**SA WG2 Meeting #140 S2-2005982**

**19 Aug – 1 Sep 2020, Elbonia (revision of S2-2005801r1)**

**Source: Huawei, HiSilicon, InterDigital Inc., Apple, ITRI**

**Title: Update to Solution #39: EAS relocation coordinated with PSA change**

**Document for: Approval**

**Agenda Item: 8.3**

**Work Item / Release: FS\_enh\_EC / Rel-17**

***Abstract of the contribution:*** *This contribution proposes an update to Solution #39 “EAS relocation coordinated with PSA change” to address outstanding editor notes.*

# 1 Introduction

This solution update addresses the following Editor’s notes:

1. Whether the solution is compliant to IETF MPTCP architecture
2. How two MPTCP proxies share the MPTCP control block defined in RFC 8684 [27]
3. Further evaluation on possible impacts on SMF and UE is needed

# 2 Discussion

An MPTCP Control Block, as defined [RFC8684], contains variables that track the progress and state of an MPTCP Session and a set of linked TCP control blocks that correspond to the subflows that have been established. In this proposal, the MPTCP Session context, transferred during the preparation phase, includes the variables to track the progress and state of the MPTCP Session but does not include the linked TCP control blocks as these are related to the subflows which remain on the initial PSA1. i.e. are not transferred to the target PSA2

The MPTCP Session context needs to be transferred on the target PSA2 during the preparation phase to enable the creation of a new subflow from the target PSA2 toward the peer UE. However, since data transfer has potentially continued during the preparation phase, the MPTCP Session sequence number may need to be updated at the completion phase, prior to start using the subflow created from the target PSA2. As specified in [RFC8684], the receive window is sent with every packet thus the receiving UE may adapt to the new value, if needed

# 3 Proposal

It is proposed to include the following additions and modification to Solution #39 “EAS relocation coordinated with PSA change”.

First change

### 6.39.1 Description

This solution addresses KI #2 and enables the change of PSA, in coordination with the EAS relocation, by re-using some concepts of the MA-PDU session and path-switching mechanism based on MPTCP that was defined during ATSSS study.

As defined in TS 23.501 [2], clause 5.32, the support of MA-PDU session is enabled using MPTCP functionality, i.e. MPTCP on the UE and MPTCP Proxy on the PSA. In summary, the UE and the UPF may establish 2 MPTCP sub-flows (or data paths) from 2 different ANs (e.g. 5G and WiFi). The MPTCP Proxy on the UPF establishes a TCP session with e.g. the destination server. DL data is sent from the server to the UPF via the TCP session. The MPTCP Proxy uses one of the MPTCP sub-flows to forward data to the UE. The same is done in the UL direction, i.e. UE sends data using either of the MPTCP sub-flows and the MPTCP Proxy forwards this data to the server via the TCP session. This is illustrated in Figure 6.39.1.1-1 extracted from TS 23.501 [2], clause 4.2.10.



Figure 6.39.1-1: Non-roaming and Roaming with Local Breakout architecture for ATSSS support

In this solution the ATSSS mechanism for MA-PDU session using MPTCP protocol is enhanced to enable an MPTCP Session on the UE to be associated to multiple PSAs (i.e. multiple MPTCP Proxys). Having a sub-flow with a first PSA1 and then establishing another sub-flow, for the same MPTCP session, with a target PSA2 enables the support of PSA change.

The Edge Application Server may be relocated as well due to UE mobility and the change of PSA. In order to have a coordinated change of PSA and EAS, a 2 phases mechanism is proposed, i.e. a preparation and completion phase. Coordinating the PSA change and EAS relocation allows an efficient relocation, transparent to the UE's application layer.

Once the decision to change the PSA is taken in the network, the AF is informed. Based on this information, a decision may be taken from an entity out of the 3GPP scope to relocate the EAS. A first phase is defined where the EAS relocation (e.g. select the target EAS, transfer UE's application context, etc) is started. During this phase, the 3GPP network also prepares the PSA change, e.g. selects the target PSA2, instantiates MPTCP Proxy if not already running, transfers the UE's MPTCP context to the target PSA2, and establishes a sub-flow between the UE and the target PSA2, etc.). This preparation phase enables the last phase, i.e. the relocation completion, to be finalized very quickly, without disturbing the data exchange.

The completion phase, (e.g. enabling the usage of the MPTCP sub-flow to the target PSA2, establishment of a TCP session toward the target EAS, etc.) may be triggered upon receipt of AF response to a Late Notification and it may then finalize the PSA change and EAS relocation very quickly, without disturbing the data exchange.

To align with the IETF MPTCP architecture, it is proposed that the UE that supports MPTCP functionality is communicated with a virtual host with MPTCP proxy functionality distributed in two PSA UPFs. In this solution, at the same time, only one MPTCP subflow is used as a regular path to transmit user data and the other one is used as a backup path.



Figure 6.39.1-2: MPTCP functionality in UE and MPTCP proxy functionality in a virtual host in CN side

An MPTCP Control Block, as defined [RFC8684], contains variables that track the progress and state of an MPTCP Session and a set of linked TCP control blocks that correspond to the subflows that have been established. The MPTCP Session context, transferred during the preparation phase, includes the variables to track the progress and state of the MPTCP Session but does not include the linked TCP control blocks as these are related to the subflows which remain on the initial PSA1. i.e. are not transferred to the target PSA2.

The MPTCP Session context needs to be transferred on the target PSA2 during the preparation phase to enable the creation of a new subflow from the target PSA2 toward the peer UE. However, since data transfer has potentially continued during the preparation phase, the MPTCP Session sequence number may need to be updated at the completion phase*, prior to start using the subflow created from the target PSA2*.

The receive window is transferred to the target MPTCP Proxy as part of the MPTCP Context and is expected to be re-used by the target MPTCP proxy however, its value may be modified on target PSA2 based on the target PSA2 capacities (e.g. available memory for receive buffer). As specified in [RFC8684], the receive window is sent with every packet thus the receiving UE may adapt to the new value, if needed.

The MPTCP Session context transfer has no impact on MPTCP operations and neither MPTCP architecture, i.e. starting a new subflow, data transfer over subflows, closing a subflow, changing subflow priority, are not modified. It is still possible to have one or multiple subflows associated to the same MPTCP Session. The MPTPC Session transfer is transparent to the UE’s application layer.

Next change

### 6.39.2 Procedures

#### 6.39.2.1 PSA change and EAS relocation coordination

Figure 6.39.2.1-1 illustrates the procedure for PSA change and EAS relocation coordination. It is assumed that the AF is interacting with the source and target EASs, or with another entity interacting with those EASs. The AF then interacts with 5GC NFs to coordinate the PSA change and EAS relocation.



Figure 6.39.2.1-1: PSA change and EAS relocation coordination

1. UE establishes an MA-PDU session with MPTCP steering mode.

2. UE is assigned with an IP address (IP@2a), which is associated with PSA1, to be used with MPTCP functionality. IP@2a is allocated by PSA1, and provided by the SMF via SM NAS message.

3. An MPTCP sub-flow is created, using IP@2a on UE's side. The MPTCP Proxy on PSA1 establishes a TCP session with the EAS1. Data is exchanged from the UE to the PSA1 over the MPTCP sub-flow. PSA1 forwards this UL data to the EAS1 over the TCP connection. The reverse is done in DL direction, i.e. EAS1 sends data for the UE over the TCP connection with PSA1. MPTCP Proxy forwards this data to the UE over the MPTCP sub-flow.

4. UE moves. SMF decides to insert/change UL CL and allocate another UPF/PSA2. The AF, which has previously registered to UE mobility events, is informed that the UE has moved and that a new PSA has been selected. This triggers the EAS relocation preparation phase. AF informs SMF that EAS relocation is in preparation phase.

a. The AF interacts with the source and target EASs, or to another entity interacting with the EASs, to start the EAS relocation. EAS may stop or slow-down data transmission. This is at the application level and specified only to illustrate the relocation coordination. The interaction between the AF and EASs is out-of-scope of 3GPP.

5. SMF interacts with PSA1 to obtain the MPTCP context related to the MPTCP session with the UE. The MPTCP context includes e.g. security keys, tokens, MPTCP session sequence number. Information related to the sub-flow on PSA1 is not transferred to PSA2 since this sub-flow may not be used by PSA2.

6. SMF provides the obtained MPTCP context and UE's PDU Session IP address to the selected PSA2 for PSA change.

7. SMF provides a new IP address (IP@2b) to the UE which is associated with PSA2. The IP address (IP@2b) is allocated by PSA2.

8. MPTCP Proxy on PSA2 receiving the already existing MPTCP context establishes a new sub-flow with the UE, using IP@2b. The sub-flow is created using the MP\_JOIN option with B=1, indicating to the UE that the subflow should be treated as backup path and it should not be used to send data, unless there are no usable subflows. The sub-flow is created in advance, during the relocation preparation phase. At this point, UE has two sub-flows associated to the same MPTCP session. The first sub-flow is with PSA1 and the second sub-flow is with PSA2.

9. AF informs the SMF that the EAS relocation is completed and provides the information to reach the target EAS. This triggers the relocation completion phase. SMF interacts with PSA1 to obtain the latest information related to data transfer (e.g. MPTCP sequence number). SMF informs PSA2 to complete the PSA change. SMF provides PSA2 with the information to reach the target EAS and provides the latest information from PSA1. SMF also informs PSA1 to complete the PSA change and the MPTCP Proxy on PSA1 updates the MPTCP sub-flow's priority by cleanly retiring its use using the "REMOVE\_ADDR" option indicating that this sub-flow shall not be used or terminates the sub-flow. The MPTCP session may be silently discarded on PSA1, allowing the UE to preserve the MPTCP session.

10. PSA2 establishes a TCP session with the target EAS. This TCP session is associated with the MPTCP session and sub-flow toward IP@2b.

11. MPTCP Proxy on PSA2 completes the change of PSA by changing the MPTCP sub-flow's priority MP\_PRIO option with B=0. This means that the UE may start using this sub-flow.

12. SMF informs the AF that UE's PSA change is completed.

### 6.39.3 Impacts on services, entities and interfaces

SMF:

- Send PSA relocation indication to AF

- Receive EAS relocation preparation completed indication from AF

- Send PSA relocation preparation to UPF

- Send PSA relocation completion to UPF

- Query UPF/PSA to get MPTCP Session context

- Send MPTCP session context to target UPF/PSA

- SMF assigns new subflow address/prefix for PSA2

- Decide whether allow a MPTCP PDU Session for the UE based on the UE’s capability and the requested (S-NSSAI, DNN) or local policy.

UPF acting as a source local PSA:

- Provide MPTCP Session context to SMF

- Terminate the initial sub-flow with the UE when PSA relocation is completed

UPF acting as a target local PSA:

- Save MPTCP Session context locally

- Create a new "backup" MPTCP sub-flow to be associated with the saved MPTCP Session

- Change MPTCP subflow's priority using MP\_PRIO option B=0 to activate the MPTCP subflow

UE:

* Handle one IP assignment for subflow toward PSA1 at establishement of MPTCP-enabled PDU Session and another IP assignment for the second subflow towards PSA2
* Support MPTCP and interactions with MPTCP Proxy functionality in UPF.
* Indicate its MPTCP capability in the PDU Session establishment request

End of changes