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Wireless LANs

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| Draft technical report on interworking between 3GPP 5G network & WLAN | | | | |
| Date: 2020-01-14 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Hyun Seo OH | ETRI | Gajeongro 218 Yusunggu  Daejeon, Korea | +82.42.860.5659 | hsoh5@etri.re.kr |
| Hanbyeog CHO | ETRI | Gajeongro 218 Yusunggu  Daejeon, Korea | +82.42.860.5531 | hbcho@ etri.re.kr |
| Yoohwa Kang | ETRI | Gajeongro 218 Yusunggu  Daejeon, Korea | +82.42.860.6364 | yhkang@etri.re.kr |
| Chang Han OH | allRadio Co. Ltd | 280, Seobusaet-gil, Geumcheon-gu, Seoul, Korea | +82.2.801.1310 | choh@allradio.co.kr |
| Shinho CHO | allRadio Co. Ltd | 280, Seobusaet-gil, Geumcheon-gu, Seoul, Korea | +82.10.3351.8424 | shcho@allradio.co.kr |
| Raeman KIM | allRadio Co. Ltd | 280, Seobusaet-gil, Geumcheon-gu, Seoul, Korea | +82.10.5512.9390 | rmkim01@allradio.co.kr |
| Si Young HEO | KT | KT R&D Center, 151, Taebong-ro, Seocho-gu, Seoul, Korea | +82.10.266.4569 | siyoung.heo@kt.com |
| Yangseok Jeong | KT | KT R&D Center, 151, Taebong-ro, Seocho-gu, Seoul, Korea | +82.10.9530.0856 | Yangseok.jeong@  kt.com |
| Hyeong Ho LEE | Nevision Telecom Inc., Korea Univ. | 412, 199, Techno2-ro, Yuseong-Gu, Daejeon, 34025, Korea | +82.42.931.4130 | hhlee@netvisiontel.com |
| Youngjae KIM | TTA | 47, Bundang-ro, Bundang-gu, Seongnam-city, Gyeonggi-do, 13591, Korea | +82.10.5110,2895 | yjkim@tta.or.kr |
| Choon Sik Yim | RCN | 199, Techno2-ro, Yuseong-Gu, Daejeon | +82.10.9531.3610 | Yim25@hnamail.net |

Abstract

This contribution is a draft technical report on WLAN interworking to 3GPP 5G network. It describes the interworking reference model and interworking types supported by 3GPP 5G network and WLAN, and defines the necessary functionalities and specific procedures that enable WLAN access networks to interwork with 3GPP 5G network. This technical report on interworking between 3GPP 5G network and WLAN will provide a reference and guideline for stakeholders with interest in standardization and system development.

1. **Definition, acronyms and abbreviations**
   1. **Definitions**

**ANC**  Access network control function of WLAN access network, which refers to IEEE 802 network reference model [15].

**NWu** Reference point between the UE and N3IWF for establishing secure tunnel(s) between the UE and N3IWF so that control-plane and user-plane exchanged between the UE and the 5G Core Network is transferred securely over untrusted non-3GPP access, which refers to 3GPP TS 23.502 [8]. This is in the domain of WLAN access network.

**STA** WLAN STA consists of TEC (terminal control) and TEI (terminal data path interface), which refers to IEEE 802 network reference model [15].

**N1** Reference point between the UE and the AMF in 5G core network [7].

**N2**  Reference point between the (R)AN and the AMF in 5G core network [7].

**N3** Reference point between the (R)AN and the UPF in 5G core network [7].

**N4** Reference point between the SMF and the UPF in 5G core network [7].

**N7** Reference point between the SMF and the PCF in 5G core network [7].

**N11** Reference point between the AMF and the SMF in 5G core network [7].

**N15** Reference point between the PCF and the AMF in the case of non-roaming scenario, PCF in the visited network and AMF in the case of roaming scenario in 5G core network [7].

**Y1**  Reference point for PHY/MAC layer function between STA and the untrusted non-3GPP access network (e.g. WLAN). This depends on the non-3GPP access technology. This is in the domain of WLAN access network.

**Y2**  Reference point for PHY/MAC layer function between the untrusted non-3GPP access network (e.g. WLAN) and the N3IWF for the transport of NWu traffic which refers 3GPP TS 23.502. This is in the domain of WLAN access network.

**Y3**  Reference point for control and management interface between STA and the untrusted non-3GPP access network (e.g. WLAN). This depends on the non-3GPP access technology. This is in the domain of WLAN access network.

**Y4**  Reference point for control and management interface between the untrusted non-3GPP access network (e.g. WLAN) and the N3IWF for the transport of NWu traffic which refers 3GPP TS 23.502. This is in the domain of WLAN access network.

* 1. **Acronyms and abbreviations**

**3GPP** 3rd Generation Partnership Project

**5G** 5th Generation

**5G-AN** 5th Generation Access Network

**AIFS** Arbitrary Inter-Frame Spacing

**ANC**  Access Network Control

**AMF**  Access and Mobility Management Function

**ATSSS** Access Traffic Steering Switching and Splitting

**HCCA** Hybrid Controlled Channel Access

**EAP-5G** Extended Autenication Protocol-5th Genration

**EDCA** Enhanced Distributed Channel Access

**GBR** Guaranteed Bit Rate

**GRE** Generic Routing Encapsulation

**IKEv2** Initial Key Exchange Protocol Version 2

**IP** Internet Protocol

**IPsec** Internet Protocol Security

**MAC** Media Access Control

**NAS** Non Access Stratum

**N3IWF** Non-3GPP Inter Working Function

**PCF** Policy Control Function

**PDU** Packet Data Unit

**PER** Packet Error Rate

**PHY**  Physical Layer

**QoS** Quality of Service

**SMF** Session Management Function

**STA** Station

**TEC** Terminal Control

**TEI** Terminal Interface

**UE**  User Equipment

**UPF**  User Plane Function

**V2X** Vehicle to Antyhing

**WLAN** Wireless Local Area Network

1. **Introduction**

This clause introduces basic objectives and scope of the technical report on WLAN interworking to 3GPP 5G core network. WLAN interworking types may have tightly coupled or loosely coupled, and functional reference model to interwork with 3GPP 5G network are described in Clause 3.

And the interworking function and specific procedures regarding radio channel sharing, registration and authentication, IP tunneling, ATSSS and QoS function are described in Clause 4. Through technical study, gap analysis and technical recommendations are commented in Clause 5. And finally conclusions are summarized in Clause 6.

* 1. **Objectives**

This technical report on interworking between 3GPP 5G network and WLAN will provide a reference and guideline for stakeholders with interest in standardization and system development.

* 1. **Scope**

This report covers an interworking reference model, necessary functionalities and specific procedures that allow WLAN access network to interwork with 3GPP 5G network. We consider two types of interworking reference model, which are tightly coupled type and loosely coupled type.

The interworking reference model consists of terminal part, access networks, 3GPP 5G core network and sever as shown in Figure 1. Two access networks are connected to server via 3GPP 5G core network. 3GPP access network and 5G core network refer to 3GPP specification and WLAN access network refers to IEEE 802 network reference model of IEEE 802.1CF-2019 [15].

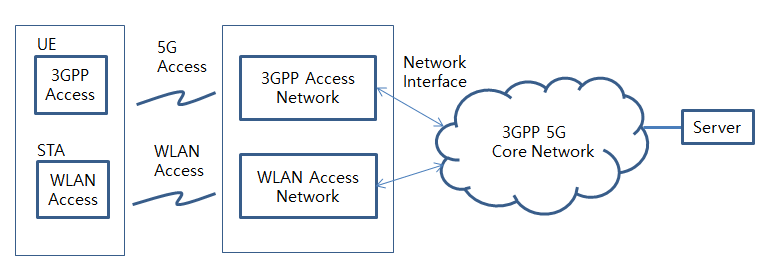


Figure 1. Overview of WLAN interworking with 3GPP core network

1. **WLAN interworking reference model**
   1. **WLAN interworking types**

There are two types of interworking model; tightly coupled or loosely coupled.

Tightly coupled interworking type assumes that fuctional entities of terminal and two access networks are combined together and two access networks are connected to 3GPP core network because 3GPP access network and WLAN access network can be located at the same position and operated together. It will optimize overall system performance by doing system integration from architecture design to system implementation.

Loosely coupled interworking type assumes that 3GPP and WLAN access network are separately located and ony terminal function can be combined. This type will provide same service functions as thigtly coupled type.

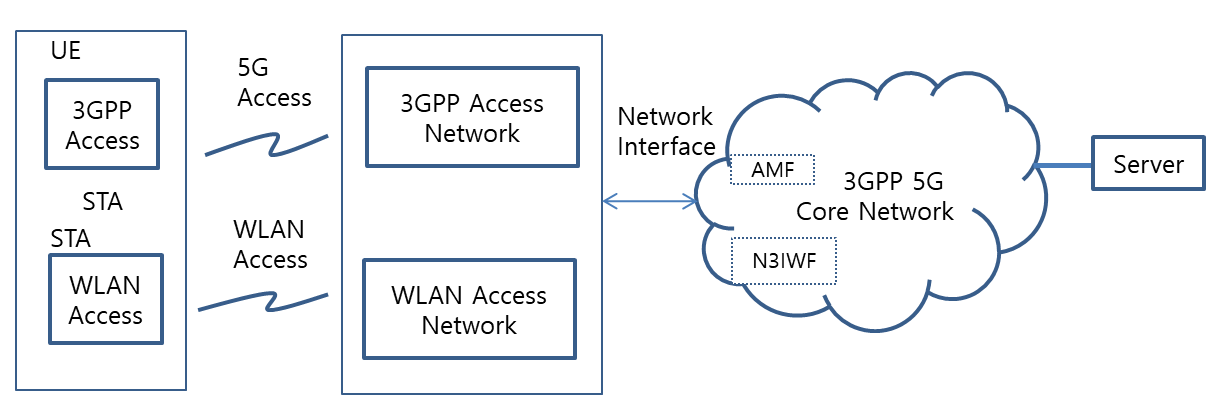


Figure 2. Tightly coupled interworking reference model between 5G core network and WLAN

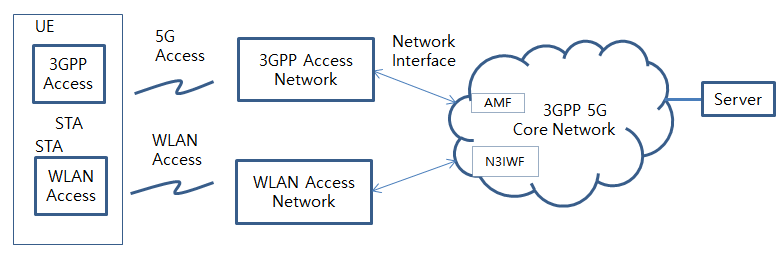


Figure 3. Loosely coupled interworking reference model between 5G core network and WLAN

* 1. **WLAN interworking functional model**

WLAN interworking function model consists of UE/STA terminal, 3GPP/WLAN access network and 3GPP core network as shown in Figure 4.

WLAN STA functions are divided into terminal interface(TEI) and terminal control(TEC). And WLAN access network functions are divided into WLAN access data path and access network control(ANC) according to WLAN network reference model IEEE 802.1CF-2019. And 3GPP fuctions are divided into UE and 3GPP access network, 5G core network and their signalling interfaces are described according to 3GPP specification.

For WLAN interworking to 3GPP core network, 3GPP N1 signalling and NWu interfaces shall be processed in WLAN domain. N1 is signalling procedures between UE and 3GPP core network to support Authentication and Mobility Function (AMF). NWu is signalling procedures between UE and N3IWF of 3GPP core network to support secured IP channel.

In WLAN domain, Y1 and Y2 interfaces are PHY and MAC layer function of STA and WLAN access network. And Y3 and Y4 interfaces are control and management interface to provide ATSSS and QoS management. These red coloured Y1, Y2, Y3 and Y4 interfaces are in the domain of WLAN and may be provided in STA and WLAN access network. The other reference interfaces are referred to 3GPP core network.

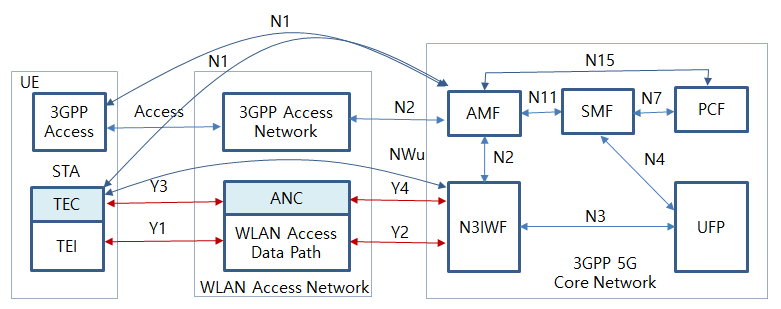


Figure 4. WLAN interworking reference model with 5G core network

1. **Interworking function and procedures**

The radio channel access and communication procedures have to be specified to provide WLAN interworking with 5G core network. Even though there are tightly coupled or loosely coupled interworking types, the common procedures can be applied for them.

Radio channel sharing method is described in 4.1. And initial registration and authentication procedures between STA of UE and AMF of 5G core network are described in 4.2, IP secure transport and data exchange between STA of UE and UPF of 5G core network are described as an example in 4.3.

ATSSS function and QoS management on WLAN will be expected to have some interface or modification on MAC layer of STA and wireless access network. These functions will be described in 4.4 and 4.5.

* 1. **Radio channel sharing method**

TEI of STA monitors the usage of WLAN access network if the radio channel is busy or idle. If the radio channel is idle, STA tries to send control or traffic data.

* 1. **Registration and authentication and its message procedures**

STA shall initially support registration and authentication to be connected between UE and N3IWF. NWu for registration and authorization involves IP protocol, IKEv2 and EAP-5G protocol. And N1 signalling is needed to exchange NAS signal.

* + 1. **Registration and authentication function**

TEC of UE and ANC of WLAN access network shall have specific functional requirements to interwork with 3GPP 5G core network

* IP communication protocol
* IKEv2 authorization protocol
* EAP-5G protocol
* NAS signalling

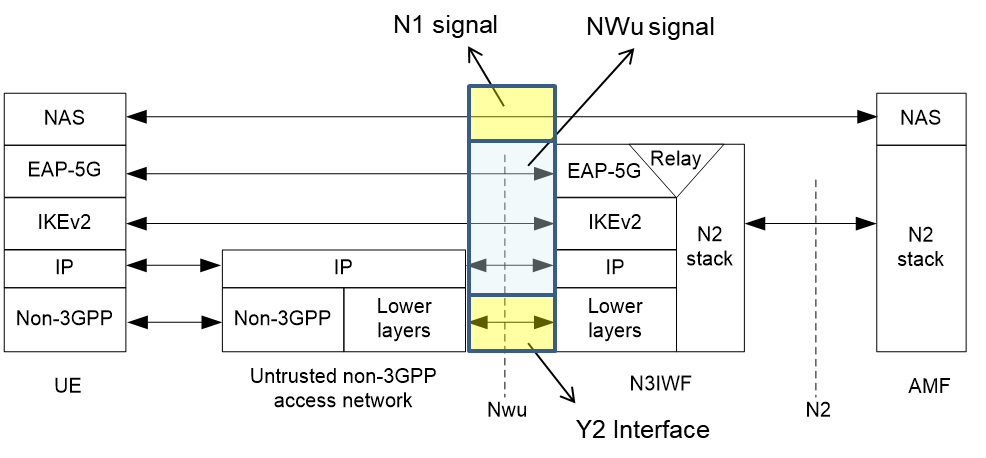


Figure 5. Control Plane between UE and N3IWF (3GPP TS 23.501)

* + 1. **Message procedures**
* **Y2 interface**

Y2 interface is PHY/MAC data communication protocol between ANC of WLAN access network and N3IWF of 3GPP 5G core network. Y2 follows IEEE 802.3 standard.

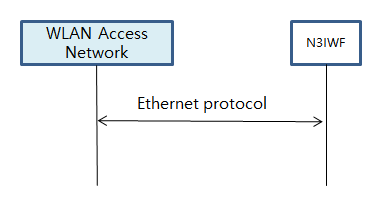


Figure 6. Y2 interface

* **NWu interface**

NWu interface is IP based communication protocol between STA of WLAN access network and N3IWF of 3GPP 5G core network to establish secured data channel. IKEv2 authorization protocol and EAP-5G protocol is applied

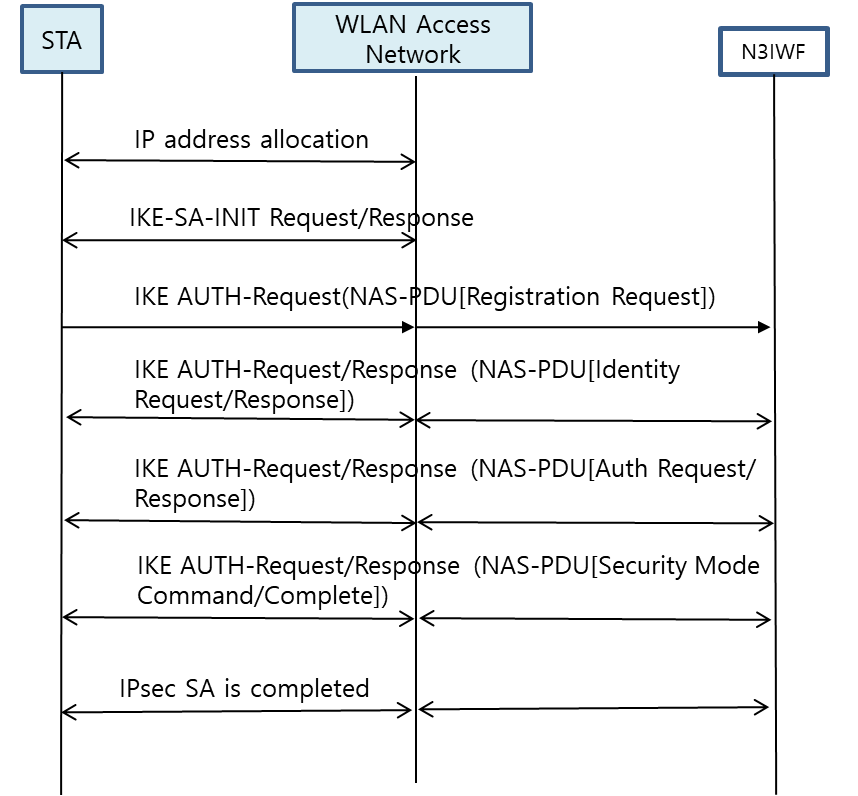


Figure 7. NWu interface

* **N1 interface**

N1 interface is secured IP communication protocol between UE of WLAN access network and AMF of 3GPP 5G core network to provide NAS signalling

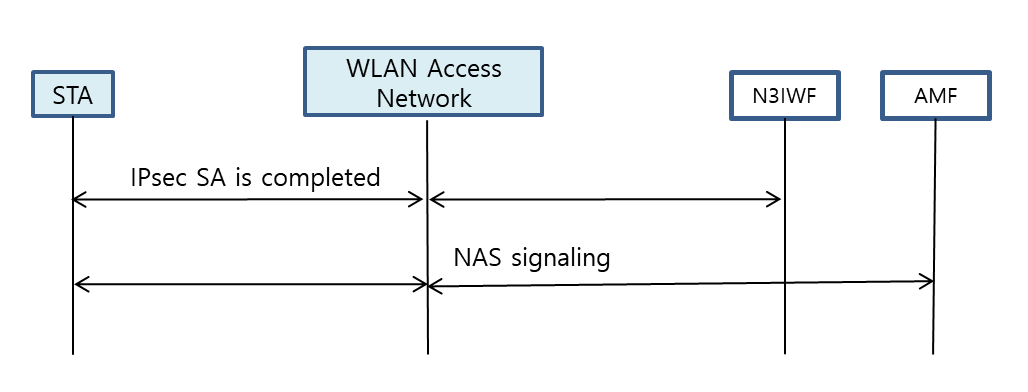


Figure 8. N1 interface

* 1. **IP Tunnelling function and its message procedures**

STA shall initially support secured IP transport between UE and UPF, and traffic data is exchanged over the established IP channel.

* + 1. **IP Tunnelling Function**

SC of UE and ANC of WLAN access network shall have specific functional requirements to interwork with 3GPP 5G core network.

* IP communication protocol
* IPsec communication protocol
* GRE communication protocol

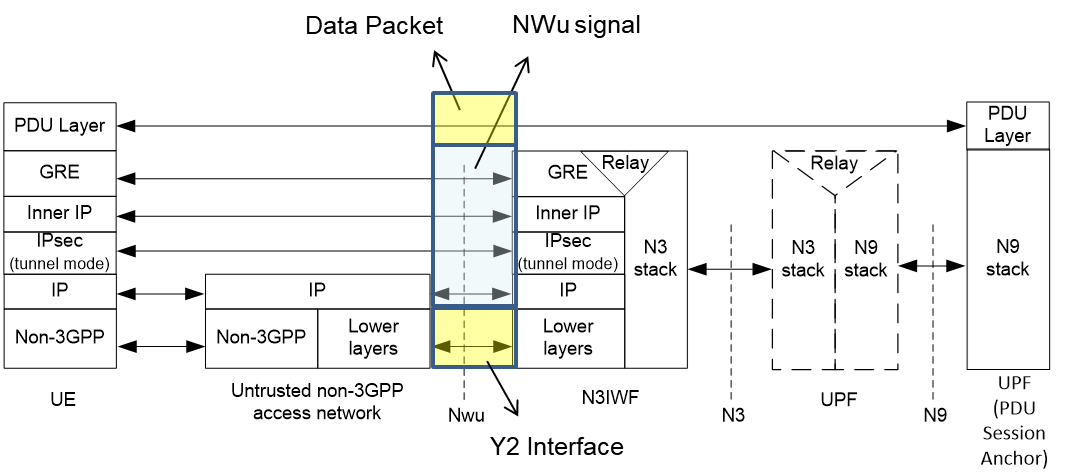


Figure 9. Data Plane between UE and N3IWF (3GPP TS 23.501)

* + 1. **Message procedures**

* IPsec tunnelling procedures shall be processed via WLAN access network
* PDU session establishmenr shall be processed via WLAN access network.
  1. **ATSSS function support**

Traffic data shall be transmitted over WLAN access channel and/or 3GPP access channel by using ATSSS function.

* 3GPP supports ATSSS between 3GPP and non-3GPP access networks
* ATSSS can enable traffic selection, switching and splitting between 5G-AN and WLAN



Figure 10. Architecture reference model for ATSSS support (3GPP TS 23.501)

The 3GPP QoS flow is access agnostic, so the same QoS is supported when the traffic is distributed over 5G access network and WLAN access network. The QoS flow may be either gurauranteed flow bit rate (GBR) or Non-GBR, so 3GPP can support GBR traffic as well as Non-GBR traffic defined in 3GPP TS 23.501 as follows:

* GBR QoS Flow: A QoS Flow using the GBR resource type or the Delay-critical GBR resource type and requiring guaranteed flow bit rate.
* Non-GBR QoS Flow: A QoS Flow using the Non-GBR resource type and not requiring guaranteed flow bit rate.

Table 1 shows the characteristics of GBR and delay-critical GBR QoS flows from 3GPP. Therefore, it is required to consider how to support GBR flows in WLAN.

Table 1. QoS characteristics (3GPP TS 23.501)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Resource Type | Default Priority Level | Packet Delay Budget | Packet Error  Rate | Default Maximum Data Burst Volume | Default  Averaging Window | Example Services |
| GBR | 20 | 100 ms | 10-2 | N/A | 2000 ms | Conversational Voice |
| 40 | 150 ms | 10-3 | N/A | 2000 ms | Conversational Video (Live Streaming) |
| 30 | 50 ms | 10-3 | N/A | 2000 ms | Real Time Gaming, V2X messages  Electricity distribution – medium voltage, Process automation - monitoring |
| 50 | 300 ms | 10-6 | N/A | 2000 ms | Non-Conversational Video (Buffered Streaming) |
| 7 | 75 ms | 10-2 | N/A | 2000 ms | Mission Critical user plane Push To Talk voice (e.g., MCPTT) |
| 20 | 100 ms | 10-2 | N/A | 2000 ms | Non-Mission-Critical user plane Push To Talk voice |
| 15 | 100 ms | 10-3 | N/A | 2000 ms | Mission Critical Video user plane |
| 56 | 150 ms | 10-6 | N/A | 2000 ms | "Live" Uplink Streaming (e.g. TS 26.238 [y]) |
| 56 | 300 ms | 10-4 | N/A | 2000 ms | "Live" Uplink Streaming (e.g. TS 26.238 [y]) |
| 56 | 300 ms | 10-8 | N/A | 2000 ms | "Live" Uplink Streaming (e.g. TS 26.238 [y]) |
| 56 | 500 ms | 10-8 | N/A | 2000 ms | "Live" Uplink Streaming (e.g. TS 26.238 [y]) |
| 56 | 500 ms | 10-4 | N/A | 2000 ms | "Live" Uplink Streaming (e.g. TS 26.238 [y]) |
| Delay Critical GBR | 19 | 10 ms | 10-4 | 255 bytes | 2000 ms | Discrete Automation (see TS 22.261 [x]) |
| 22 | 10 ms | 10-4 | 1354 bytes | 2000 ms | Discrete Automation (see TS 22.261 [x]) |
| 24 | 30 ms | 10-5 | 1354 bytes | 2000 ms | Intelligent transport systems (see TS 22.261 [x]) |
| 21 | 5 ms | 10-5 | 255 bytes | 2000 ms | Electricity Distribution- high voltage (see TS 22.261 [x]) |

* 1. **QoS function and its message procedures**

3GPP resource types and QoS related parameters shall be shared with WLAN using Y3 and Y4 interfaces and WLAN will support QoS function and related message procedures. QoS management functions need to cover QoS mapping, scheduling algorithm and MAC interface and TEC of STA and ANC of WLAN access network will deal with them.

PHY and MAC specification are important factor to meet the required QoS value. The current technologies to provide QoS management is EDCA and HCCA, which are distributed based access scheme. IEEE 802.11e provides 4 kinds of access categories, which are best effort, video probe, video and voice. According to access categories, contention widow size and arbitration inter-frame space (AIFS) is variable to meet the erquired qualtity of service.

3GPP specification provides GBR, Non-GBR and delay critical GBR. Delay critical GBR needs lower latency (less than 30msec) and higher packet error rate (PER) (less than 10-4). And 3GPP have more characterised QoS management to support packet delay, PER, default maximum data burst volume and default average window for the service types.

It is reviewed that EDCA and HCCA of WLAN technology will meet QoS for Non-GBR service type and will be limited to meet low latency and high reliablity for GBR and delay critical GBR types.

(To be described)

1. **Gap analysis and Recommendations**

(To be described)

1. **Conclusions**

(To be described)

1. **References**
2. 3GPP TS 22.261 V15.5.0 (2018-06) “Service requirements for the 5G system (Stage 1)”
3. 3GPP TS 22.278 “Service requirements for the Evolved Packet System (EPS)”
4. 3GPP TS 23.402 "Architecture enhancements for non-3GPP accesses”
5. 3GPP TR 23.716 “Study on the Wireless and Wireline Convergence for the 5G System Architecture”
6. 3GPP TR 23.793 “Study on Access Traffic Steering, Switching and Splitting support in the 5G system architecture”
7. 3GPP TR 23.799“Study on Architecture for Next Generation System”
8. 3GPP TS 23.501“System Architecture for the 5G System (Stage 2)”
9. 3GPP TS 23.502“Procedures for the 5G System (Stage 2)”
10. 3GPP TS 24.302 “Access to the 3GPP Evolved Packet Core (EPC) via non-3GPP access networks (Stage 3)”
11. 3GPP TS 24.501 “Non-Access-Stratum (NAS) protocol for 5G System (5GS) (Stage 3)”
12. 3GPP TS 24.502 “Access to the 3GPP 5G Core Network (5GCN) via Non-3GPP Access Networks (N3AN) (Stage 3)”
13. 3GPP TS 33.501 “Security Architecture and Procedure for the 5G System”
14. 3GPP TR 33.899 “Study on the Security Aspects of the Next Generation System”
15. RAN convergence paper, WBA and NGMN alliance, September, 2019.
16. IEEE 802.1CF-2019; IEEE Recommended Practice for Network Reference Model and Functional Description of IEEE 802® Access Network, 2019.