R3 - Test Documentation

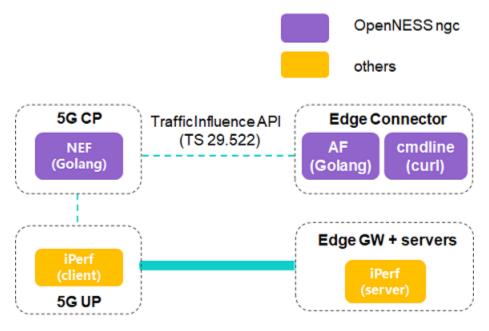
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Test-Env Setup

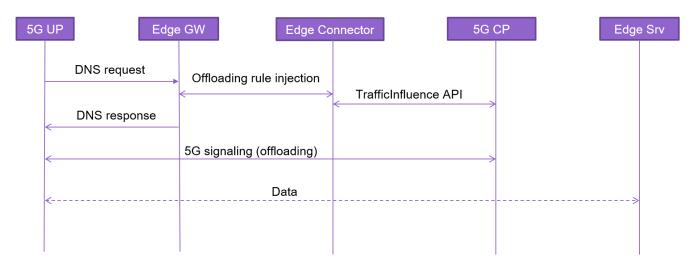
End-to-end test with the 5GC emulator

To validate the BP, a 5GC emulator is provided, which consists of a 5G CP and UP.

- The 5G CP is based on the Network Exposure Function (NEF) implemented by openNESS ngc
- The 5G UP is an iPerf instance running in the client mode, controller by the 5G CP



Offloading call flow



The offloading call flow is as follows.

- 1. A UE (not shown in the figure) sends a DNS request via the 5G user plane, which is detected by the Local DNS (LDNS) at the Edge GW.
- 2. A new offloading rule is injected to the Edge Connector by the Edge GW.
- 3. AF function hosted on the Edge Connector invokes the TrafficInfluence API, offered by the 5G CP.
- 4. A DNS response is composed and sent by the LDNS, which includes an IP pointing to an Edge server.
- 5. 5G CP configures the 5G UP with standardized 5G signaling related to offloading.
- 6. Traffic from the UE is offloaded to the Edge server.

Setup guide

- Step 1, deploy edge GW and on-board iPerf (server) following the steps described in Installation Documentation.
- Step 2, run ngc/start.sh to launch the 5G CP (NEF), Edge GW+server and AF. A DNS request will be sent hereafter.
- Step 3, run ngc/test/Post.sh to start traffic offloading or ngc/test/Delete.sh to stop offloading.

Unit Test

Enter test directory:

cd ./5g-mec-cloud-gaming

Execute the versify.sh script to setup the test environment:

versify.sh script first installs Golang and ginkgothen installs docker and docker-compose.

The test commands for the three submodules are as follows:

- make -C 5GCEmulator/ngc build && make -C 5GCEmulator/ngc test-unit-nef
- make -C edgenode networkedge
- make -C edgecontroller build-dnscli && make -C edgecontroller test-dnscli

Test results

End-to-end test

Non-offloading case

The 5GC prints "No data offloaded..." when offloading is not enabled.

```
Launching NEF
<134>Mar 2 13:09:19 nef[4534]: [NEF-MAIN] Logger Level: 6
<134>Mar 2 13:09:19 nef[4534]: [NEF-MAIN] Starting NEF serve:
(134>Mar 2 13:09:19 nef[4534]: [NEF] *********
<134>Mar 2 13:09:19 nef[4534]: [NEF] APIRoot: localhost
134>Mar 2 13:09:19 nef[4534]: [NEF] LocationPrefix: /3qpp-t
        2 13:09:19 nef[4534]: [NEF] UpfNotificationResUriPa
:134>Mar
134>Mar
         2 13:09:19 nef[4534]:
                                [NEF]
                                      UserAgent: NEF-OPENNESS-
134>Mar
         2 13:09:19 nef[4534]:
                                [NEF]
         2 13:09:19 nef[4534]:
:134>Mar
                                [NEF]
                                      EndPoint(HTTP): :8061
                                      EndPoint(HTTP2): :8060
134>Mar
         2 13:09:19 nef[4534]:
                                [NEF]
134>Mar
         2 13:09:19 nef[4534]:
                                [NEF]
                                      ServerCert(HTTP2): /etc
         2 13:09:19 nef[4534]:
                                      ServerKey(HTTP2): /etc/
:134>Mar
                                [NEF]
         2 13:09:19 nef[4534]:
                                [NEF] AFClientCert(HTTP2): /e
<134>Mar
         2 13:09:19 nef[4534]:
<134>Mar
                                [NEF]
<134>Mar
         2 13:09:19 nef[4534]:
                                [NEF] PCF Stub Client created
<134>Mar
         2 13:09:19 nef[4534]:
                                [NEF] UDR Stub Client created
         2 13:09:19 nef[4534]:
<134>Mar
                                [NEF] NEF Location URL Prefix
<134>Mar 2 13:09:19 nef[4534]: [NEF] SMF UPF Notification UR
<134>Mar 2 13:09:19 nef[4534]: [NEF] HTTP 2.0 listening on :
<134>Mar
         2 13:09:19 nef[4534]: [NEF] HTTP 1.1 listening on :
<131>Mar 2 13:09:19 nef[4534]: [NEF] HTTP2server error: open
No data offloaded...
```

The 5GC prints "Offloading in progress", while the Edge GW prints the mount of data it receives in realtime.

```
Cyangf@fengfyang-LC0:~/Documents/5GCEmulator/ngc$ iperf -u -s -i 1
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size: 208 KByte (default)
   3] local 127.0.0.1 port 5001 connected with 127.0.0.1 port 46324
  ID] Interval
                                            Bandwidth
                                                                   Jitter Lost/Total Datagrams
       0.0- 1.0 sec
1.0- 2.0 sec
2.0- 3.0 sec
                                                                                          90 (0%)
                            129 KBytes 1.06 Mbits/sec
                                                                   0.004 ms
                                            1.05 Mbits/sec
                             128 KBytes
                                                                   0.001 ms
                                                                                    0/
                                                                                          89 (0%)
                                            1.05 Mbits/sec
                             128 KBytes
                                                                   0.002 ms
                                                                                          89 (0%)
                             128 KBytes 1.05 Mbits/sec
                                                                   0.001 ms
                                                                                          89 (0%)
                                                                                    0/
        0.0- 4.0 sec
                             514 KBytes 1.05 Mbits/sec
                                                                   0.001 ms
                                                                                         358 (0%)
       local 127.0.0.1 port 5001 connected with 127.0.0.1 port 49316
                            129 KBytes 1.06 Mbits/sec
128 KBytes 1.05 Mbits/sec
128 KBytes 1.05 Mbits/sec
       0.0- 1.0 sec
1.0- 2.0 sec
                                                                  0.001 ms
                                                                                    0/
                                                                                           90 (0%)
                                                                   0.003 ms
                                                                                           89 (0%)
                                                                   0.006 ms
                                                                                          89 (0%)
   41
                             128 KBytes 1.05 Mbits/sec
        3.0- 4.0 sec
                                                                   0.001 ms
   4]
                                                                                    0/
                                                                                          89 (0%)
                             514 KBytes 1.05 Mbits/sec
                                                                                         358 (0%)
        0.0- 4.0 sec
                                                                   0.001 ms
                                                                                    0/
       local 127.0.0.1 port 5001 connected with 127.0.0.1 port 44311
        0.0- 1.0 sec
1.0- 2.0 sec
                             129 KBytes 1.06 Mbits/sec
128 KBytes 1.05 Mbits/sec
                                                                   0.001 ms
                                                                                           90 (0%)
                                                                   0.001 ms
                                                                                           89 (0%)
                             128 KBytes 1.05 Mbits/sec
        2.0- 3.0 sec
                                                                   0.001 ms
                                                                                          89 (0%)
                                                                                    0/
        3.0- 4.0 sec
                             128 KBytes 1.05 Mbits/sec
                                                                   0.001 ms
                                                                                    0/
                                                                                          89 (0%)
                                                                   0.001 ms
                             514 KBytes 1.05 Mbits/sec
                                                                                         358 (0%)
        0.0- 4.0 sec
       local 127.0.0.1 port 5001 connected with 127.0.0.1 port
                                                                                  42806
        0.0- 1.0 sec
1.0- 2.0 sec
                             129 KBytes 1.06 Mbits/sec
128 KBytes 1.05 Mbits/sec
   4]
                                                                   0.002 ms
                                                                                    0/
                                                                                           90 (0%)
                                                                    0.001 ms
                                                                                    0/
                                                                                               (0왕)
                             128 KBytes 1.05 Mbits/sec
                                                                   0.002 ms
                                                                                           89 (0%)
   41
         3.0- 4.0 sec
                             128 KBytes 1.05 Mbits/sec
                                                                    0.005 ms
                                                                                           89 (0%)
        0.0 - 4.0 \text{ sec}
                             514 KBytes 1.05 Mbits/sec
                                                                                          358 (0%)
                                                                    0.005 ms
                                                                                    0/
              13:14:15 nef[4652]: [NEF] HTTP Request Received :HTTP/2.0
:134>Mar 2 13:14:15 nef[4652]: [NEF] =
<134>Mar 2 13:14:15 nef[4652]: [NEF]
<134>Mar 2 13:14:15 nef[4652]: [NEF]
                                                Method : POST
                                                URL PATH : /3gpp-traffic-influence/v1/1/subscriptions
:134>Mar
           2 13:14:15 nef[4652]: [NEF]
                                                Route Name : CreateTrafficInfluenceSubscription
<134>Mar 2 13:14:15 nef[4652]: [NEF]
<134>Mar 2 13:14:15 nef[4652]: [NEF]
<134>Mar 2 13:14:15 nef[4652]: [NEF]
                                              HTTP Request Handling -- STARTS
                                               AFID : 1
            2 13:14:15 nef[4652]: [NEF]
                                              NO AF PRESENT CREATE AF
<131>Mar
<134>Mar 2 13:14:15 nef[4652]: [NEF] PCFs PolicyAuthorizationCreate Entered
<134>Mar 2 13:14:15 nef[4652]: [NEF] PCFs Policy Authorization DB size: 0
<134>Mar 2 13:14:15 nef[4652]: [NEF] PCFs Policy Authorization AppSessionId created: 8081
<134>Mar 2 13:14:15 nef[4652]: [NEF] PCFs PolicyAuthorizationCreate [CorrId,NotifUrl,DnaiChg
<134>Mar 2 13:14:15 nef[4652]: [NEF] PCFs PolicyAuthorizationCreate Exited successfully with
<134>Mar 2 13:14:15 nef[4652]: [NEF] PCF Policy Authorization Create Success. Response Code:
<134>Mar 2 13:14:15 nef[4652]: [NEF]
                                               NEW AF Subscription added 11111
<134>Mar 2 13:14:15 nef[4652]: [NEF]
<134>Mar 2 13:14:15 nef[4652]: [NEF]
                                              https://localhost:8060/3gpp-traffic-influence/v1/1/subs
CreateTrafficInfluenceSubscription responses => 201
<134>Mar 2 13:14:15 nef[4652]: [NEF] AF count 1
<1349Mai 2 13:14:15 nef[4652]: [NEF] AF ID : 1, Sub Registered Count 1
<1349Mar 2 13:14:15 nef[4652]: [NEF] SubId : 11111, ServiceId:
<1349Mar 2 13:14:15 nef[4652]: [NEF] HTTP Request Handling -- ENDS. Time Taken: 387.002µs</pre>
<134>Mar 2 13:14:15 af[4643]: [ngc-af] Deleted transaction ID 1
Offloading in progress...
```

Unit Test

5GCEmulator

```
NefServer NefServer init
 Will init NefServer - No HTTP endpoints
<3>Jun 8 12:52:55 nef.test[4805]: [NEF] Failed to load NEF configuration: open noconfig: no such file or directory
Ran 27 of 27 Specs in 8.097 seconds
SUCCESS! -- 27 Passed | O Failed | O Pending | O Skipped
<6>Jun 8 12:52:55 nef.test[4805]: [NEF] APIRoot: localhost
<6>Jun 8 12; 52; 55 nef. test[ 4805]; [ NEF] LocationPrefix; /3qpp-traffic-influence/v1/
<6>Jun 8 12:52:55 nef.test(4805): [NEF] UpfNotificationResUriPath:/3gpp-traffic-influence/v1/notification/upf
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] UserAgent: NEF- OPENNESS- 1912
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] EndPoint( HTTP):
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] EndPoint( HTTP2):
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] ServerCert( HTTP2):
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] ServerKey( HTTP2):
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] AFClientCert( HTTP2):
<6>Jun 8 12: 52: 55 nef. test[4805]: [NEF] PCF Stub Client created with initial session id: 1847
<6>Jun 8 12:52:55 nef.test[4805]: [NEF] UDR Stub Client created
<6>Jun 8 12:52:55 nef.test[4805]: [NEF] NEF Location URL Prefix: http://localhost/3gpp-traffic-influence/v1/
<6>Jun 8 12:52:55 nef.test[4805]: [NEF] SMF UPF Notification URL: http://localhost/3gpp-traffic-influence/v1/notification/upf
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] HTTP Server not configured
<6>Jun 8 12: 52: 55 nef. test[ 4805]: [ NEF] HTTP 2 Server not configured
<3>Jun 8 12:52:55 nef. test[4805]: [NEF] HTTP Servers are not configured
coverage: 71.1% of statements
Ginkgo ran 1 suite in 36.760164264s
Test Suite Passed
make: 离开目录*/home/gerrit/5g-mec-cloud-gaming/5GCEmulator/ngc"
[root@127 5g-mec-cloud-gaming]#

    EdgeNode

Step 9/15: RUN echo '%sudo ALL=(ALL) NOPASSWD: ALL' >> /etc/sudoers
---> Using cache
 ---> d3666b70a917
Step 10/15 : RUN echo 'Set disable_coredump false' >> /etc/sudo.conf
 ---> Using cache
---> 8cf8b5bdc0ff
Step 11/15 : USER $username
 ---> Using cache
 ---> 4fb34038f995
Step 12/15 : WORKDIR $user_dir
 ---> Using cache
---> da4de25f7dfa
Step 13/15 : COPY ./edgednssvr ./
 ---> ea822a827fce
Step 14/15 : ENTRYPOINT ["sudo", "./edgednssvr"]
 ---> Running in 7a43029600d8
Removing intermediate container 7a43029600d8
---> 5441ebe3b7a2
Step 15/15 : CMD ["-port=53", "-fwdr=8.8.8.8"]
 ---> Running in e84bd8018bbe
Removing intermediate container e84bd8018bbe
 ---> a5fec2d50f6a
Successfully built a5fec2d50f6a
Successfully tagged edgednssvr: 1.0
VER=1.0 docker-compose build syslog-ng
WARNING: The OVN_NB_DB variable is not set. Defaulting to a blank string.
WARNING: The NTS_MEM_MB_SO variable is not set. Defaulting to a blank string.
WARNING: The NTS_MEM_MB_S1 variable is not set. Defaulting to a blank string.
WARNING: The OVS_BRIDGE_NAME variable is not set. Defaulting to a blank string.
WARNING: The OVSE variable is not set. Defaulting to a blank string.
```

syslog-ng uses an image, skipping

make: 离开目录"/home/gerrit/5g-mec-cloud-gaming/edgenode"

WARNING: The REMOTE_SYSLOG_IP variable is not set. Defaulting to a blank string.

```
CLI test when DNS CLI DelA is called With folder path instead of file
  Should trigger an error
del failure: Failed to read JSON file /tmp: Failed to read file /tmp: read /tmp: is a directory.
CLI test when DNS CLI DelA is called Correct del, empty record_type field
  Should pass
/home/gerrit/5g-mec-cloud-gaming/edgecontroller/edgednscli/cli_test.go: 243
RecordType not provided, setting "A" as defaultConnecting to EdgeDNS server(localhost: 14204)[Test Server] DeleteAuthoritative: [A
d authoritative host: [A, baz.bar.foo.com.] •
CLI test when DNS CLI DelA is called Wrong record_type
  Should fail
del failure: RecordType of HostRecordSet is not valid[incorrect_type_passed]. Please provide 'None' or 'A' or ... in JSON file.
CLI test when DNS CLI DelA is called With non existing file
  Should trigger an error
del failure: Failed to read JSON file /some/not/existing/file: Failed to find file /some/not/existing/file: stat /some/not/existir
CLI test when DNS CLI DelA is called Correct del, without record_type field
Connecting to EdgeDNS server(localhost:14204)[Test Server] DeleteAuthoritative: [A baz.bar.foo.com.] Successfully deleted authoritative
Ran 15 of 15 Specs in 4.061 seconds
SUCCESS! -- 15 Passed | O Failed | O Pending | O Skipped
Ginkgo ran 1 suite in 22.368337811s
Test Suite Passed
make: 离开目录"/home/gerrit/5g·mec-cloud-gaming/edgecontroller"
[root@127 5g-mec-cloud-gaming]#
```

CI/CD logs

Pushed to the Nexus server.