA server/proxy.

5.3.9 Additional functions of the Wx reference point

- Retrieval of WLAN access-related subscriber information (profile), including QoS profile, from HSS.

6 Policy control for I-WLAN

Policy control for WLAN 3GPP IP Access is covered by the work done in TR 23.803, and will not be further studied within this TR.

The PDG contains the gateway functionalities, as defined in TR 23.803.

7 Conclusions

This feasibility study has the following objectives:

- investigate the necessity and reliability of the applicable QoS mechanism between the WLAN UE and PDG, and the possible impacts to the 3GPP-WLAN interworking entities;
- ensure that the architecture for 3GPP/WLAN Interworking defined by TS 23.234 is supported by the following QoS-related mechanisms being developed in 3GPP:
  a. E2E QoS architecture being studied in TR 23.802;
  b. policy and charging evolution capabilities being studied in TR 23.803.

It is concluded that it is feasible to specify reliable QoS mechanisms for 3GPP-WLAN Interworking, which can inter-work with Policy and charging evolution capabilities as studied in TR 23.803. There is no relation to the E2E QoS architecture as studied in TR 23.802. The impact on the 3GPP-WLAN interworking entities has been studied in chapter 5.3 'New functions in network elements and reference points'.

It is recommended that:

- DiffServ is used as QoS mechanism between WLAN UE and PDG;
- existing AAA reference points are extended to transport QoS authorization and charging information;
- QoS profile information is added to the WLAN user profile.

Annex A:
QoS mapping

A.1 WMM specifications from Wi-Fi Alliance

WMM defined by Wi-Fi Alliance, is a profile based on IEEE 802.11e draft specifications. WMM provides support for multimedia applications by defining four access categories derived from 802.1D specifications. These access categories as shown in the following table A.1, map to priority levels in 802.1D specifications of IEEE.

Table A.1: Mapping of WMM access categories and 802.1d tags

Access Category	802.1d Tags
WMM Voice Priority	7,6
WMM Video Priority	5,4
WMM Best Effort Priority	0,3
WMM Background Priority	2,1

A.2 802.1D specifications from IEEE

The IEEE 802.1D specification is the IEEE standard for bridges that also addresses how to prioritise different classes of user traffic at layer 2. Section 6.4 of 802.1D specifications provide the following definition of user priority,

*"The **user_priority** parameter is the priority requested by the originating service user. The value of this parameter is in the range 0 through 7.*

NOTE—The default user_priority value is 0. Values 1 through 7 form an ordered sequence of user_priorities, with 1 being the lowest value and 7 the highest. See 7.7.3 and Annex G (informative) for further explanation of the use of user_priority values."

Annex G in 802.1D specifications provide traffic class mapping as shown in the following Table A.2.

Table A.2: traffic class mapping according to the number of queues

Number of queues in the system	Types/classes of traffic supported by the queues
1	{Best Effort, Excellent effort, Background, Voice, Controlled Load, Video, Network Control}
2	{Best Effort, Excellent effort, Background} {Voice, Controlled Load, Video, Network Control}
3	{Best Effort, Excellent effort, Background} {Controlled Load, Video} {Voice, Network Control}
4	{Background} {Best Effort, Excellent effort} {Controlled Load, Video} {Voice, Network Control}
5	{Background} {Best Effort, Excellent effort} {Controlled Load} {Video} {Voice, Network Control}
6	{Background} {Best Effort} {Excellent effort} {Controlled Load} {Video} {Voice, Network Control}
7	{Background} {Best Effort} {Excellent effort} {Controlled Load} {Video} {Voice} {Network Control}

A.3 IR 34 specifications from GSMA

GSMA's IREG 34 is a specification for the GRX. It also describes how DiffServ's bits are interpreted by the inter PLMN backbone (GRX). Table A.3 shows this mapping.

Table A.3: QoS mapping in GRX

3GPP QoS Information		Diffserv PHB	DSCP	QoS Requirement on GRX				Service Example
Traffic Class	THP			Max Delay	Max Jitter	Packet Loss	SDU Error Ratio	
Conversational	N/A	EF	101110	20ms	5ms	0.5%	10^{-6}	VoIP, Video Conferencing
Streaming	N/A	$AF4_1$	100010	40ms	5ms	0.5%	10^{-6}	Audio/Video Streaming
Interactive	1	$AF3_1$	011010	250ms	N/A	0.1%	10^{-8}	Transactional Services
	2	$AF2_1$	010010	300ms	N/A	0.1%	10^{-8}	Web Browsing
	3	$AF1_1$	001010	350ms	N/A	0.1%	10^{-8}	Telnet
Background	N/A	BE	000000	400ms	N/A	0.1%	10^{-8}	E-mail Download

Annex B:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2005-04					First version created	0.0.0	0.0.1
2005-04	SA2#45	S2-050963			QoS enhancement for 3GPP-WLAN Interworking	0.0.1	0.1.0
2005-05	SA2#46	S2-051458			QoS Architecture for 3GPP-WLAN Interworking	0.1.0	0.2.1
2005-07	SA2#47	S2-051833 S2-051834 S2-051863			QoS Architecture for WLAN Direct IP Access Restructuring and requirement clarification Architectural requirements on PDG for Policy Control for I-WLAN	0.2.1	0.3.0
2005-09	SA2#48	S2-052420 S2-052437 S2-052341			Use of CoS based DiffServ for providing QoS over I-WLAN using 3GPP IP Access QoS Procedures in I-WLAN Requirements for QoS provisioning for I-WLAN	0.3.0	0.4.0
2005-11	SA2#49	S2-052635 S2-052955 S2-052956			Editorial Corrections New functions in network elements and reference points Proposed conclusions for TR 23.836	0.4.0	0.5.0
2005-11					Editorial correction	0.5.0	0.5.1
2005-11	SP#30	SP-050679	-	-	Updated by MCC for presentation to TSG SA for information	0.5.1	1.0.0