**SA WG2 Meeting #161 S2-2402319r02**

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**Source: Ericsson, Intel**

**Title: KI#2.2, New Sol: Simplified ATSSS over non-3GPP using direct MPQUIC connection between UE and UPF**

**Document for: Approval**

**Agenda Item: 19.13**

**Work Item / Release: FS\_MASSS / Rel-19**

*Abstract of the contribution: This contribution proposes a solution for KI#2.2.*

# Discussion

The KI#2.2 is targeting to study the following aspects (from TR 23.700-54):

*1) Protocol stack simplification*

*- Whether and how to eliminate the NAS signalling connection over non-3GPP access, or not.*

*- Whether and how to eliminate IPSec tunnel encapsulation on the user plane only or both on the control plane and the user plane, in order to simplify the UE protocol stack and reduce the user plane overhead.*

*2) "non-3GPP access without 5G NAS over non-3GPP".*

*- Whether and how to support splitting, switching, steering between 3GPP access and "non-3GPP access without 5G NAS".*

*- Whether and how to enhance registration and security aspects for supporting "non-3GPP access without 5G NAS over non-3GPP". This may include studying also whether registration would be used over non-3GPP access.*

One option to simplify ATSSS over non-3GPP is to utilize the fact that QUIC is encrypted and can be used without additional protection (subject to SA3 analysis). It is therefore possible to use the MPQUIC Steering Functionality between UE and UPF without the underlying IPSec layer and without a Gateway such as N3WIF or TNGF.

In case there is no NAS signaling connection via non-3GPP access, MA PDU Session can be established and managed via 3GPP access. This may be seen as a disadvantage, e.g. because it is not possible to e.g. establish or modify the MA PDU Session via non-3GPP access. However, a main scenario for ATSSS is that both 3GPP and non-3GPP accesses are available and, even if the 3GPP coverage is lost it is possible to maintain the MA PDU Session via the non-3GPP for a while without NAS connectivity. A solution is proposed below. It can be further studied whether and how to also be able to establish MA PDU Sessions via non-3GPP access even without N3IWF/TNGF.

# Proposal

It is proposed to update TR 23.700-54 as described below.

\*\*\*\* First Change \*\*\*\*

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of DualSteer Solutions to Key Issues

|  |  |
| --- | --- |
|  | Key Issues for DualSteer |
| Solution# | <Key Issue #1.1> | <Key Issue #1.2> |  |  |
| #X |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Table 6.0-2: Mapping of ATSSS\_Ph4 Solutions to Key Issues

|  |  |
| --- | --- |
|  | Key Issues for ATSSS\_Ph4 |
| Solution# | <Key Issue #2.1> | <Key Issue #2.2> |  |  |
| #Y |  | X |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

\*\*\*\* Next Change \*\*\*\*

# 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 22.261: "Service requirements for the 5G system".

[3] 3GPP TS 23.501: "System architecture for the 5G System (5GS)".

[4] 3GPP TS 23.502: "Procedures for the 5G System (5GS)".

[5] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[xx] IETF RFC 9000: "QUIC: A UDP-Based Multiplexed and Secure Transport".

[yy] draft-ietf-quic-multipath: "Multipath Extension for QUIC".

\*\*\*\* Next Change (all new text) \*\*\*\*

### 6.2.Y Solution #Y: Simplified ATSSS over non-3GPP based on direct MPQUIC connection between UE and UPF

#### 6.2.Y.1 Description

##### 6.2.Y.1.1 General

This solution addresses KI#2.2.

Since QUIC is encrypted, there is a possibility to use the MPQUIC Steering Functionality between UE and UPF without the underlying IPSec layer and without a Gateway such as N3WIF or TNGF (subject to SA3 analysis and confirmation). In this case there is no NAS signalling connection via non-3GPP access, and therefore the MA PDU Session needs to be established and managed via 3GPP access.

This solution is based on the following basic principles and assumptions:

- N3IWF/TNGF is not used when accessing over non-3GPP access.

- The NAS procedures over 3GPP access are used to register in 5GC and establish MA PDU Session.

- The NAS procedures via 3GPP access are also used to provision the UE with necessary information to connect towards the UPF with MPQUIC over non-3GPP access.

- UE has no N1 (NAS) signalling connection with the 5G Core (5GC) network over non-3GPP access.

- Before using non-3GPP access, the UE must first have an established PDU Session with 5GC over 3GPP access.

- The UPF (PSA) must have at least one transport address (i.e. an IP address and a port number) that is reachable via the Internet.

- The solution only supports MPQUIC Steering Functionality. ATSSS\_LL and MPTCP are not supported.



Figure 6.2.Y.1.1-1. Architecture for simplified ATSSS over non-3GPP based on direct MPQUIC connection between UE and UPF.

The Nx reference point supports MPQUIC connectivity between UE and UPF and is based on existing MPQUIC interface between UE and UPF.

Editor’s note: It is FFS whether there is a need to give it a separate designation / reference point name or not.

#### 6.2.Y.2 Procedures

##### 6.2.Y.2.1 MA PDU Session Establishment via 3GPP access



Figure 6.2.Y.2.1-1. PDU Session Establishment over 3GPP access

1. The UE sends a PDU Session Establishment Request message and includes its ATSSS Capabilities,also indicating that it is capable of “direct ATSSS via non-3GPP access using MPQUIC”.

NOTE 1: The MA PDU Session in this solution is different from the MA PDU Session in Rel-18 in that it is transparent to the AMF.

2. The AMF selects an SMF and sends a Nsmf\_PDUSession\_Create Request message with the PDU Session Establishment Request message.

3. The SMF interacts with UDM as per existing specifications.

4. The SMF replies to AMF with an Nsmf\_PDUSession\_Create Response, as per existing specifications.

5. The SMF selects a UPF supporting “direct ATSSS via non-3GPP access using MPQUIC”.

6. The SMF sends a N4 Session Establishment Request message to the UPF and includes the required ATSSS features that should be activated in the UPF. In this case MPQUIC is indicated together with an indication for “direct ATSSS via non-3GPP access using MPQUIC”.

If the message from SMF instructs the UPF to activate MPQUIC functionality with “direct ATSSS via non-3GPP access using MPQUIC”, the UPF allocates MPQUIC proxy information for both the N3 tunnel used via 3GPP access and for the Nx interface (non-3GPP access), i.e. the UPF allocates separate IP addresses and ports of the MPQUIC proxy in UPF for N3 and Nx interfaces.

If the message from the SMF instructs the UPF to activate MPQUIC functionality, the UPF also allocates a UE "MPQUIC link-specific multipath" addresses/prefixes for 3GPP access and provides these to SMF, as per rel-18. The UPF does not allocate a UE "MPQUIC link-specific multipath" addresses/prefixes for non-3GPP access.

NOTE 2: The UE uses the local IP address allocated by the non-3GPP access to reach the MPQUIC proxy via non-3GPP access.

The UPF replies with a N4 Session Establishment Response message and provides the UE "MPQUIC link-specific multipath" addresses/prefixes for 3GPP access and the MPQUIC proxy information to the SMF.

7-8. The SMF sends the PDU Session Establishment Accept to the UE and includes the following information:

- MPQUIC Proxy address information (IP address and port number) for 3GPP access

- MPQUIC Proxy address information (IP address and port number) for non-3GPP access

- Link-Specific Multipath IP address for 3GPP Access

9. The rest of the MA PDU Session procedure is executed, as described in TS 23.502 [4].

10. After the MA PDU Session establishment, the UE determines to establish at least as many multipath QUIC connections as the number of QoS flows of the MA PDU Session, i.e. one multipath QUIC connection per QoS flow, as described in TS 23.501 [3] and TS 23.502 [4]. These multipath QUIC connection are established via 3GPP access, allowing the UPF to associate the QUIC connection with the PDU Session / N3 tunnel.

 For each QUIC connection the UE obtains the following information from the UPF using inherent QUIC mechanisms:

- At least two Connection IDs for a QUIC connection: A QUIC connection can be associated with multiple Connection IDs. To support multi-path QUIC operation, the QUIC endpoints must use different Connection IDs on different paths (see IETF draft-ietf-quic-multipath [yy]).

- Token for Address Validation: The UE must present a token in the initial QUIC handshake to prove its IP address to the UPF, mitigating against potential spoofing and amplification attacks. This token is used as part of QUIC's path validation mechanism.

##### 6.2.Y.2.2 Addition of non-3GPP access user-plane resources

The use of MPQUIC over non-3GPP access is based on the MPQUIC steering functionality in Rel-18, with the clarifications and changes described in this clause.



Figure 6.2.Y.2.2-1. Addition of non-3GPP access user-plane resources

After MA PDU Session Establishment via 3GPP access, and after the multipath QUIC connections are established via 3GPP access, the UE may add non-3GPP access user plane resources. This is done by adding MPQUIC paths to the existing QUIC connection in the same way as already defined Rel-18 but with the difference that the UE uses the local IP address assigned by the non-3GPP access as the UE IP address and the non-3GPP MPQUIC proxy address and port received from SMF during MA PDU Session Establishment, as illustrated in Figure 6.2.Y.2.2-1.

1. UE has an established MPQUIC connection with the UPF over 3GPP access, as described in clause 6.2.Y.2.1.

2. UE obtains a local IP address from the non-3GPP access. This IP address, combined with a UE-assigned port number, is to be used as UE’s transport address for the MPQUIC path established over non-3GPP access and via the Internet.

3. UE initiates validation of the new path with the UPF via non-3GPP access as defined in the QUIC specification (IETF RFC 9000 [xx]) and the QUIC multi-path extensions (IETF draft-ietf-quic-multipath [yy]).

 The UE selects an unused Connection ID provided by the UPF for the new path and sends a packet containing a PATH\_CHALLENGE frame, initiating the path validation process. This action demonstrates the UE's intention to establish or migrate to a new path using the selected Connection ID. The UPF receives the PATH\_CHALLENGE and responds with a PATH\_RESPONSE frame, acknowledging the challenge and completing the path validation process. This exchange ensures the UE and UPF can securely communicate over the new path.

 The UPF sends a PATH\_CHALLENGE frame to the UE for path validation as part of its response. The PATH\_CHALLENGE frame contains data that the UE must echo back in a PATH\_RESPONSE frame, proving the bidirectional validity of the path. This step is crucial for establishing that the UE can receive and send packets on this new path, providing assurance against potential address spoofing and ensuring the integrity of the connection path.

4-5. Once the new path has been validated, the UPF informs the SMF of the establishment of the new path using the N4 Session Report procedure.

6. Having been informed of the establishment of the new path, the SMF may provide updated N4 rules to the UPF using the N4 Session Modification procedure.

7. The UE and UPF can start sending data packets via the new path. Packets belonging to the same QUIC connection can be routed via either of the two paths.

Apart from the IP address aspects described above, the MPQUIC functionality over non-3GPP access follows the description in TS 23.501 [3], clause 5.32.6.2.2, i.e. there is no impact to the use of MPQUIC or HTTP/3 protocols as such. In particular, to support steering, switching and splitting, for each uplink UDP flow, the UE selects a QoS flow (based on the QoS rules), a steering mode and a transport mode (based on the ATSSS rules) and execute the required HTTP/3 signalling to proxy the UDP flow, as described in TS 23.501 [3].

The UPF shall block incoming traffic to the MPQUIC proxy address for non-3GPP access that is not associated to existing QUIC connections. This ensures that only UEs with valid QUIC connections can communicate with the UPF via non-GPP access.

##### 6.2.Y.2.3 Handling of the MA PDU Session in case the UE loses 3GPP access coverage

###### 6.2.Y.2.3.1 General

In case the UE loses 3GPP coverage and is no longer reachable via 3GPP access, it is not possible to execute NAS procedures between the UE and 5GC. In this case the UE and SMF may keep the MA PDU Session active over non-3GPP access with limited capabilities (no support for PDU Session Modification) during a limited time, e.g. in case the UE returns to 3GPP coverage. The time limit for how long the MA PDU Session can be active via non-3GPP access without the UE being available in 3GPP access is determined by SMF based on operator policies. When the time expires, the SMF releases the MA PDU Session and also notifies UPF, PCF etc. Also the UE may decide to release the MA PDU Session.

Editor’s note: Whether and how it is possible to keep the MA PDU Session via non-3GPP access even if the UE is deregistered from 3GPP access is FFS.

###### 6.2.Y.2.3.2 PCF- or SMF-initiated PDU Session release when UE is not reachable via 3GPP access

If the UE is not reachable via 3GPP access and the SMF wants to release the MA PDU Session, the SMF releases the N4 Session and the UPF releases the QUIC connections towards the UE and other context for the N4 session. This is described in following procedure.



Figure 6.2.Y.2.3-1. PCF- or SMF-initiated PDU Session release when UE is not reachable via 3GPP access

0. The SMF or PCF determines to release the MA PDU Session.

1. The SMF may send a Namf\_Communication\_N1N2MessageTransfer Request with a PDU Session Release Command to the UE via 3GPP access. If the UE is not reachable, the AMF will send a Namf\_N1N2TransferFailureNotification to the SMF.

2. The SMF initiates a N4 Session Release Request to UPF.

3. The UPF removes the associated context and releases the QUIC connection(s) towards the UE. The UE will not trigger establishment of new QUIC connections in non-3GPP access for this MA PDU Session (As described in clause 6.2.Y.2.2, QUIC connections are assumed to be established via 3GPP access).

4. The UPF replies to SMF.

5. The SMF terminates the SM policy association, if needed.

6. The SMF deregisters the PDU Session from UDM.

The PDU Session status will be synced between UE and network the next time the Registration procedure is executed via 3GPP access, as per existing specifications.

###### 6.2.Y.2.3.3 UE-initiated PDU Session release via non-3GPP access when UE is not registered via 3GPP access.

If the UE wants to release the MA PDU Session and the 5GC is not reachable via 3GPP access, the UE releases the QUIC connection. If the SMF has requested the UPF to report access availability and unavailability, the UPF notifies the SMF that non-3GPP access is unavailable when the last QUIC connection for a N4 session is removed.



Figure 6.2.Y.2.4-2. UE-initiated PDU Session release via non-3GPP access when UE is not registered via 3GPP access.

0. The UE determines to release the MA PDU Session but is not reachable via 3GPP access.

1. The UE releases the QUIC connections towards UPF.

2. The UPF reports to SMF that the non-3GPP access is not available.

If the SMF becomes aware that the UE is not reachable via 3GPP access (e.g. in case downlink data arrives and it is not possible to establish the user plane connection via 3GPP access), the SMF may decide to start a timer and then trigger PDU Session release as described in clause 6.2.Y.2.4.

The PDU Session status will also be synced between UE and network the next time the Registration procedure is executed via 3GPP access, as per existing specifications.

###### 6.2.Y.2.3.4 Establishment of a MA PDU Session via non-3GPP access if 3GPP access is not available

Editor’s note: Whether and how this solution can be enhanced to support establishment of a MA PDU Session via non-3GPP access is FFS.

#### 6.2.Y.3 Impacts on services, entities and interfaces

UE:

- Support for ATSSS using MPQUIC towards UPF without N3IWF/TNGF, using separate MPQUIC proxy address for 3GPP and non-3GPP accesses.

- Receives two MPQUIC Proxy address information items (instead of one in Rel-18) from the SMF: one each to be used by the QUIC client for QUIC paths established via 3GPP access and non-3GPP access, respectively.

- Receives one Link-Specific Multipath IP address (instead of two in Rel-18) to be used by the QUIC client via 3GPP access.

SMF:

- Ability to select a UPF capable of “direct ATSSS over non-3GPP access using MPQUIC”.

- Provisioning of new MPQUIC proxy information between UPF and UE (e.g. MPQUIC proxy address for Nx interface).

- Support of MA PDU Sessions via non-3GPP access without a SM NAS connection via non-3GPP access. This includes handling of the MA PDU Session in case the UE is not reachable via 3GPP access.

- Receives access availability/unavailability reports from UPF for non-3GPP access based on the existence of QUIC connections.

UPF:

- ATSSS with MPQUIC connectivity without GTP-U tunnel.

- New UPF capability for “direct ATSSS via non-3GPP using MPQUIC” in N4 signalling and UPF profile in NRF

- Trigger access availability/unavailability reports to SMF for non-3GPP access based on the existence of QUIC connections.

No impacts to AMF, UDM, PCF

\*\*\*\* End of Changes \*\*\*\*