ETSI TS 124 193 V18.5.0 (2024-05)

5G;
5G System;
Access Traffic Steering, Switching and Splitting (ATSSS);
Stage 3
(3GPP TS 24.193 version 18.5.0 Release 18)

Reference
RTS/TSGC-0124193vi50

Keywords
5G

ETSI

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Sous-Préfecture de Grasse (06) N° w061004871

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Contents

Foreword

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

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  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

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.

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 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 UE can also simultaneously use one 3GPP access network connected to EPC and one non-3GPP access network connected to 5GCN as specified in 3GPP TS 23.502 [3].

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 23.501: "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

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

[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".

[9A] IETF RFC 9000: "QUIC: A UDP-Based Multiplexed and Secure Transport".

[9B] IETF RFC 9001: "Using TLS to Secure QUIC".

[9C] IETF RFC 9002: "QUIC Loss Detection and Congestion Control".

[9D] IETF RFC 9221: "An Unreliable Datagram Extension to QUIC".

[9E] IETF RFC 9298: "Proxying UDP in HTTP".

[9F] IETF RFC 9114: "Hypertext Transfer Protocol Version 3 (HTTP/3)".

[9G] IETF RFC 9297: "HTTP Datagrams and the Capsule Protocol".

[9H] IETF RFC 9220: "Bootstrapping WebSockets with HTTP/3".

[9I] draft-ietf-quic-multipath-03 (April 2023), "Multipath Extension for QUIC".

Editor's note (WI: IMSProtoc9, CR#5979): The above document cannot be formally referenced until it is published as an IETF RFC.

[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".

[15] 3GPP TS 37.324: "E-UTRA and NR; Service Data Adaptation Protocol (SDAP) specification".

[16] 3GPP TS 29.244: "Interface between the Control Plane and the User Plane Nodes; Stage 3".

[17] 3GPP TS 24.302: "Access to the 3GPP Evolved Packet Core (EPC) via non-3GPP access networks; Stage 3".

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].

MPTCP client: A UE supporting MPTCP functionality by supporting the TCP extensions for multipath operation specified in IETF RFC 8684 [8].

MPQUIC client: A UE supporting QUIC functionality by supporting QUIC protocol as defined IETF RFC 9000 [9A], IETF RFC 9001[9B], IETF RFC 9002 [9C] and the extensions defined in:

a) IETF RFC 9221 [9D] for supporting unreliable datagram transport with QUIC; and

b) draft-ietf-quic-multipath [9I] for supporting QUIC connections using multiple paths simultaneously.

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
LADN	Local Area Data Network
MA PDU	Multi-Access PDU
MAI	Measurement Assistance Information
MPTCP	Multi-Path TCP Protocol
MPQUIC	Multi-Path QUIC
PCO	Protocol Configuration Options
PDU	Protocol Data Unit
PLR	Packet Loss Rate

PMF	Performance Measurement Function
QFI	QoS Flow Identifier
RTT	Round Trip Time
SA PDU	Single-Access PDU
SDF	Service Data Flow
TDR	Traffic Duplication Resume
TDS	Traffic Duplication Suspend
UAD	UE Assistance Data
UAT	UE Assistance data Termination
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 MPTCP or MPQUIC steering functionality or any combination of them as described in clause 4.3, with associated steering modes, i.e. active-standby, smallest delay, load balancing, priority based or redundant. 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 the ATSSS capable UE 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.

MA PDU sessions for LADN are not supported.

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 steering functionalities as defined in clause 5.32.6 of 3GPP TS 23.501 [2], in the categories of:

a) high-layer steering functionalities i.e.:

   i) the MPTCP steering functionality which operates above the IP layer, where the UE and an associated MPTCP proxy functionality in the UPF can communicate by using the MPTCP protocol; and

   ii) the MPQUIC steering functionality which operates above the UDP/IP layer, where the UE and an associated QUIC proxy in the UPF can communicate by using the QUIC protocol; and

b) low-layer steering functionalities, i.e.:

   i) the ATSSS-LL steering functionality which 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. The access performance measurements can be performed by using the QoS flow(s) of default QoS rule. Based on the UE capability that the UE has indicated to the network, the access performance measurements can also be performed by using the QoS flows of non-default QoS rules.

An ATSSS capable UE receives MAI from the SMF during the PDU session establishment procedure for an MA PDU session as described in clause 5.32.5 of 3GPP TS 23.501 [2], during a network-requested PDU session modification procedure as specified in clause 6.3.2 of 3GPP TS 24.501 [6], during UE requested PDN connectivity procedure according to clause 6.5.1 of 3GPP TS 24.301 [10] or during EPS bearer context modification procedure according to clause 6.4.3 of 3GPP TS 24.301 [10]. The MAI can contain the addressing information of the PMF in the UPF, as well as an indicator on whether access availability/unavailability reports need to be sent to the network. If the UE indicates to the network the capability to perform the access performance measurements by using the QoS flows of non-default QoS rules, the MAI can also indicate to the UE that the performance measurement is for the QoS flows of non-default QoS rules and therefore include a QoS flow list for which, the measurements are to be performed. The encoding of the MAI 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.

An ATSSS capable UE that supports the MPQUIC steering functionality can use the measurements available at the MPQUIC 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;

b) messages for reporting access availability/unavailability by the UE to the UPF;

c) messages for PLR measurements, only applicable for the ATSSS-LL steering functionality; or

d) messages for UAD provisioning ;

e) messages for UAT ;

f) messages for TDS; or

g) messages for TDR.

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

The performance measurement function protocol procedures are specified with following procedures:

a) UE-initiated RTT measurement (see clause 5.4.3);

b) Network-initiated RTT measurement (see clause 5.4.4);

c) UE-initiated PLR measurement (see clause 5.4.6);

d) Network-initiated PLR measurement (see clause 5.4.7);

e) UE assistance data provisioning procedure (see clause 5.4.8);

f) The access availability/unavailability procedures (see clause 5.4.5);

g) UE assistance data termination procedure (see clause 5.4.9);

h) Traffic duplication suspend procedure (see clause 5.4.10); and

i) Traffic duplication resume procedure (see clause 5.4.11).

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. The ATSSS rule ID and ATSSS rule operation for each rule is used to add a new ATSSS rule, or to delete or update an existing ATSSS rule. 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 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 and the UE did not indicate its support of establishing a PDN connection as the user plane resource of an MA PDU session during the MA PDU session establishment procedure as specified in clause 6.4.1.2 of 3GPP TS 24.501 [6], 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 the MA PDU session over 3GPP access and non-3GPP access;

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.