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Transport aware 5G mobility with PPR
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Abstract

This document describes few 5G mobility scenarios and how mobile network functions map its SST criteria to identifiers in IP packets that transport segments use to grant transport layer services. This is based on mapping between mobile and IP transport underlays (IPv6, MPLS, IPv4) and a new transport network underlay routing mechanism, Preferred Path Routing (PPR), which brings slice properties and works with any underlying transport (L2, IPv4, SR and MPLS) is described.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119](#) [[RFC2119](#)].

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[1.](#) Introduction

[I-D.clt-dmm-tn-aware-mobility] describes in detail on how TN aware mobility can be built irrespective of underlying TN technology used.

This document specifies an approach to fulfil the needs of 5GS to transport user plane traffic from 5G-AN to UPF for all session and

service continuity modes (SSC) [[TS.23.501-3GPP](#)] in an optimized fashion. This is done by, keeping establishment and mobility procedures aware of underlying transport network along with slicing requirements using integrated routing and traffic engineering mechanism, Preferred Path Routing (PPR).

PPR is applicable to any transport network underlay (IPv6, MPLS and IPv4) is detailed in [Section 2.1](#) used 5G x-haul as described in [[I-D.clt-dmm-tn-aware-mobility](#)]. At the end, [Section 3](#) further describes the applicability and procedures of PPR with 5G mobility scenarios in various mobility scenarios in various SSC modes on F1-U, N3 and N9 interfaces.

[1.1](#). Acronyms

5G-AN	-	5G Access Network
BP	-	Branch Point (5G)
CSR	-	Cell Site Router
DN	-	Data Network (5G)
eMBB	-	enhanced Mobile Broadband (5G)
FRR	-	Fast ReRoute
gNB	-	5G NodeB
GBR	-	Guaranteed Bit Rate (5G)
GTP-U	-	GPRS Tunneling Protocol - Userplane (3GPP)
IGP	-	Interior Gateway Protocols (e.g. IS-IS, OSPFv2, OSPFv3)
mIOT	-	Massive IOT (5G)
MPLS	-	Multi Protocol Label Switching
NSSMF	-	Network Slice Selection Management Function
PPR	-	Preferred Path Routing

PDU	- Protocol Data Unit (5G)
RAN	- Radio Access Network
SID	- Segment Identifier
SSC	- Session and Service Continuity (5G)
SST	- Slice and Service Types (5G)
SR	- Segment Routing

TE	- Traffic Engineering
ULCL	- Uplink Classifier (5G)
UP	- User Plane(5G)
UPF	- User Plane Function (5G)
URLLC	- Ultra reliable and low latency communications (5G)

[2.](#) Transport Network Underlays

Apart from the various flavors of IETF VPN technologies to share the transport network resources and capacity, TE capabilities in the underlay network is an essential component to realize the 5G TN requirements. This section focuses on PPR and its applicability to realize Midhaul/Backhaul transport networks. Focus is on the user/data plane i.e., F1-U/N3/N9 interfaces as laid out in the framework [[I-D.clt-dmm-tn-aware-mobility](#)].

[2.1.](#) Using PPR as TN Underlay

In a network implementing source routing, packets may be transported through the use of Segment Identifiers (SIDs), where a SID uniquely identifies a segment as defined in [[I-D.ietf-spring-segment-routing](#)]. The need for underlay agnostic (L2/IPv4/IPv6/MPLS) TE requirements are addressed by PPR, of which this section provides an overview.

With PPR, the label/PPR-ID refer not to individual segments of which

the path is composed, but to the identifier of a path that is deployed on network nodes. The fact that paths and path identifiers can be computed and controlled by a controller, not a routing protocol, allows the deployment of any path that network operators prefer, not just shortest paths. As packets refer to a path towards a given destination and nodes make their forwarding decision based on the identifier of a path, not the identifier of a next segment node, it is no longer necessary to carry a sequence of labels. This results in multiple benefits including significant reduction in network layer overhead, increased performance and hardware compatibility for carrying both path and services along the path.

Details of the IGP extensions for PPR are provided here:

- o IS-IS - [[I-D.chunduri-lsr-isis-preferred-path-routing](#)]
- o OSPF - [[I-D.chunduri-lsr-ospf-preferred-path-routing](#)]
- o PPR Graph Structure (P2MP) - [[I-D.ce-lsr-ppr-graph](#)]

2.1.1. PPR on F1-U/N3/N9 Interfaces

PPR does not remove GTP-U, unlike some other proposals laid out in [[I-D.bogineni-dmm-optimized-mobile-user-plane](#)]. Instead, PPR works with the existing cellular user plane (GTP-U) for F1-U/N3 and N9 (encapsulation or no-encapsulation). In this scenario, PPR will only help providing TE benefits needed for 5G slices from transport domain perspective. It does so for any underlying user/data plane used in the transport network (L2/IPv4/IPv6/MPLS). This is achieved by:

- o For 3 different SSTs, 3 PPR-IDs can be signaled from any node in the transport network. For Uplink traffic, the 5G-AN will choose the right PPR-ID based on the S-NSSAI the PDU Session belongs to and/or the UDP Source port (corresponds to the MTNC-ID [[I-D.clt-dmm-tn-aware-mobility](#)]) of the GTP-U encapsulation header. Similarly in the Downlink direction matching PPR-ID of the 5G-AN is chosen based on the S-NSSAI the PDU Session belongs to. The table below shows a typical mapping:

+-----+-----+-----+-----+		+-----+-----+-----+-----+	
GTP/UDP SRC PORT	SST	Transport Path	Transport Path

	in S-NSSAI	Info	Characteristics
Range Xx - Xy X1, X2(discrete values)	MIOT (massive IOT)	PW ID/VPN info, PPR-ID-A	GBR (Guaranteed Bit Rate) Bandwidth: Bx Delay: Dx Jitter: Jx
Range Yx - Yy Y1, Y2(discrete values)	URLLC (ultra-low latency)	PW ID/VPN info, PPR-ID-B	GBR with Delay Req. Bandwidth: By Delay: Dy Jitter: Jy
Range Zx - Zy Z1, Z2(discrete values)	EMBB (broadband)	PW ID/VPN info, PPR-ID-C	Non-GBR Bandwidth: Bx

Figure 1: Mapping of PPR-IDs on N3/N9

- o It is possible to have a single PPR-ID for multiple input points through a PPR tree/graph structure ([\[I-D.ce-lsr-ppr-graph\]](#)) separate in UL and DL direction.
- o Same set of PPRs are created uniformly across all needed 5G-ANs and UPFs to allow various mobility scenarios.
- o Any modification of TE parameters of the path, replacement path and deleted path needed to be updated from TNF to the relevant ingress points. Same information can be pushed to the NSSF, and/or SMF as needed.
- o PPR can be supported with any native IPv4 and IPv6 data/user planes ([Section 2.1.2](#)) with optional TE features ([Section 2.1.3](#)) . As this is an underlay mechanism it can work with any overlay

encapsulation approach including GTP-U as defined currently for N3 interface.

[2.1.2.](#) Path Steering Support to native IP user planes

PPR works in fully compatible way with SR [[RFC8402](#)] defined user planes (SR-MPLS and SRv6) by reducing the path overhead and other challenges as listed in Section 5.3.7 of [[I-D.bogineni-dmm-optimized-mobile-user-plane](#)]. PPR also expands the source routing to beyond SR-MPLS and SRv6 i.e., L2, native IPv6 and IPv4 user planes.

This helps legacy transport networks to get the immediate path steering benefits and helps in overall migration strategy of the network to the desired user plane. Some of these benefits with PPR can be realized with no hardware upgrade except control plane software for native IPv6 and IPv4 user planes.

[2.1.3.](#) Service Level Guarantee in Underlay

PPR optionally allows to allocate resources that are to be reserved along the preferred path. These resources are required in some cases (for some 5G SSTs with stringent GBR and latency requirements) not only for providing committed bandwidth or deterministic latency, but also for assuring overall service level guarantee in the network. This approach does not require per-hop provisioning and reduces the OPEX by minimizing the number of protocols needed and allows dynamism with Fast-ReRoute (FRR) capabilities.

[3.](#) PPR with various 5G Mobility procedures

PPR fulfills the needs of 5GS to transport the user plane traffic from 5G-AN to UPF in all 3 SSC modes defined [[TS.23.501-3GPP](#)]. This is done in keeping the backhaul network at par with 5G slicing requirements that are applicable to Radio and virtualized core network to create a truly end-to-end slice path for 5G traffic. When UE moves across the 5G-AN (e.g. from one gNB to another gNB), there

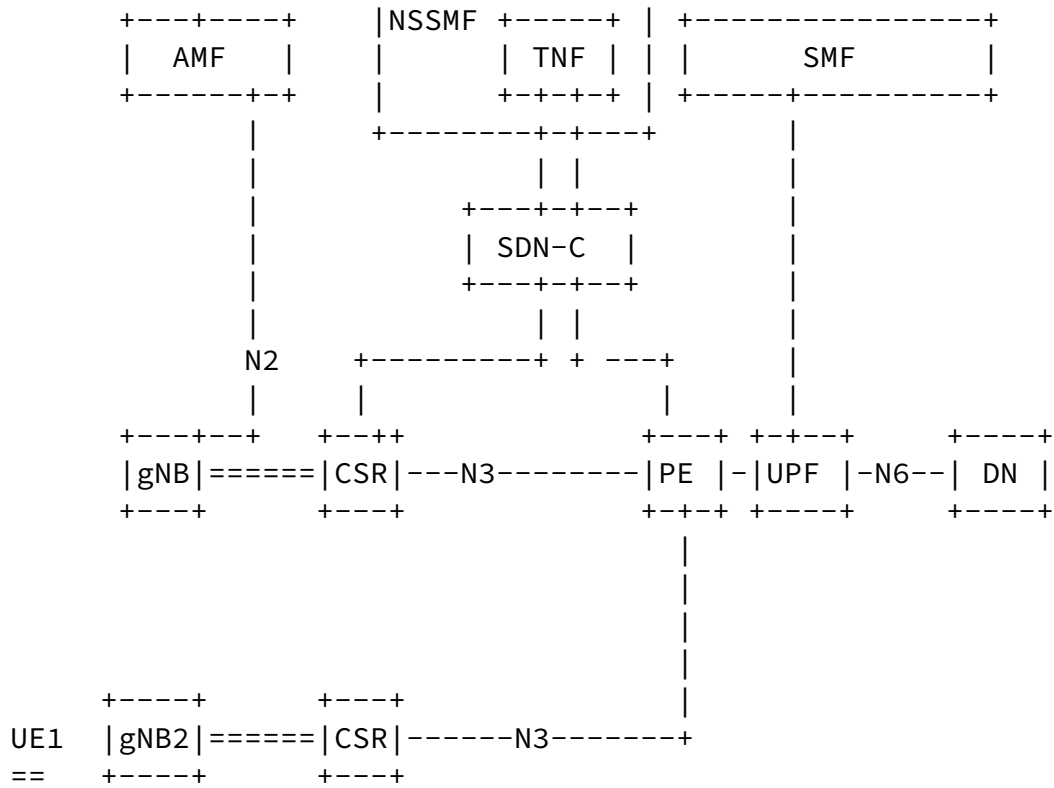


Figure 3: SSC Model1 with integrated Transport Slice Function

In this mode, IP address at the UE is preserved during mobility events. This is similar to 4G/LTE mechanism and for respective slices, corresponding PPR-ID (TE Path) has to be assigned to the packet at UL and DL direction. During Xn mobility as shown above, source gNB has to additionally ensure transport path's resources from TNF are available at the target gNB apart from radio resources check (at decision and request phase of Xn/N2 mobility scenario).

3.2. SSC Mode2

In this case, if IP Address is changed during mobility (different UPF area), then corresponding PDU session is released. No session continuity from the network is provided and this is designed as an application offload and application manage the session continuity, if needed. For PDU Session, Service Request and Mobility cases mechanism to select the transport resource and the PPR-ID (TE Path) is similar to SSC Model1.

3.3. SSC Mode3

In this mode, new IP address may be assigned because of UE moved to another UPF coverage area. Network ensures UE suffers no loss of 'connectivity'. A connection through new PDU session anchor point is established before the connection is terminated for better service continuity. There are two ways in which this happens.

- o Change of SSC Mode 3 PDU Session Anchor with multiple PDU Sessions.
- o Change of SSC Mode 3 PDU Session Anchor with IPv6 multi-homed PDU Session.

In the first mode, from user plane perspective, the two PDU sessions are independent and the use of PPR-ID by gNB and UPFs is exactly similar to SSC Mode 1 described above. The following paragraphs describe the IPv6 multi-homed PDU session case for SSC Mode 3.

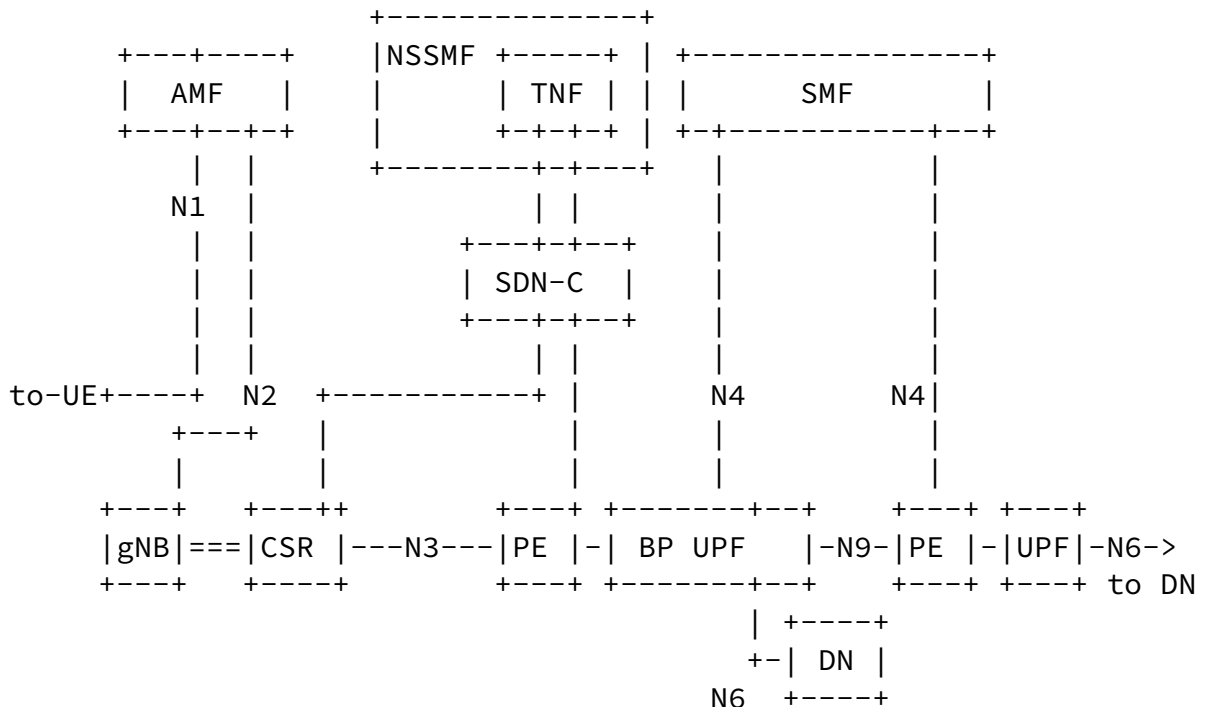


Figure 4: SSC Mode3 and Service Continuity

In the uplink direction for the traffic offloading from the Branching

Point UPF, packet has to reach to the right exit UPF. In this case packet gets re-encapsulated by the BP UPF (with either GTP-U or the

chosen encapsulation) after bit rate enforcement and LI, towards the anchor UPF. At this point packet has to be on the appropriate VPN/PW to the anchor UPF. This mapping is done based on the S-NSSAI the PDU session belongs to and/or with the UDP source port (corresponds to the MTNC-ID [[I-D.clt-dmm-tn-aware-mobility](#)]) of the GTP-U encapsulation header to the PPR-ID of the exit node by selecting the respective TE PPR-ID (PPR path) of the UPF. If it's a non-MPLS underlay, destination IP address of the encapsulation header would be the mapped PPR-ID (TE path).

In the downlink direction for the incoming packet, UPF has to encapsulate the packet (with either GTP-U or the chosen encapsulation) to reach the BP UPF. Here mapping is done based on the S-NSSAI the PDU session belongs, to the PPR-ID (TE Path) of the BP UPF. If it's a non-MPLS underlay, destination IP address of the encapsulation header would be the mapped PPR-ID (TE path). In summary:

- o Respective PPR-ID on N3 and N9 has to be selected with correct transport characteristics from TNF.
- o For N2 based mobility SMF has to ensure transport resources are available for N3 Interface to new BP UPF and from there the original anchor point UPF.
- o For Service continuity with multi-homed PDU session same transport network characteristics of the original PDU session (both on N3 and N9) need to be observed for the newly configured IPv6 prefixes.

[4.](#) Acknowledgements

TBD.

[5.](#) IANA Considerations

This document has no requests for any IANA code point allocations.

[6.](#) Security Considerations

This document does not introduce any new security issues.

7. References

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7.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.

7.2. Informative References

- [I-D.bogineni-dmm-optimized-mobile-user-plane]
Bogineni, K., Akhavain, A., Herbert, T., Farinacci, D., Rodriguez-Natal, A., Carofiglio, G., Auge, J., Muscariello, L., Camarillo, P., and S. Homma, "Optimized Mobile User Plane Solutions for 5G", [draft-bogineni-dmm-optimized-mobile-user-plane-01](#) (work in progress), June 2018.
- [I-D.ce-lsr-ppr-graph]
Chunduri, U. and T. Eckert, "Preferred Path Route Graph Structure", [draft-ce-lsr-ppr-graph-04](#) (work in progress), September 2020.
- [I-D.chunduri-lsr-isis-preferred-path-routing]
Chunduri, U., Li, R., White, R., Tantsura, J., Contreras, L., and Y. Qu, "Preferred Path Routing (PPR) in IS-IS", [draft-chunduri-lsr-isis-preferred-path-routing-06](#) (work in progress), September 2020.
- [I-D.chunduri-lsr-ospf-preferred-path-routing]
Chunduri, U., Qu, Y., White, R., Tantsura, J., and L. Contreras, "Preferred Path Routing (PPR) in OSPF", [draft-chunduri-lsr-ospf-preferred-path-routing-04](#) (work in

progress), March 2020.

[I-D.clt-dmm-tn-aware-mobility]

Chunduri, U., Li, R., Bhaskaran, S., Kaippallimalil, J., Tantsura, J., Contreras, L., and P. Muley, "Transport Network aware Mobility for 5G", [draft-clt-dmm-tn-aware-mobility-07](#) (work in progress), September 2020.

[I-D.ietf-dmm-srv6-mobile-uplane]

Matsushima, S., Filsfils, C., Kohno, M., Camarillo, P., Voyer, D., and C. Perkins, "Segment Routing IPv6 for Mobile User Plane", [draft-ietf-dmm-srv6-mobile-uplane-09](#) (work in progress), July 2020.

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[I-D.ietf-spring-segment-routing]

Filsfils, C., Previdi, S., Ginsberg, L., Decraene, B., Litkowski, S., and R. Shakir, "Segment Routing Architecture", [draft-ietf-spring-segment-routing-15](#) (work in progress), January 2018.

[RFC8402] Filsfils, C., Ed., Previdi, S., Ed., Ginsberg, L., Decraene, B., Litkowski, S., and R. Shakir, "Segment Routing Architecture", [RFC 8402](#), DOI 10.17487/RFC8402, July 2018, <<https://www.rfc-editor.org/info/rfc8402>>.

[TS.23.501-3GPP]

3rd Generation Partnership Project (3GPP), "System Architecture for 5G System; Stage 2, 3GPP TS 23.501 v2.0.1", December 2017.

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