TELECOM INFRA PROJECT

Closed Loop Automation for Mobile Gaming

Lab Exit Report: E2E-NS UC001

Issue 1.0

End-2-End Network Slicing
(E2E-NS) Project Group

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Introduction

This project was set up to demonstrate a means to create and assure network slices to meet the needs of a particular application (e.g., mobile gaming).

The key partner vendors in this project were:

- BT (use case sponsor)
- Cloudstreet
- EXFO
- TechMahindra (TIP Community Lab support and PoC testing)
- Baicells (eNB supplier and support)
- Athonet (vEPC supplier and support)

Project Objective

The objective of this PoC is to show how automating network slice testing can ensure provisioned slices can be delivered to meet the intended needs of a user's application. This is an initial demonstration of closed-loop automation for network slicing—an area that is expected to be of significant business and operational value to network operators.

Additional learning is expected regarding definition and creation of network slices for different use cases. This is relative to any established baseline from this group and/or others. Consideration should be given to both slice management and execution aspects.

This use case should also contribute to the cumulative knowledge of the project group regarding network slicing architecture, concepts, and ecosystem.

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Use Case Overview

Figure 1 illustrates the main components and dynamic behavior of the use case solution:

- The user's device ("gaming UE"), running the Cloudstreet DPC Agent and EXFO Agent
- A Baicells eNodeB and Athonet EPC
- Cloudstreet's Dynamic Profile Controller (DPC), integrated with EPC's PCRF
- EXFO's EXFOWorx application

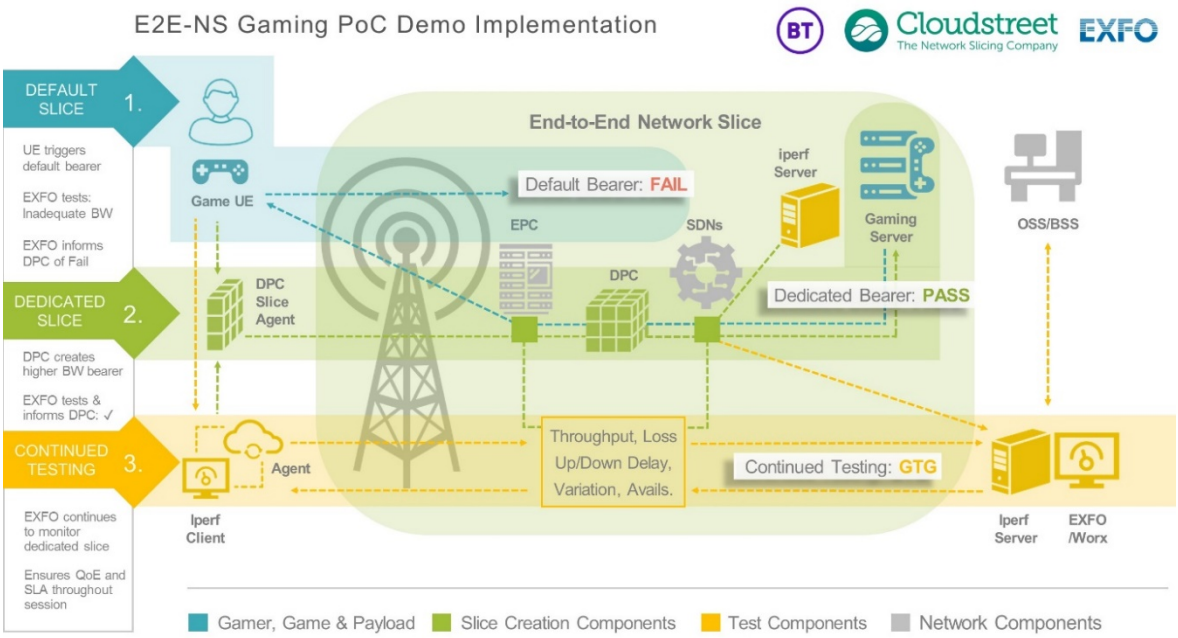

Figure 1 – Use case overview

The use case has three main steps:

1. The user wants to initiate a gaming session and connects to their mobile network. This connection uses the default bearer (representing a "default network slice") provided by the mobile network. The EXFO agent onboard the user device (UE) detects that this session provides insufficient bandwidth for the gaming session and informs the DPC.
2. The DPC creates a higher bandwidth bearer (a "dedicated slice") for the gaming session. The EXFO Agent and EXFOWorx tests if this bearer is providing sufficient bandwidth. If so, it informs the DPC, which moves the user's connection to the new bearer. This step is the illustration of closed loop automation.
3. EXFOWorx continues to monitor the bearer throughout the session.

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The TIP Community Lab at Adastral Park was used for this use case and was supported by Tech Mahindra. Figure 2 illustrates network design of the lab is shown below.

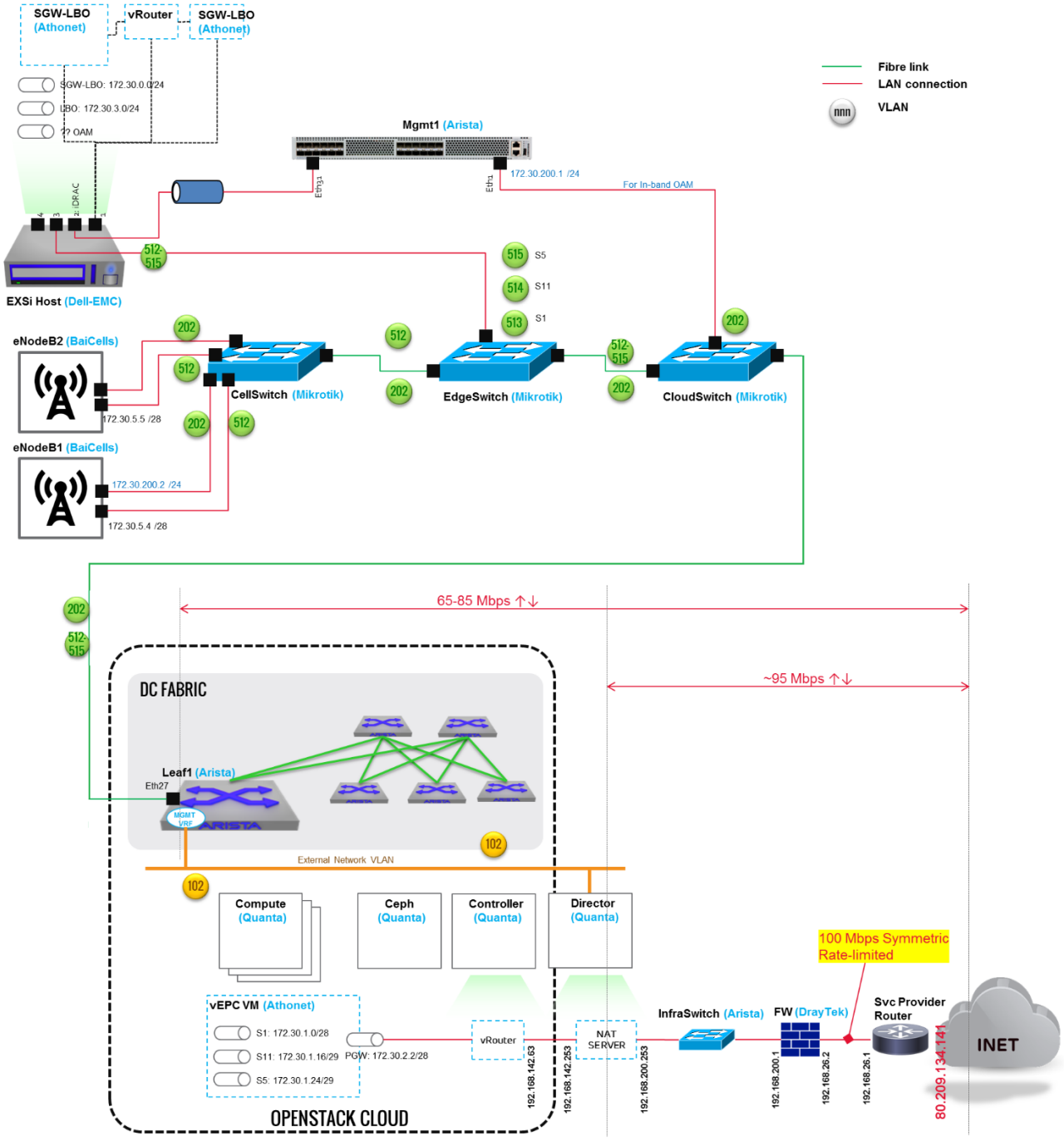

Figure 2 – TIP Community Lab Network Design

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Test Description

The following is an overview of the test approach:

- Create a representative mobile network to facilitate one or more devices to connect to one or more applications
- Prove the creation of the default environment, i.e., the device attached to the mobile network (the default slice creation)
- Prove default conditions can be detected, i.e.:
  - ✓ detect that a device is requesting to use an application
  - ✓ create a default slice for this purpose (if not preconfigured)
  - ✓ detect that the default connection is inadequate for the desired application (detection timeframe to be recorded)
- Prove this condition can be automatically signaled to the network controller
- Prove the network controller can create a dedicated slice tailored to the needs of the specific application
- Prove a device can use the application over this dedicated slice
- Prove the dedicated slice can be torn down when no longer required to ensure efficient network resource use

The detailed test execution steps were as follows.

S NO	Test Case	Steps	Description	Expected
1	Verify UE attach to the network on default bearer and browsing data	Step 1	UE in flight mode or disconnected state	Initially UE should be in disconnect state
		Step 2	Login to EPC VM and capture the logs	Start TCP dump in the VM using command
		Step 3	In UE disable the flight mode or connect to the network	Attach should be successful and able to browse the data traffic
		Step 4	Collect the logs and verify	Attach should be successful and should be able to see the data packets in logs

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S NO	Test Case	Steps	Description	Expected
2	Verify EXFO works; collects UE KPI and updates score on http://192.168.142.58:8080/API/REST/Status/v1/TestStatus/1074?size=1	Step 1	Verify the RestAPI link	Log in to https://192.168.142.58/restapi
		Step 2	Verify the KPI stats for the UE	Stats should be below the EXFO works score
3	Verify that DPC connection with EXFO works through rest API http://192.168.142.58:8080/API/REST/Status/v1/TestStatus/1074?size=1	Step 1	Verify the RestAPI link	Log in to https://192.168.142.58/restapi
		Step 2	Verify the connection from DPC to EXFO works	Connection should exist through the RestAPI
4	Verify throttling is applied from Raspberry Pi to change the EXFO works score	Step 1	UE in flight mode or disconnected state	Initially UE should be in disconnect state
		Step 2	Login to EPC VM and capture the logs	Start TCP dump in the VM using command
		Step 3	In UE, disable the flight mode or connect to the network	Attach should be successful and able to see the following: 1) Create session req and Create session resp 2) Credit control req and Credit control resp 3) Modified bearer req and resp
		Step 4	Initiate Iperf traffic on the network	IPRF traffic should start and cause congestion in the network
		Step 5	Check the EXFO works score	EXFO works score should come down

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S NO	Test Case	Steps	Description	Expected
5	Verify that DPC initiate Rx session toward PCRF once EXFO touches the threshold score and then Dedicated bearer is established	Step 1	UE in flight mode or disconnected state	Initially UE should be in disconnect state
		Step 2	Login to EPC VM and capture the logs	Start TCP dump in the VM using command
		Step 3	In UE, disable flight mode or connect to the network	Attach should be successful and see the following: 1) Create session req and Create session resp 2) Credit control req and Credit control resp 3) Modified bearer req and resp
			Start iperf traffic and initiate throttling, monitor EXFO score	EXFO works score should come down
		Step 4	DPC should initiate Rx session once EXFO score reaches threshold	DPC should initiate AAR towards PCRF: AAR: framed--IP-address media-component-description media-component-number:1 Media-Type:application Flow-Status:enabled UL/DL media-subcomponent flow-description: specific action AF-application identifier called-station-ID:internet
		Step 5	PCRF send RAR to create Dedicated bearer	PCRF will initiate RAR toward GW with: charging-rule-install flow-information

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S NO	Test Case	Steps	Description	Expected
				flow status QOS information
		Step 6	GW have to send Create bearer toward MME to create new bearer	Should observe Create bearer request with TFT and with TEID Create bearer response should be successful
6	Verify that GBR traffic should go in Dedicated bearer based on the protocol and destination without affecting Default bearer	Step 1	UE in flight mode or disconnected state	Initially UE should be in disconnect state
		Step 2	Login to EPC VM and capture the logs	Start TCP dump in the VM using command
		Step 3	In UE disable the flight mode or connect to the network	Attach should be successful and see the following: 1) Create session req and Create session resp 2) Credit control req and Credit control resp 3) Modified bearer req and resp

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S NO	Test Case	Steps	Description	Expected
6	Verify GBR traffic should go in Dedicated bearer based on protocol and destination without affecting Default bearer	Step 4	Initiate Iperf traffic : 1) DPC have to send AAR to PCRF, 2) PCRF have to send RAR to create Dedicated bearer	1) DPC should initiate AAR towards PCRF: AAR: framed--IP-address media-component-description Media-component-Number:1 media-type:application flow-status:enabled UL/DL Media-subcomponent flow-description specific action AF-application identifier called-station-ID:internet 2) PCRF will initiate RAR toward GW with: charging-rule-install flow-information flow status QOS information 3) We should observe Create bearer request with TFT and with TEID Create bearer response should be successful 4) Verify the TEID for the Dedicated bearer in Create bearer req and resp
		Step 5	Start browsing IP from flow description or defined protocol	We should observe the traffic flow in dedicated bearer (IP or protocol), ping and ICMP will be in Default bearer

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S NO	Test Case	Steps	Description	Expected
7	Verify that GBR should be removed from network when IPERF session is closed	Step 1	UE in flight mode or disconnected state	Initially UE should be in disconnect state
		Step 2	Login to EPC VM and capture logs	Start TCP dump in VM using command
		Step 3	In UE, disable flight mode or connect to the network	Attach should be successful and see the following: 1) Create session req and Create session resp 2) Credit control req and Credit control resp 3) Modified bearer req and resp
		Step 4	Initiate Iperf traffic 1) DPC have to send AAR to PCRF, 2) PCRF have to send RAR to create Dedicated bearer	1) DPC should initiate AAR towards PCRF: AAR: framed--IP-address media-component-description media-component-number:1 media-type:application flow-status:enabled UL/DL media-subcomponent flow-description specific action AF-application identifier called-station-ID: internet 2) PCRF will initiate RAR towards GW with: charging-rule-install flow-information flow status QOS information 3) We should observe Create bearer req with

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S NO	Test Case	Steps	Description	Expected
				TFT and with TEID Create bearer resp should be successful
		Step 5	Stop IPERF from DPC	DPC will send ASR to terminate the session and to downgrade or delete the Dedicated bearer

Test Results

The test results are summarized below.

S NO	Test Case	Execution Status	Status (Pass/Fail)	Remarks
1	Verify UE attach to network on Default bearer and browsing data	Executed	**Pass**	UE attached in vEPC
2	Verify EXFOWorx collects UE KPI and updates score on http://192.168.142.58:8080/API/REST/Status/v1/TestStatus/1074?size=1	Executed	**Pass**	EXFOWorx is updating API score per UE activity

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S NO	Test Case	Execution Status	Status (Pass/Fail)	Remarks
3	Verify DPC connection with EXFOWorx through RestAPI http://192.168.142.58:8080/API/REST/Status/v1/TestStatus/1074?size=1	Executed	**Pass**	DPC is collecting API score from EXFOWorx through RestAPI
4	Verify throttling is applied from Raspberry Pi to change EXFO works score	Executed	**Pass**	EXFO API score decreased to 19 due to throttling initiated from Raspberry Pi, causing network congestion
5	Verify DPC initiates Rx session toward PCRF once EXFO touches threshold score and then dedicated bearer is established	Executed	**Pass**	Per logic in EXFO, if API score dips below 50, DPC triggers the Rx session toward PCRF for Dedicated bearer creation; since DPC score is 19, hence GBR is created
6	Verify that GBR traffic should go in Dedicated bearer based on protocol and destination without affecting the Default bearer	Executed	**Pass**	EXFOWorx was keeping an eye on IPERF traffic which needs to go through the Dedicated bearer and ICMP traffic should go through the Default bearer
7	Verify that GBR should be removed from network when IPERF session is closed	Executed	**Pass**	Completed – see pcap.

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Summary

These are the main conclusions from this use case testing:

- The use case concept was successfully constructed in the TIP Community Lab environment at Adastral Park.
- The agreed-upon tests were successfully executed with evidence captured.
- The environment has been preserved for future consideration and demonstration purposes (if required) to show (through software innovation) how network slice testing automation can ensure provisioned network slices can be delivered to meet the intended needs of a user's application.

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