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Stage 3
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Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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In the present document, certain modal verbs have the following meanings:

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

NOTE 1: The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

NOTE 2: The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

NOTE 3: The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can indicates that something is possible

cannot indicates that something is impossible

NOTE 4: The constructions "can" and "cannot" shall not to be used as substitutes for "may" and "need not".

will indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

NOTE 5: The constructions "is" and "is not" do not indicate requirements.

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1 Scope

The present document specifies the procedures for access traffic steering, switching and splitting (ATSSS) between the UE and the network across one 3GPP access network and one non-3GPP access network as specified in 3GPP TS 23.501 [2], 3GPP TS 23.502 [3], and 3GPP TS 23.316 [4].

The ATSSS can be supported over the access network where an MA PDU session can be established. The type of access network includes NG-RAN and untrusted non-3GPP access network as specified in 3GPP TS 23.501 [2], trusted non-3GPP access network, wireline access network and as specified in 3GPP TS 23.316 [4]. An MA PDU session established by the 5G-RG can also simultaneously use one 3GPP access network connected to EPC and one wireline access network connected to 5GCN as specified in 3GPP TS 23.316 [4].

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.
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- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".
- [3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".
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- [4] 3GPP TS 23.316: "Wireless and wireline convergence access support for the 5G System (5GS)".
- [5] 3GPP TS 24.526: "UE policies for 5G System (5GS); Stage 3".
- [6] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".
- [7] 3GPP TS 24.502: "Access to the 3GPP 5G System (5GS) via non-3GPP access networks; Stage 3".
- [8] IETF RFC 8684: "TCP Extensions for Multipath Operation with Multiple Addresses".
- [9] IETF RFC 8803: "0-RTT TCP Convert Protocol".
- [10] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3".
- [11] IEEE Std 802-2014: "IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture".
- [12] IEEE 802.3-2018: "IEEE Standard for Ethernet".
- [13] 3GPP TS 24.007: "Mobile radio interface signalling layer 3; General aspects".
- [14] 3GPP TS 33.501: "Security architecture and procedures for 5G system".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.501 [2] apply:

MA PDU session
Measurement assistance information

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

5G-RG	5G Residential Gateway
ATSSS	Access Traffic Steering, Switching, Splitting
ATSSS-LL	ATSSS Low-Layer
MA PDU	Multi-Access PDU
MPTCP	Multi-Path TCP Protocol
PDU	Protocol Data Unit
PMF	Performance Measurement Function
RTT	Round Trip Time
SA PDU	Single-Access PDU
SDF	Service Data Flow
UPF	User Plane Function
URSP	UE Route Selection Policy

4 General description

4.1 Introduction

ATSSS is an optional feature that can be supported by the UE and the 5GC network to route data traffic across 3GPP access and non-3GPP access networks. An ATSSS capable UE establishes an MA PDU session supporting multi-access connectivity over 3GPP access and non-3GPP access networks as described in clause 4.2. The ATSSS capable UE can support ATSSS-LL and/or MPTCP steering functionality as described in clause 4.3, with associated steering modes, i.e. active-standby, smallest delay, load balancing, priority based. The ATSSS capable UE indicates the steering functionality and associated steering modes to the 5GC network.

When the ATSSS capable UE registers to a registration area, it receives an indication from the AMF if the network supports the ATSSS. The procedure for how the AMF indicates the UE about its ATSSS support is specified in 3GPP TS 24.501 [6]. The UE capable ATSSS and the network supporting ATSSS exchange access performance measurements as described in clause 4.4. Clause 4.5 describes the traffic distribution over 3GPP access and non-3GPP access networks. Clause 4.6 provides a description for interworking with EPS network. Clause 4.7 describes ATSSS when 5G-RG is interconnected with EPS.

The architecture reference model for ATSSS support is described in clause 4.2.10 of 3GPP TS 23.501 [2].

4.2 Multi-access PDU session

A PDU session supporting a multi-access PDU connectivity service is referred to as multi-access PDU (MA PDU) session. An MA PDU session is a PDU session which can use one 3GPP access network or one non-3GPP access

network at a time, or simultaneously one 3GPP access network and one non-3GPP access network as defined in 3GPP TS 23.501 [2].

An MA PDU session can be established when the UE is registered to the same PLMN over 3GPP access network and non-3GPP access network or registered to different PLMNs over 3GPP access network and non-3GPP access network respectively. A UE can initiate MA PDU session establishment when the UE is registered to a PLMN over both 3GPP access network and non-3GPP access network, or only registered to one access network. Therefore, at any given time, the MA PDU session can have user-plane resources established on both 3GPP access and non-3GPP access, or on one access only (either 3GPP access or non-3GPP access), or can have no user-plane resources established on any access.

An ATSSS capable UE can establish an MA PDU session based on the URSP rules as defined in 3GPP TS 24.526 [5].

The following PDU session types are defined for an MA PDU session: IPv4, IPv6, IPv4v6 and Ethernet.

NOTE 1: The unstructured PDU session type is not supported in this release of the specification.

NOTE 2: An MA PDU session using IPv6 multi-homing or uplink classifier is not specified in this release of the specification.

4.3 Steering functionalities

An ATSSS capable UE can use a steering functionality to steer, switch and split the UL traffic across the 3GPP access network and the non-3GPP access network as defined in clause 5.32.6 of 3GPP TS 23.501 [2]. An ATSSS capable network can use the corresponding steering functionality for the DL traffic.

The UE and the network can support one or more of the following steering functionalities:

- a) the MPTCP steering functionality operates above the IP layer. The UE and an associated MPTCP proxy functionality in the UPF can communicate by using the MPTCP protocol; and
- b) the ATSSS-LL steering functionality operates below the IP layer as a data switching function.

4.4 Support of access performance measurements

The ATSSS capable UE can perform access performance measurements to decide how to distribute traffic over 3GPP access and non-3GPP access.

An ATSSS capable UE receives measurement assistance information from the network during the PDU session establishment procedure for an MA PDU session as described in clause 5.32.5 of 3GPP TS 23.501 [2]. The measurement assistance information (MAI) can contain the addressing information of the PMF in the UPF, as well as the indicator on whether access availability/unavailability reports need to be sent to the network. The encoding of the measurement assistance information is specified in clause 6.1.5.

An ATSSS capable UE that supports the MPTCP steering functionality can use the measurements available at the MPTCP layer.

The following PMF protocol messages can be exchanged between the PMF in the UE and the PMF in the UPF:

- a) messages for RTT measurements, only applicable for the ATSSS-LL steering functionality; or
- b) messages for reporting access availability/unavailability by the UE to the UPF.

An ATSSS capable UE does not apply the ATSSS rules to the PMF protocol messages.

The performance measurement function protocol procedures are specified in clause 5. 4.3 and 5.4.4 including the procedures for:

- a) UE-initiated RTT measurement; and
- b) Network-initiated RTT measurement.

The access availability/unavailability procedures are specified in clause 5.4.5.

4.5 Distribution of traffic across 3GPP access and non-3GPP access networks

The UE can receive ATSSS rules during the PDU session establishment procedure for an MA PDU session or network-requested PDU session modification procedure, and the UE can distribute the UL traffic except for the PMF protocol messages across the 3GPP access network and the non-3GPP access network according to the ATSSS rules and other local conditions (such as network interface availability, signal loss conditions, user preferences, etc.).

NOTE: On the network side, the SMF configures relevant N4 rules according to the ATSSS control information provided by the PCF for the UPF to distribute DL traffic across two access networks.

4.6 EPS interworking

In this release of specification, with the exception of an MA PDU session established as specified in clause 4.7, the MA PDU session is established in 5GS.

In the network supporting N26 interface:

- a) if the UE established an MA PDU session over non-3GPP access only, no EPS bearer identity can be assigned to any QoS flow of the MA PDU session as specified in 3GPP TS 23.502 [3];
- b) if the UE established an MA PDU session over 3GPP access and non-3GPP access and the user plane of the MA PDU session over 3GPP access is released, the EPS bearer identity assigned for the MA PDU session can be revoked as specified in 3GPP TS 23.502 [3];
- c) for an inter-system change from N1 mode to S1 mode:
 - 1) if the UE established an MA PDU session over 3GPP access only, the UE follows the procedure as specified in clause 6.1.4.1 of 3GPP TS 24.501 [6]; or
 - 2) if the UE established an MA PDU session over 3GPP access and non-3GPP access, the UE follows the procedure as specified in clause 6.1.4.1 of 3GPP TS 24.501 [6], and
 - A) if the MA PDU session is transferred to EPS as a PDN connection, the SMF can initiate the network-requested PDU session release procedure over non-3GPP access as specified in clause 6.3.3.2 of 3GPP TS 24.501 [6] or perform a local release of the MA PDU session. The UE performs a local release of locally releases the MA PDU session over 3GPP access and non-3GPP access; or

NOTE 1: If the UE receives from the network a PDU SESSION RELEASE COMMAND message which indicates to release the MA PDU session over non-3GPP access and the UE has already performed or is performing a local release of the MA PDU session, the error handling as specified in clause 6.3.3.6 of 3GPP TS 24.501 [6] is applied.

NOTE 2: The QoS flow(s) with EBI assigned over non-3GPP access is also transferred to the corresponding PDN connection.

- B) if the MA PDU session is not transferred to EPS as a PDN connection and the SMF decides to move the traffic of the MA PDU session from 3GPP access to non-3GPP access, the SMF can initiate the network-requested PDU session modification procedure as specified in clause 6.3.2.2 of 3GPP TS 24.501 [6]; and
- d) for an inter-system change from S1 mode to N1 mode, if the UE requests an MA PDU session or the related URSP or UE local configuration does not mandate that the PDU session is established over a single access when transferring the PDN connection to 3GPP access, the PDN connection can be converted by the network to an MA PDU session via the UE-requested PDU session modification procedure (see clause 5.2.5).

In the network not supporting N26 interface:

- a) for an inter-system change from N1 mode to S1 mode, if the UE intends to transfer the MA PDU session to EPS, the UE follows the procedure as specified in clause 6.1.4.2 of 3GPP TS 24.501 [6] and performs a local release of the MA PDU session over 3GPP access and non-3GPP access. The SMF can initiate the network-requested PDU session release procedure over non-3GPP access as specified in clause 6.3.3.2 of 3GPP TS 24.501 [6] or perform a local release of the MA PDU session; and

NOTE 3: If the UE receives from the network a PDU SESSION RELEASE COMMAND message which indicates to release the MA PDU session over non-3GPP access and the UE has already performed or is performing a local release of the MA PDU session, the error handling as specified in clause 6.3.3.6 of 3GPP TS 24.501 [6] is applied.

- b) for an inter-system change from S1 mode to N1 mode, if the related URSP or UE local configuration does not mandate that the PDU session is established over a single access, the UE can initiate the UE-requested PDU session establishment procedure to request an MA PDU session (see clause 5.2.1) or to allow the PDU session to be upgraded to an MA PDU session (see clause 5.2.6) when transferring the PDN connection to 5GS.

4.7 MA PDU session when 5G-RG is connected to EPS

A 5G-RG can connect to both 5GCN and EPC as specified in clause 4.12 of 3GPP TS 23.316 [4].

When establishing a PDN connection over EPS, the 5G-RG can indicate that the PDN connection is to be used as a user-plane resource associated with:

- a) a new MA PDU session; or
- b) an existing MA PDU session established in wireline access connected to 5GCN.

In the network supporting N26 interface, for an inter-system change from N1 mode to S1 mode and from S1 mode to N1 mode, the MA PDU session established by the 5G-RG is handled as specified in clause 6.1.4.1 of 3GPP TS 24.501 [6].

In the network not supporting N26 interface, for an inter-system change from N1 mode to S1 mode and from S1 mode to N1 mode, the MA PDU session established by the 5G-RG is handled as specified in clause 6.1.4.2 of 3GPP TS 24.501 [6].

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5 ATSSS control procedures

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5.1 Introduction

The ATSSS control procedures include:

- a) handling of multi-access PDU connectivity service procedures (see clause 5.2);
- b) handling of hybrid access with multi-access PDU connectivity (see clause 5.3); and
- c) access performance measurement procedures (see clause 5.4).

In clause 5.2, handling of multi-access PDU connectivity service procedures include following management procedures:

- a) activation of multi-access PDU connectivity service;
- b) re-activation of user-plane resources;
- c) release of user-plane resources;
- d) updating ATSSS parameters;
- e) converting PDU session transferred from EPS to MA PDU session; and
- f) PDU session establishment with network modification to MA PDU session.

In clause 5.3, the multi-access PDU connectivity procedures over E-UTRAN and wireline access network are specified. In this release of the specification, the procedures are applied for 5G-RG only.

In clause 5.4, access performance measurement procedures are performed by exchanges of PMF protocol messages between the PMF in a UE and the PMF in the UPF over the user plane. For MA PDU sessions of IPv4, IPv6, or IPv4v6 PDU session type, the PMF protocol messages are transported using UDP. For MA PDU sessions of Ethernet PDU

session type, the PMF protocol messages are transported using Ethernet frames. The protocol stacks of the PMF protocol are specified in clause 5.32.5.4 of 3GPP TS 23.501 [2].

5.2 Multi-access PDU connectivity service

5.2.1 Activation of multi-access PDU connectivity service

Activating multi-access PDU connectivity service refers to the establishment of user-plane resources on both 3GPP access and non-3GPP access:

- a) if the UE is registered over both 3GPP access and non-3GPP access in the same PLMN, the UE shall initiate the UE-requested PDU session establishment procedure as specified in clause 6.4.1.2 of 3GPP TS 24.501 [6] over a selected access, either 3GPP access or non-3GPP access. Over which access to initiate this UE-requested PDU session establishment procedure is UE implementation specific. When the UE receives the PDU SESSION ESTABLISHMENT ACCEPT message including the ATSSS container IE as specified in clause 6.4.1.3 of 3GPP TS 24.501 [6], the UE shall consider that the MA PDU session has been established and the user plane resources are successfully established on the selected access. When the user plane resources are established on the access other than the selected access (e.g. received lower layer indication in 3GPP access or established user plane IPsec SA in untrusted non-3GPP access), the UE shall consider the user plane resources are established on both;

NOTE: If the UE receives the PDU SESSION ESTABLISHMENT ACCEPT message including the ATSSS container IE and determines, upon an implementation specific timer expiry, fails to receive user plane resources established on the access other than the selected access, the UE re-initiates the UE-requested PDU session establishment procedure over the access other than the selected access, in order to establish user plane resources on the access other than the selected access.

- b) if the UE is registered over both 3GPP access and non-3GPP access in different PLMNs, the UE shall initiate the UE-requested PDU session establishment procedure as specified in clause 6.4.1.2 of 3GPP TS 24.501 [6] over 3GPP access and non-3GPP access sequentially. Over which access to first initiate the UE-requested PDU session establishment procedure is UE implementation specific. When the UE receives the PDU SESSION ESTABLISHMENT ACCEPT message including the ATSSS container IE as specified in clause 6.4.1.3 of 3GPP TS 24.501 [6] over the selected access, the UE shall consider that the MA PDU session has been established and the user plane resources of the MA PDU session on this access are successfully established. The UE shall then initiate the UE-requested PDU session establishment procedure with the same PDU session ID, as specified in clause 6.4.1.2 of 3GPP TS 24.501 [6] over the other access, in order to establish user plane resources on the other access for the MA PDU session. If the UE receives the PDU SESSION ESTABLISHMENT ACCEPT message as specified in clause 6.4.1.3 of 3GPP TS 24.501 [6] over the other access, the UE shall consider that the user plane resources of the MA PDU session have been established on both 3GPP access and non-3GPP access; or
- c) if the UE is registered to a PLMN over only one access, either 3GPP access or non-3GPP access, the UE shall initiate the UE-requested PDU session establishment procedure as specified in clause 6.4.1.2 of 3GPP TS 24.501 [6] over this access. When the UE receives the PDU SESSION ESTABLISHMENT ACCEPT message including the ATSSS container IE as specified in clause 6.4.1.3 of 3GPP TS 24.501 [6] over the access, the UE shall consider that the MA PDU session has been established and the user plane resources of the MA PDU session on this access are successfully established. When the UE at a later point in time registers over the other access, either in the same PLMN or in a different PLMN, the UE shall initiate the UE-requested PDU session establishment procedure with the same PDU session ID as specified in clause 6.4.1.2 of 3GPP TS 24.501 [6] over the other access in order to establish user plane resources on the other access for the MA PDU session. If the UE receives the PDU SESSION ESTABLISHMENT ACCEPT message as specified in clause 6.4.1.3 of 3GPP TS 24.501 [6] over the other access, the UE shall consider that the user plane resources of the MA PDU session have been established over both 3GPP access and non-3GPP access.

If the UE is in the non-allowed area, the UE shall not initiate a PDU session establishment procedure for an MA PDU session over the 3GPP access. It may still initiate a PDU session establishment procedure for an MA PDU session over the non-3GPP access other than wireline access network, however the network shall not establish user plane resources for the 3GPP access if the UE is in the non-allowed area. The handling of non-allowed area when using wireline access is described in 3GPP TS 23.316 [4].

5.2.2 Re-activation of user-plane resources

In order to re-establish the user-plane resources of an MA PDU session:

- a) if the UE requests re-establishment of the user-plane resources of the MA PDU session over 3GPP access which were released, the UE shall include the Uplink data status IE indicating the related MA PDU session,
 - 1) in the REGISTRATION REQUEST message when the registration procedure for mobility and periodic registration update is initiated by the UE over 3GPP access as specified in clause 5.5.1.3.2 of 3GPP TS 24.501 [6]; or
 - 2) in the SERVICE REQUEST message when the service request procedure initiated by the UE over 3GPP access as specified in clause 5.6.1.2 of 3GPP TS 24.501 [6];
- b) if the UE requests re-establishment of the user-plane resources of the MA PDU session over non-3GPP access which were released and the UE is in 5GMM-CONNECTED mode over non-3GPP access, the UE shall include the Uplink data status IE indicating the related MA PDU session,
 - 1) in the REGISTRATION REQUEST message when the registration procedure for mobility registration update is initiated by the UE over non-3GPP access as specified in clause 5.5.1.3.2 of 3GPP TS 24.501 [6]; or
 - 2) in the SERVICE REQUEST message when the service request procedure initiated by the UE over non-3GPP access as specified in clause 5.6.1.2 of 3GPP TS 24.501 [6];
- c) if the UE requests re-establishment of the user-plane resources of the MA PDU session over non-3GPP access which were released and the UE is in 5GMM-IDLE mode over non-3GPP access,
 - 1) for untrusted non-3GPP access, the UE shall perform the procedure as specified in clause 7.3 of 3GPP TS 24.502 [7] and include the Uplink data status IE indicating the related MA PDU session in the SERVICE REQUEST message when the service request procedure initiated by the UE over non-3GPP access as specified in clause 5.6.1.2 of 3GPP TS 24.501 [6]; or
 - 2) for trusted non-3GPP access, the UE shall perform the procedures as specified in clause 7.3A of 3GPP TS 24.502 [7] and include the Uplink data status IE indicating the related MA PDU session in the SERVICE REQUEST message when the service request procedure initiated by the UE over non-3GPP access as specified in clause 5.6.1.2 of 3GPP TS 24.501 [6]; and
- d) if the network requests re-establishment of the user-plane resources of the MA PDU session over 3GPP access which were released, the UE in 5GMM-IDLE mode over 3GPP access shall initiate the service request procedure by sending a SERVICE REQUEST message to the AMF upon receipt of the paging request as specified in clause 5.6.1.2 of 3GPP TS 24.501 [6].

NOTE: When the UE is in 5GMM-IDLE mode over non-3GPP access, the network does not request the UE to re-establish the user-plane resources of the MA PDU session over non-3GPP access which were released as specified in 3GPP TS 23.502 [3].

If the UE is in the non-allowed area, the UE shall not request re-establishment of the user plane resources of the MA PDU session for the 3GPP access. It may still request re-establishment of the user plane resources of the MA PDU session for the non-3GPP access.

5.2.3 Release of user-plane resources

In order to release the MA PDU session:

- a) the SMF shall initiate the network-requested PDU session release procedure as specified in clause 6.3.3.2 of 3GPP TS 24.501 [6] over 3GPP access or non-3GPP access, by sending the PDU SESSION RELEASE COMMAND message to the UE. Over which access to initiate this network-requested PDU session release procedure is SMF implementation specific; or
- b) the UE shall initiate the UE-requested PDU session release procedure as specified in clause 6.4.3.2 of 3GPP TS 24.501 [6] over 3GPP access or non-3GPP access by sending the PDU SESSION RELEASE REQUEST message to the network. Over which access to initiate this UE-requested PDU session release procedure is UE implementation specific.