**SA WG2 Meeting #170 S2-2506872r01**

**25 – 29 Aug, 2025, Goteborg, SE**

**Source: Futurewei**

**Title:** **[WT#1.2, Enhanced User Plane] Scope and Key Issue for Enhanced User Plane**

**Document for: Agreement**

**Agenda Item: 20.6.1.2**

**Work Item / Release: FS\_6G\_ARC/Rel-20**

*Abstract of the contribution:* *This contribution discusses areas to study for enhanced user plane and QoS mechanisms that enable high scalability for user plane transport and functional entities, and mechanism to provide QoS that is adaptable over the life of flows.*

1. Justifications

Editor's Note: This justification section is not included in the TR; it is intended solely to justify the scope of the proposed WT.

**Work Task #1.2 of the FS\_6G\_ARC study (SP-250806):**
1.2. Study whether and how to support and/or enhance the following aspects in 6G: the SBA framework, network slicing, network sharing, user plane architecture, QoS framework, policy framework, network exposure framework, architecture for specific scenarios e.g. fixed wireless access, localized service access.

1. Documents proposing User Plane Architecture

The following Tdocs on WT1.2 User Plane are merged into this baseline contribution.

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 20.6.1.2 | - | - | - | Study on Architecture for 6G System (FS\_6G\_ARC) - WT#1.2 User Plane | - | - |   |
| 20.6.1.2 | [S2-2506320](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2506320.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, User Plane Architecture, QoS Framework] User Plane Architecture and QoS Framework  | InterDigital Inc. | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2506524](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2506524.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, User plane architecture, QoS framework] 6G QoS framework | Ofinno | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2506639](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2506639.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, User Plane Architecture] User Plane Architecture for 6GS | vivo | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2506825](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2506825.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, User Plane Architecture] Enhancements for the 6G User Plane | China Telecom | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2506872](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2506872.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, Enhanced User Plane and QoS] Scope and Key Issue for Enhanced User Plane and QoS | Futurewei | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2506930](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2506930.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, UP] User plane architecture | Ericsson | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2507018](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2507018.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, user plane enhancements] User Plane Enhancement for 6G | Cisco Systems, Deutsche Telekom, | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2507023](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2507023.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, User plane architecture] Scope and New Key Issue for User plane architecture | LG Electronics | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2507156](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2507156.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, User Plane Enhancement] User plane enhancement | Huawei, HiSilicon | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2507293](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2507293.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, user plane architecture] Enhancement on the user plane architecture  | CATT | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2507376](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2507376.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2, user plane architecture enhancement] Multi-vendor N4 interface | VODAFONE | Rel-20 | FS\_6G\_ARC |
| 20.6.1.2 | [S2-2507379](file:///C%3A%5C%5CWork-documents%5C%5CMy%20Documents%5C%5C3GPP-Meetings%5C%5CTS-S2-170-Goteborg%5C%5CDocs%5C%5CS2-2507379.zip%22%20%5Ct%20%22_blank) | P-CR | Approval | 23.801-01: [WT#1.2] User Plane architecture | NEC | Rel-20 | FS\_6G\_ARC |

**General considerations on merge:**

* QoS semantics, transport:
QoS specific clauses (i.e., *semantics*) in S2-2506320, S2-2506524, S2-2506639 and S2-2506872 are not addressed here. They considered merged into **WT1.2 QoS baseline (**S2-2506935).
However, clauses on how to carry the traffic treatment (i.e., *transport*) in the user plane is included here.
* Clauses that identify programming use plane aspects over “N4” are covered here. However, SBA specific clauses in S2-2506825, S2-2507293 are considered merged into **WT 1.2 SBA baseline (**S2-2507126).
* Control signaling for communication service/beyond communication service/paging is not covered here. It is considered merged into **WT 1.1 NAS** (S2-2507055 / S2-2506517/ S2-2506840)).

S2-2506320/Interdigital

One aspect of this work task is to study whether and how to support and/or enhance the user plane architecture and QoS framework in 6G. Aspects that can be studied includes:

* Whether and how the QoS Framework can be designed to efficiently accommodate traffic flows whose PDUs can receive treatment on a per packet basis and traffic flows whose PDUs can receive treatment that is based on the status of other PDUs in the same or different traffic flows.
* Whether and how the UE, Application Layer, RAN, and UPF can be provided with information and constraints that can be used to determine how to map traffic to a set of QoS Requirements, packet handling rules, or packet markings based on the real-time application needs, radio resource utilization, QoE measurements, energy efficiency considerations, and local UE conditions (e.g. speed).
* Whether and how a single protocol can be used to influence how traffic is transported within a PDU Session. For example, what protocol is used to send and receive QoS Rules and traffic steering, switching, and splitting rules. In other words, whether and how a single protocol can be used to influence traffic handling within a PDU Session.
* What are the architectural requirements for the interface between the UPF and RAN Node and between UPFs. For example, whether and how the UPF and RAN Node should be able to influence (i.e. steer) how traffic is routed towards the traffic destination and how meta data is signalled between the UPF and RAN.
* Whether and how to optimize downlink data handling so that the user plane (e.g. UPF and SMF) functionality is less involved in the overall paging procedure.

NOTE: This work task will require coordination with RAN WGs.

S2-2506524 Offino

**WT#1.2**: Study how to enhance the QoS framework and user plane architecture to support 6G services. The following aspects will be at least considered:

* How define and enhance QoS control granularity for 6G services such as AI/ML services, sensing services, immersive media, time-sensitive networking.
* How to enhance QoS control mechanisms to support dynamic and adaptive controls with reduced signalling dependencies and lower latency.
* How to enhance QoS control signalling path management with the aim of avoiding multi-node involvement (e.g. dependent on AMF availability), including the signalling via the control plane and signalling via the user plane supporting in-band signalling.

S2-2506639 Vivo

This WT for User Plane Architecture for 6GS includes the following aspects:

- Study on QoS monitoring over UP, including:

- UE and UPF interaction for QoS monitoring, including:

- what parameters can be supported by QoS monitoring between UE and UPF (e.g., RTT measurement).

- procedure to support UE and UPF interactions.

- study on 6G user plane architecture, including:

- potential architecture of 6G user plane, including N3 and N9 reference point

- how to dynamically insert PSA UPF while maintaining the continuity of IP address

- how to support single PDU session with multiple PDU session anchors in 6G (e.g. ULCL+, BP+)

- study on 6G user plane protocols, including:

- candidate protocols for 6G user plane (e.g. GTP-U+, SRv6, QUIC, etc.)

- how to support a dynamic N3/N9 traffic routing

- how to minimize the impact due to endpoint change over N3 and N9 (e.g. change of PSA UPF, change of I-UPF)

NOTE: Study on 6G UP protocols needs to coordinate with CT4.

- study on small data packet transmission over user plane, including:

- UL and DL user plane optimisation for small data packet transmission

- how to minimize the N3/N9 management overload considering similar traffic patten of massive devices.

S2-2506825 China Telecom

This work aims to define enhancements for the 6G user plane architecture to meet the requirements of novel services. The study shall investigate at least the following aspects:

* Programmable User Plane Framework:
	+ Study how to enable multi-dimensional programmability in the UPF architecture, negotiable protocol stack, dynamic routing orchestration, combinable and atomized user plane functions to enhance 6G packet forwarding performance.
* Service-Based Control interfaces:
	+ Study the architecture and feasibility of evolving the UPF's control interfaces to be fully service-based, enabling more granular and dynamic interactions with control plane functions.
* AI-assisted Service Awareness and Control:
	+ Study the introduction of AI/ML capabilities into the UPF to enable intelligent traffic identification (covering encrypted service flows), traffic prediction, and closed-loop QoS assurance with QoS enforcement monitoring and feedback.
	+ Study mechanisms to realize real-time, bi-directional information exchange between the network and applications to boost service awareness.
* Coordination of Computing and Network:
	+ Study how to extend the UPF to support beyond-connectivity services, such as computing and network convergence, on-demand in-network computing and computational task offloading.
* Direct Communication Capability between UE and UPF:
	+ Study how to enable the UPF to directly communicate with the UE to exchange service-related context and application-awareness information.

S2-2506872 Futurewei

Study the architectural aspects for an enhanced user plane:

* Investigate enhanced mechanisms and procedures to manage connection state efficiently in user plane for a high number of connections/sessions.
* Investigate enhancements for user plane transport between the UP functional entities that contain minimal per-user/session state in the transport layer for more flexible forwarding of data packets.

S2-2506930 Ericsson

WT #1.2 The 6G study assumes the 5G User Plane Architecture and studies enhancements on the user plane architecture in relation to the following topics:

* What enhancements are needed to support the new 6G access on the user plane and new UE-connectivity based 6G use cases, including interworking with 5G (and potentially 4G), different mobility events with consideration of session continuity, non-roaming and roaming scenarios and variety of deployments (e.g. specific network service areas, like SMF service areas in 5G)
* Whether enhancements can be identified in the control of the data paths and the user plane packet processing (e.g. dynamic activation/deactivation of capabilities) which further improve UP performance and UP scaling and energy efficiency.
* Whether and how the user plane can be enhanced to provide better application-network collaboration (e.g. with in-band mechanisms) for application traffic.

S2-2507018 Cisco

The Sub-Work Task for user plane architecture for UPF enhancement includes the following aspects:

* Study how to enhance the user plane architecture and its control to achieve performance, ultra reliability, and low latency goals defined in IMT-2030 [x1], enable 6G services and meet operator’s requirements specified in TR 22.780 [x2], regarding efficiency, latency, and flexibility.
	+ Explore new transport protocol which can meet performance, scalability, security and other needs of the future 6G network.
	+ Study user plane Interworking and Migration in coordination with WT#2.
	+ Study how to fully integrate with the control of the user plane with the SBA architecture.
* Study how to enable efficient path programming and context aware forwarding in the user plane functions with the focus on performance optimization, diverse service/application and dynamic QoS requirements.
* Study how to leverage AI/ML to achieve autonomous user plane adaptation and improved resource management.
* Study how to improve security and resilience in the user plane.

S2-23507023 LG

**WT#1.2.x** Study whether and how to enhance the user plane architecture to reduce signalling and simplify the procedure when I-SMF/I-UPF are involved.

S2-2507156 Huawei (Marco Spini)

The proposed Work Task includes following aspects regarding UP enhancements:

- Study how to support flexible user plane path based on service requirements and transmission performance of the end-to-end path.

- Study how to enhance user plane to avoid the anchoring of UE traffic to reduce sub-optimal route.

- Study how to support runtime and dynamic redundant user plane path with consideration of service requirements and network performance.

S2-2507293 CATT (Xiaofei Gu)

It proposes to keep WT#1.2 as it is.

S2-2507376 Vodafone

Study whether and how to enhance the user plane architecture by:

* Improving multi-vendor operation on the “SMF” - “UPF” interface, e.g. by identifying options on the N4 interface and studying how to remove them.

S2-2507379 NEC

WT 1.2 covers whether and how *to enhance user plane architecture in 6GS.*

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

# Annex A.X. WT#1.2 [UP Architecture] Scope

 Editor's Note: Describe the technical scope of the proposed Work Task. If applicable, suggest logical subdivision of this WT into smaller sub-WT. This clause is part of the TR Annex.

[WT#1.2 UP Architecture] The 6G user plane study applies the basic principles in the 5G user plane and studies how to enhance the user plane architecture to support connectivity for a diverse set of applications with new traffic patterns and treatment of traffic, higher number of connections, programmability of the user plane, flexible routing, session continuity and handling of mobility.

# Support for transport of adaptive signaling of QoS for a variety of traffic including basic connectivity and new traffic such as AI application traffic, sensing, computing offloading and immersive media.

Details/approaches from the following need to be discussed and worked out for potential inclusion:

* single protocol to signal QoS rules and traffic steering/switching/splitting (S2-2506320)
* direct transport of signaling from UE to UPF to enable faster negotiation (S2-2506524, S2-2506825)
* support transport of user plane signaling based on application network collaboration (S2-2506930)
* transport of AI-assisted service awareness signaling to achieve autonomous user plane adaptation and improved resource management (S2-2507018, S2-2506825)

# Enhancements to programmability of user plane entities to be scalable, efficient and support programming of different levels of service capabilities.

Details/approaches from the following need to be discussed and worked out for potential inclusion:

* enable multi-dimensional programmability in the UPF architecture, negotiable protocol stack, dynamic routing orchestration, combinable and atomized user plane functions to enhance 6G packet forwarding performance (S2-2506825):
* manage/minimize connection state per-user/per-session for better scalability (S2-2506872)
* control and user plane packet processing to improve performance, scaling and energy efficiency (S2-2506930).
* Improving multi-vendor operation on the “SMF” - “UPF” interface, e.g. by identifying options on the N4 interface and studying how to remove them. (S2-2507376)

# Enhancements to User Plane transport for flexible and dynamic traffic handling that supports different service requirements and scale, transmission performance, session continuity and mobility.

Details/approaches from the following need to be discussed and worked out for potential inclusion:

* minimize the N3/N9 management overload considering similar traffic pattern of massive devices (S2-2506639)
* minimal user/session state in transport layer for flexible user plane setup (S2-2506872).
* support flexible user plane path based on service requirements and transmission performance of the end-to-end path (S2-2507156).
* support a dynamic N3/N9 traffic routing; dynamically insert PSA UPF while maintaining the continuity of IP address (S2-2506639)
* UL and DL user plane optimisation for small data packet transmission (S2-2506639)
* how to support single PDU session with multiple PDU session anchors in 6G (e.g. ULCL+, BP+) (S2-2506639)
* Enhancements to avoid the anchoring of UE traffic to reduce sub-optimal state (S2-2507156).
* Support runtime and dynamic redundant user plane path with consideration of service requirements and network performance (S2-2507156)
* Enhancements to support new 6G access and new UE-connectivity services including support for different mobility events, session continuity, roaming, non-roaming and scenarios with specific network service areas (S2-2506930).

# Support for migration and interworking between 6G user plane and 5G user plane.

Details/approaches from the following need to be discussed and worked out for potential inclusion:

* Study user plane Interworking and Migration in coordination with WT#2 (S2-2507018)
* enhancements needed to support the new 6G access on the user plane and new UE-connectivity based 6G use cases, including interworking with 5G (and potentially 4G). (S2-2506930)

**Aspects requiring further attention:**

Differing views on user plane transport protocol:

- “The KI assumes the 5G User Plane as base for the study” (S2-2506930 - Ericsson)

- “Explore new transport protocol which can meet performance, scalability, security and other needs of future 6G network” (S2-2507018 – Cisco, DT)

“Whether and how to support replacing GTP-U with SRv6” (S2-2507293 - CATT)

“candidate protocols for 6G user plane (e.g. GTP-U+, SRv6, QUIC, etc.)” (S2-2506639)

\*\*\*\* Second Change \*\*\*\*

# 5.X. Key Issue #X User Plane //key issue 1

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