Project II

(Academic Year 2022/2023)

Project Title:

5G Framed Route

Supervisor(s) Name(s) and Department affiliation

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Project definition

Objective: Development of a proof-of-concept implementation of *Framed Routing* in a state-of-the-art open-source 5G Core

Context:
When authenticating and attaching to cellular mobile networks (PLMN), mobile devices (UE – *User Equipment*) are normally assigned with a single IP address. For some scenarios, it is of utmost importance that those UEs can also be used as access devices and share their Internet access with other nodes. This is already the case of mobile hotspots (WLAN) and Bluetooth/USB/Ethernet Tethering that often employ NAT as the IP translation mechanism, forcing all connected devices behind the UE to be seen on the Internet with a single IP address (the one assigned by the 5G core to the UE). While this is acceptable for the typical needs of a common user (e.g. for browsing the Internet, video streaming or social networking) such approaches pose multiple drawbacks for advanced use-cases.

More complex scenarios (e.g. associated to industrial use cases and SOHO [1]), require 5G UEs to behave as routers and serve one or more LAN segments, explicitly forwarding connected device traffic while avoiding NAT since it limits the reachability and the bi-directional connectivity. 5G solves this limitation by natively adding the *Framed Route* functionality [2] [3]. *Framed Route* allows the deployment of additional IP networks behind a UE, such that a range of IPv4 addresses or IPv6 prefixes are reachable from external networks like the Internet, over the established 5G PDU Session(s), for instance in the context of private 5G networks when a 5G gateway provides connectivity to remote non-5G sensors and actuators. The framed route feature is well introduced in 3GPP TS 23.501 [2], with their types defined in TS 29.503 [4] and RFC-2865 [5], respectively.

Currently, none of the 5G Core implementations Altice Labs is working with supports the Framed Route feature. Thus, the main objective of the project is to add such feature to one of the available opensource 5G Core implementations, preferably to Open5GS [6] [7]. In the case of Open5GS most of the required interfaces and procedures are already implemented as part of the project. Hence, this proposal aims at extending those interfaces to include the necessary types and make the framed routing feature a reality.

Objectives:
The main objective of the project is the development and addition of the *Framed Route* feature to a reference 3GPP compliant open source 5G core implementation (preferably Open5GS).

For each UE, the solution shall allow the assignment of IPv4/v6 prefixes in the scope of UE provisioning via the WebGUI (and the companion CRUD operations and route prefix syntax validations), with that change being reflected in the Open5GS subscriber database (MongoDB) and later to the 5G Core network functions in charge of the PDU session establishment procedure (SMF, UDM and UPF). The 5G Core UPF must also be able to receive the framed route TLVs from the SMF (via the PFCP protocol) when the UE attaches to the 5G network.

Having that, packets received at the UPF N6 interface targeting any address associated with those prefixes, shall be forwarded to the right UE, via the corresponding GTP tunnel, with no NAT operations involved. In the UE side, packets are retrieved from the tunnels (downstream) and sent to the final destination; in the opposite direction (upstream) packets received from the LAN segments served by the UE are inserted in the GTP tunnel, according to the existing routing rules at the UE.

3GPP does not specify how the UEs get aware of the IP prefixes they become responsible for and, thus, how the respective routing tables are updated. It is an optional requirement of the project to identify, implement and demonstrate a dynamic mechanism to allow UEs, upon authentication, registration and 5G PDU Sessions establishment, to receive the information about the IP prefixes and routes to add (and delete when disconnecting from the 5G network). As a starting point, TR-069 and GenieACS (*Automatic Configuration Service*) [8] can be evaluated and used or better alternatives can be found.

For the project development, the UERANSIM [9] simulator shall be used to emulate the RAN and the UEs. Depending on the project evolution, but being strongly advised, the possibility of executing tests and a demonstration at a real 5G network, with real UEs, at AlticeLabs premises in Aveiro, will be evaluated.

References:
[1] BBF, TR-470, 5G Wireless Wireline Convergence Architecture
[2] 3GPP, TS 23.501
[3] 3GPP, TS 23.502
[4] 3GPP, TS 29.503
[5] IETF RFC-2865, https://datatracker.ietf.org/doc/rfc2865/
[6] https://open5gs.org/open5gs/docs/guide/01-quickstart/
[7] https://github.com/open5gs/open5gs
[8] https://genieacs.com/
[9] https://github.com/aligungr/UERANSIM/wik

Requirements (list of requirements by classes: Mandatory/additional)

Mandatory requirements for the 5G Framed Routing implementation:
1- Add the Framed Routing feature to Open5GS, in particular to the following components

- WebGUI, UDM DB, SMF and UPF

2- Demonstrate the feature with UERANSIM

Optional requirements:

3- Identify, implement and demonstrate a suitable mechanism for automatic *Framed Routes* configuration at 5G UEs

Deliverables (list of expected deliverables for successful completion of the proposal)

This project is considered successful when delivers a working prototype that satisfies the mandatory requirements.

The engineering team must deliver the following documents:

1- Project proposal.
2- Project pitch (written).
3- Mid-term technical report.
4- Final technical report.
5- Oral communication/demonstration of the prototype with associated developed code and respective documentation.

In collaboration with:

Altice Labs, S.A.