**SA WG2 Meeting #162S2-240xxxx**

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**Source: Nokia, Nokia Shanghai Bell**

**Title: Solution for KI#4: Support of "combo Ethernet + IP" service**

**Document for: Approval**

**Agenda Item: 19.8**

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*Abstract of the contribution: solution addressing KI#4*

# 1 Discussion

This document describes a solution addressing KI#4. The coverage of this document focuses on achieving end to end solution for the non-3GPP Devices connecting behind the 5G-RG, as defined as a problem statement as part of KI#4.

# 2 Proposal

It is proposed to update TR 23.700-32 as follows.

\* \* \* \* First change \* \* \* \*

## 6.0 Mapping Solutions to Key Issues

Table 6.0-1: Mapping Solutions to Key Issues

|  |  |
| --- | --- |
|  | Key Issues |
| Solutions | <Key Issue #1> | <Key Issue #2> | <Key Issue #3> | <Key Issue #4> |
| #X: Support of "combo Ethernet + IP" service |  |  |  | x |
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\* \* \* \* Next change (All new text) \* \* \* \*

## 6.X Solution #X: Support of "combo Ethernet + IP" service

### 6.X.1 Introduction

For the non-3GPP Devices connecting behind the UE or 5G-RG for whom the problem statement is defined in KI#4 is described in this solution.

This solution aims at serving UE or 5G-RG working in Bridged and Bridged/Routed mode (at least for some services), where the 5GC may need to:

- provide an IP service to the Customer premises devices e.g. allocate IPv4/v6 address / Prefix to devices behind the UE or 5G-RG.

- identify each device / terminal behind the UE or 5G-RG via its MAC address: for this purpose, Ethernet frames are exchanged between the UE or 5G-RG and the 5GC so that the network (UPF) is capable to identify traffic from different individual devices in the Customer Premises. In this solution, a device / terminal behind the 5G-RG may be a UE or a non 3GPP device.

NOTE 1: This is e.g. to apply specific policies related with the terminal (e.g. parental control or Enhanced home office service where a work laptop gets bandwidth and prioritization).

This solution is only meant to be used in deployments with UE or 5G-RG working in Bridged and Bridged/Routed mode.

The Ethernet PDU Session Type does not support an IP service over N6. For example, TS 23.501 [2] states that "Neither a MAC nor an IP address is allocated by the 5GC to the UE for a PDU Session". Furthermore, with the Ethernet PDU Session the Layer 2 header received from the access side is copied on the N6 side of the PSA while it is not meant to be copied over N6 in the case of an IP service provided to RG working in Bridged and Bridged/Routed mode. In case of Ethernet PDU Session Type DL forwarding is basically done based on the Destination MAC address of the UE while here DL forwarding is to be made based on the IP address of the target device ; in case an IP PDU Session type would be used to support an 5G-RG working in Routed mode with no NAT, as many PDU Sessions as there are devices in the Customer Premises requiring an IP address would be required.

A dedicated PDU Session Type called "Combo Ethernet + IP" is used for that purpose. It basically supports an access **Router** in the PSA while an Ethernet PDU Session supports a **bridge** in the PSA;

In case of "combo Ethernet + IP" PDU Session Type:

1. Ethernet frames are exchanged between the UE or 5G-RG and the UPF acting as PSA (PDU Session Anchor).

2. Ethernet frames exchanged between the UE or 5G-RG and the UPF acting as PSA carry IP traffic (and IP auxiliary protocols: ARP, ND).

3. An IP service is delivered at N6 where for example IP addresses are allocated to individual devices (devices in the Customer Premises) behind the UE or 5G-RG. Any IP address delivery mechanism may be used to deliver an IP address to the devices behind the UE or 5G-RG i.e. SLACC, DHCPV4 or DHCPV6. The SMF related subscription data associated with the 5G-RG apply to a whole PDU Session regardless of whether multiple IP addresses are allocated on this PDU Session.

NOTE 2: IP address(es) allocated to devices can correspond to public or to private addresses.

4. In the UL direction the UPF acting as PSA receives (as a payload of the GTP-u tunnel coming from the AGF) IP traffic within a Layer 2 framing; This layer 2 framing below IP is called "access side layer 2 header" below. The PSA maps between the IPv4/v6 address / Prefix of a device behind the 5G-RG and the " access side layer 2 header" as follows:

- in UL the "access side layer 2 header" framing coming from a device in the Customer Premises is removed by the PSA. The UPF keeps track of the association between the IP address of the device and the corresponding "access side layer 2 header".

- in DL the " access side layer 2 header" is added by the UPF before sending the traffic towards a device in the Customer Premises. Necessary MAC address swapping (source/destination) is enforced by the PSA on the "access side layer 2 header" stored from UL traffic.

The "access side layer 2 header" handled by the PSA contains the IEEE 802.3 MAC header possibly augmented by IEEE 802.1q header or by a IEEE 802.1ad header (also known as « QinQ »).

NOTE 3: It is up to BBF access to determine whether this "access side layer 2 header" includes any VLAN tagging (possibly multiple levels of VLAN tagging) e.g. VLAN tagging added by the BBF access on top of the UL Ethernet frames received from the 5G-RG. The PSA performs the mapping above regardless of whether the " access side layer 2 header" contains 0, 1 or 2 level of VLAN tagging. Potential VLAN tagging addition by 5G-RG is defined by existing BBF specifications.

For a Combo Ethernet and IP PDU session type the UE or 5G-RG exchanges with the 5GC IP packets each carried within an Ethernet frame. The 5GC delivers an IP service to the devices locally connected to the UE or 5G-RG while it is able to identify traffic of these devices by the MAC address, they are using.

NOTE 4: No new traffic filters (for N4 PDR or PCC rule or N1 SM QoS related signalling) need to be defined.



Figure 6.X.1-1: Protocol stack for the combo PDU Session Type

In this release of the specification, SSC mode 3, UL CL and IPV6 multihoming do not apply to a PDU Session of the Combo type.

In this release of the specification, the Combo PDU Session type applies only to the Wireline access.

A UE or 5G-RG may use simultaneously a PDU Session with the "combo Ethernet + IP" PDU Session type and PDU Session(s) with another PDU Session type.

A UE or 5G-RG configured to work in Bridged and Bridged/Routed mode requests PDU Sessions with the PDU Session Type "combo IP + Ethernet" or may be associated in its subscription with this default PDU Session Type.

NOTE 5: This PDU Session Type has many similarities with the Ethernet PDU Session Type but services described in bullets 3 and 4 above are not supported by the Ethernet PDU Session Type.

The support of "combo IP + Ethernet" PDU Session type assume that multiple devices served by the PDU Session may request an IP address at any time during the lifetime of the PDU Session. The release of an IP address to such device (e.g. when the DHCP lease has expired) does not release the PDU Session. The SMF may allocate multiple IPv4 addresses in one PDU session of "combo IP + Ethernet" PDU Session type (when each device has its own IP address). IP address allocation takes place as in R18, i.e. options for SMF and UPF to allocate IP address, SMF handling the DHCP signalling, SLAAC etc are supported.

There is an unique UDM subscription for the UE or 5G-RG regardless of the number of devices in the customer premises that are subject of a specific handling.

When some devices are subject of a specific service, the identity of these devices (MAC address) and the parameters of their specific service (e.g. Access restriction for parental control, dedicated QoS) are configured in the policy (PCF) data related with the subscription (UDR). Other devices benefit of a baseline service and do not require to be individually identified in the policy data related with the subscription (UDR).

### 6.X.2 Description of the solution

The "Combo Ethernet + IP" PDU Session Type supports following features:

- An IP service is delivered at N6 where for example IP addresses are allocated to individual devices behind the UE or 5G-RG. The same IP address allocation mechanisms (including deferred IPv4 and DHCPV6 IP address allocation) are supported than in case of UE or 5G-RG supported by the IP PDU Session Type.

- The SMF indicates to the PSA that a PDU Session is of "Combo Ethernet + IP" type at the N4 Session Establishment. Based on this the PSA (UPF) acts as the first hop router of the devices in the customer premises with regard to the handling of the layers below IP. The SMF remains responsible of the RA/RS/ND handling. Especially it supports the behaviour described in bullet 4 of clause 6.X.1 related with " access side layer 2 header".

Editor's note: It is FFS whether signalling a new " 'combo Ethernet + IP' service" PDU Session type can be avoided to be signalled by/to the 5G-RG (i.e. Ethernet PDU Session type can still be signalled by/to 5G-RG).

- N4 FAR and PDR are those used for an IP PDU Session Type.

- based on the PDU Session type, the UPF handles the Ethernet layer towards the UE on its own without instructions from SMF

- The QER is updated for the SMF to be able to control the Priority Code Point of the VLAN Headers within the "access side layer 2 header".

- When an IP address/prefix has been allocated to the PDU Session the SMF reports it together with the corresponding MAC address (of the UE or 5G-RG or of a device behind the UE or 5G-RG) to the PCF and the PCF may use this MAC address to derive policies dedicated to a given device (PCF policy subscription data stored in UDR for the UE or 5G-RG subscription may contain a device category that is to be handled in a similar way as Subscriber category already defined in 23.503 [4]). For a "Combo Ethernet + IP" PCC rules (sent to the SMF) need only to refer to the IP header. No PCF policy differentiation is defined that would use the VLAN header received by the UPF over a PDU Session.

- PCF binding using BSF is based on the IP address of the devices. Service differentiation upon application (AF) request is also possible using the same mechanisms (e.g. Npcf\_authorization service) as in the case of an IP PDU Session type: the AF provides requests identifying the IP flow of a terminal it wants to act upon, session binding with the IP address of the terminal applies as described in clause 6.1.1.2 of TS 23.503 [4] and the PCF provides corresponding updated PCC rule. The BSF need not to be aware of "access side layer 2 header".

- There is no authentication of the devices behind the UE or 5G-RG that are identified by their MAC address.

The following figure shows the message flow for a PDU Session establishment (copied from Figure 4.3.2.2.1-1 of TS 23.502 [3]). The changes to existing procedure introduced for the support of the solution are described in the text below the figure while otherwise the PDU Session Establishment proceeds as described in existing specifications.



Figure 6.X.2-1: impacts of Combo IP + Ethernet PDU Session Type to 23.502 [3] Figure 4.3.2.2.1-1: UE-requested PDU Session Establishment for non-roaming and roaming with local breakout.

Step 1: The UE or 5G-RG may be configured (e.g. URSP) to request a PDU Session of the Combo IP + Ethernet PDU Session Type. Other parameters of the PDU Session may be the same than in IP PDU Session Type (E.g. the PDU Session establishment request may contain PCO asking for a P-CSCF address, ACS address, etc.).

Step 4: The subscription data retrieved from the UDM may contain Combo IP + Ethernet PDU Session Type as allowed PDU Session Type for a subscription.

Step 6 is optional (as in Rel-17 TS 23.502 [3]).

Step 7. The SMF may indicate to the PCF that the PDU Session is of Combo IP + Ethernet PDU Session Type.

 Per PDU Session policies sent by the PCF may contain a control on the Maximum Number of IP address to allocate as part of the PDU Session to devices in the customer premises (MNIP).

Step 10a. The N4 session between the SMF and an UPF acting as PSA for the PDU Session may be associated by the SMF with a Combo IP + Ethernet PDU Session Type; the SMF controls the UPF to report MAC addresses detected in UL traffic of the PDU Session.
If the SMF requests the UPF to forward DHCP/RS (Router Solicitation) traffic from devices using the PDU Session, the SMF may request the UPF to report the "access side layer 2 header" on which the DHCP/RS has been received.

Access to ACS (Autoconfiguration server used in BBF TR 069 procedures) is supported as for IP or Ethernet PDU Session types (e.g. as described in TS 23.316 [5]).



Figure 6.X.2-2: Allocation of an IP address to a device behind the 5G-RG

For Combo PDU Session Type, the SMF requests the UPF to forward DHCP / RS signalling over N4; the reporting from UPF shall contain the MAC address of the device.

When during the lifetime of a PDU Session, an IP address is allocated to a device supported by a PDU Session established with the Combo IP + Ethernet PDU Session Type, the following applies:

1) In band IP address allocation procedure (RS/RA, DHCPv4, DHCPv6). The SMF / UPF uses policies received in step 7 of Figure 6.X.2-1 (IP index, max number of IP addresses for the PDU Session) to determine whether to grant an IP address to the device and if yes to determine the IP pool / allocation method to use.

NOTE: The usage of DHCPV4 signalling to allocate IP address to devices behind the 5G-RG does not require sending dedicated NAS signalling with a request of deferred IP address allocation. ; it is possible that the IP address allocated to the 5G-RG itself is provided via NAS to the 5G-RG while in band IP address allocation applies for the devices behind the 5G-RG.

2) If this corresponds to a PCRT (Policy Control Request Trigger) received previously from the PCF, the SMF initiates the SM Policy Association Modification procedure described in clause 4.16.5.1 of TS 23.502 [3].

The reception of new policies from the PCF in step 2 may trigger the network initiated PDU Session modification procedure in clause 4.3.3 of TS 23.502 [3] which may include a corresponding N4 session modification procedure to create or update the corresponding PDR/FAR/QER/URR on the UPF and SMF sending updates of QOS rules to the 5G-RG to apply new QoS flows.

### 6.X.3 Impacts on existing functions

The impact on existing network function is the following:

- SMF / UPF(N4), UDM and PCF (Npcf) need to support a new PDU Session type.

- Support of Multiple IP address for a PDU session. The SMF may allocate multiple IPv4 addresses in one PDU session of "combo IP + Ethernet" PDU Session type.

- When the N4 session is associated by the SMF with a Combo IP + Ethernet PDU Session Type, the UPF enforces the behaviour in bullet 4 of clause 6.X.1.

- Npcf Policy Request Control Trigger mechanism is upgraded for the SMF to be able to report the allocation of an IP address to a device behind the 5G-RG together with the MAC address of that device.

- the PCF may apply policies (possibly related with IP level traffic) related with the MAC address of a device (as reported by the SMF via a Policy Request Control Trigger). PCF policy subscription data stored in UDR for the 5G-RG subscription may contain a device category that is to be handled in a similar way as Subscriber category already defined in TS 23.503 [4].

- The CHF and LI may receive an indication of a new IP address having been allocated to a PDU Session together with the indication of the corresponding MAC Address.

- UE or 5G-RG: Support the new "combo IP + Ethernet" PDU Session type value in NAS signalling.

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