OpenAirInterface

Training of Continuous Integration bench: Jenkins, Scripting and Test Provisioning

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Question Rule

- If you have any questions, please don’t hesitate to interrupt me. You can ask your questions anytime.
Why CI?
Why CI?

CI for existing features

CI = Continuous Integration

Question

Why do we need to integrate OAI software continuously?

OAI = Open Air Interface

What about existing features?

Who is responsible for it?

Developers

Users

Core Members
Why CI?
Positive Spiral

Better Quality ➔ More Users ➔ More Attractive Features

Quality

Current OAI Software Quality
Desired OAI Software Quality

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Concept and Architecture

CI for new features

- CI triggered immediately after Merge Request (Pull Request).
  - Automatically validate whether the compile/build is OK
  - Automatically validate whether or not we have any degradation.

To be discussed

- How to validate NEW features?
- How to merge tests for new features into CI test suite?
Concept and Architecture
Concept and Architecture

Concept

- Everyone can use / modify / customize it easily!
- Last December, we created CI environment with Jenkins only, but we decided to give it up.
- Avoid Jenkins 職人 problem
  - Previously configuring Jenkins was not well visible, difficult to be documented. The skills tended to be available only to the person in charge, which could be a single point of failure.
    - Solved by introducing pipeline script
- Easy to replicate

Infrastructure as Code
Jenkins (Declarative Pipeline)

Environment (Parameters)
- eNB IP Address
- eNB Username
- eNB Password
- eNB Repository
- eNB Branch
- eNB Commit ID
- EPC IP Address
- EPC Username
- EPC Password
- ADB IP Address
- ADB Username
- ADB Password

Functions
- Trigger
- Control
- Log Collection
- Alarm Notification
- Terminate Processes

Python File

Basic Test Patterns
- eNB Initialization
- EPC Initialization
- UE Initialization
- eNB Termination
- EPC Termination
- UE Termination
- UE Detach
- UE Attach
- ping
- iperf3

XML File

Various Test Cases
- 010101 Build eNB (USRP)
- 010201 Build eNB (BladeRF)
- 030101 Initialize eNB (FDD/Band1/5MHz/info)
- 030104 Initialize eNB (TDD/Band38/5MHz/info)
- 030107 Initialize eNB (FDD/Band3/5MHz/info)
- 040301 Attach UE
- 040401 Detach UE

Order of Test Cases
- 040101 050101 060101 070101 030107 040301 040502 040603 040643 040401 040301 040401 040301 040501 040201 030201 070201 060201 050201

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Jenkins (Declarative Pipeline)

Environments (Parameters)

- eNB IP Address
- eNB Username
- eNB Password
- eNB Repository
- eNB Branch
- eNB Commit ID
- EPC IP Address
- EPC Username
- EPC Password
- ADB IP Address
- ADB Username
- ADB Password

Functions

- Trigger Control
- Log Collection
- Alarm Notification
- Terminate Processes

Python File

Basic Test Patterns

- eNB Initialization
- EPC Initialization
- UE Initialization
- eNB Termination
- EPC Termination
- UE Termination
- UE Detach
- UE Attach
- ping
- iperf3

Functions

- Log Collection
- Time Stamp

XML File

Various Test Cases

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- 030101 Initialize eNB (FDD/Band1/5MHz/info)
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- 040201 030201 070201 060201 050201
- perf3

Order of Test Cases

- 040101 050101 060101 070101 030107 040101 040502 040603
- 040643 040401 040301 040401 040301 040401 040501
- 040201 030201 070201 060201 050201

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Demonstration①
Demonstration

Configuration

Typical Configuration

- FUJITSU PRIMERGY (Xeon 2.4GHz/14cores/35MB)
- OAI-eNB
- USRP X310
- SDR
- COTS-UE
- ADB
- Jenkins

Today's Configuration

- FUJITSU PRIMERGY (Xeon 2.4GHz/14cores/35MB)
- OAI-EPC
- MME / SP-GW / HSS
- SDR
- COTS-UE
- ADB
- Jenkins

※ Amazon Price (2018/06/18)

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1. Start Jenkins manually
2. Initialize 2UEs (Confirm they are in Airplane Mode ON)
3. Initialize EPC (HSS / MME / SP-GW)
4. Initialize eNB
5. Attach 2UEs (Airplane Mode OFF)
6. Ping to 2UEs (for 10sec)
7. iperf3 to 2UEs (DL for 10 sec)
8. iperf3 from 2UEs (UL for 10 sec)
9. Detach ➔ Attach × 3 times
10. Ping to 2UEs (for 10sec)
11. Terminate 2UEs (Flight Mode ON)
12. Terminate eNB / SP-GW / MME / HSS
13. Log Collection of eNB / SP-GW / MME / HSS / ping / iperf3
Technical Design and Implementation in CI
ADB (Android Debug Bridge)

- Count the number of UEs and retrieve UE’s device IDs
  - `adb devices`

- Retrieve IP Addresses of UEs
  - `adb -s DEVICEID shell ip addr show`

- Airplane Mode OFF
  - `adb -s DEVICEID settings put global airplane_mode_on 0`
  - `adb -s DEVICEID am broadcast -a android.intent.action.AIRPLANE_MODE --ez state false`

- Airplane Mode ON
  - `adb -s DEVICEID settings put global airplane_mode_on 1`
  - `adb -s DEVICEID am broadcast -a android.intent.action.AIRPLANE_MODE --ez state true`
Calculation for suitable values

**Timer duration**

- CI script is waiting for appearing of the expected strings when ping and iperf3, but the timeout duration value is automatically calculated from the value in ping/iperf3 arguments.
  - ex. ping -c 10 ➞ T.O. value is 10 sec x 3 = 30 sec

**iperf3**

- iperf3’s bitrate is automatically calculated (Given bitrate is going to be divided by the number of UEs).
  - ex. 12Mbps system throughput ➞ iperf3 -b 6M (in case of 2 UEs)
    - iperf3 -b 4M (in case of 3 UEs)
Colorful Console Output


All UE operations are done in parallel.
Technical Design and Implementation in CI

Exclusive Lock while Log Output

**w/o Exclusive Lock**

Packet Loss : 0%

RTT(Min) : 22.874 ms
RTT(Avg) : 32.363 ms
RTT(Max) : 101.017 ms

**w/ Exclusive Lock**

Packet Loss : 0%

RTT(Min) : 17.867 ms
RTT(Avg) : 31.129 ms
RTT(Max) : 98.128 ms

Mixed Up
Simultaneous Termination and Log Collection

- Termination processes and Log Collection processes should be executed after the test regardless of the test result.

- All Termination and Log Collection processes are now parallelized.
Speedup Jenkins Process

Jenkins Option Changed

(MAX_SURVIVABILITY ➔ PERFORMANCE_OPTIMIZED)

Reduce disk I/O
Commit ID can be specified

- You can specify the Commit ID for eNB to be tested.

- This parameter is optional. If it’s blank, the latest one will be tested.
Technical Design and Implementation in CI

**password for ssh and sudo**

**Jenkins** | **Python** | **XML**

- **How to make SSH connection without being asked about password?**
  - `sshpass -p PASSWORD ssh USERNAME@HOSTNAME`

- **How to “sudo” without being asked about password?**
  - `echo PASSWORD | sudo -S ./run_hss`

- **How to hide these Credential information in Jenkins log?**

```python
withCredentials([
    [class: 'UsernamePasswordMultiBinding',
     credentialsId: "${params.eNB_Credentials}",
     usernameVariable: 'Username',
     passwordVariable: 'Password']
]) {
    sh "echo Password | sudo -S ./run_hss &"
}
```

```bash
```

```bash
```
To be more precise, iperf is version 2 but it's already obsolete.

The latest iperf is iperf3 (version 3.5).

Very easy to switch DL/UL traffic direction

```
iperf
ue\$ iperf -s
epc\$ iperf <UE_IP> -u -b 6M -t 60 -i 1

ue\$ Ctrl-C
epc\$ iperf -s
ue\$ iperf <EPC_IP> -u -b 2M -t 60 -i 1

iperf3
ue\$ iperf3 -s
epc\$ iperf3 <UE_IP> -u -b 6M -t 60 -i 1

epc\$ iperf3 <UE_IP> -u -b 2M -t 60 -i 1 -R
```
Technical Design and Implementation in CI

**Timestamp**

- **Jenkins**
- **Python**
- **XML**

- 2 timestamps added.

- Jenkins Console Log Output (timestamp plugin)

- eNB/EPC log files

```bash
./run_hss 2>&1 | awk '{ print strftime("[%Y/%m/%d %H:%M:%S] ", systime()) $0 }' | tee -a hss.log
./run_mme 2>&1 | awk '{ print strftime("[%Y/%m/%d %H:%M:%S] ", systime()) $0 }' | tee -a mme.log
./run_spgw 2>&1 | awk '{ print strftime("[%Y/%m/%d %H:%M:%S] ", systime()) $0 }' | tee -a spgw.log
./lte-softmodem 2>&1 | awk '{ print strftime("[%Y/%m/%d %H:%M:%S] ", systime()) $0 }' | tee -a enb.log
```

**enb.log**

- [2018/05/28 17:21:15] [MAC][I][cancel_ra_proc] [eNB 0][RAPROC] CC_id 0 Frame 577 Canceled RA procedure for UE rnti 9ef5
- [2018/05/28 17:21:16] [MAC][I][cancel_ra_proc] [eNB 0][RAPROC] CC_
- [2018/05/28 17:21:16] In extract_harq() /home/fujitsu/smbshare/work_sawaken/CI/master/openair2/LAYER2/MAC/eNB_scheduler_primitives.c:4012
- [2018/05/28 17:21:16] Got ACK/NAK for inactive harq_pid 0 for UE 0/bd5a
- [2018/05/28 17:21:16] Exiting execution
Demonstration②
1. Get the latest scripts
2. Copy & Paste Jenkinsfile
3. Modify Jenkinsfile (IP Address, Username, Password etc.)
4. Run Jenkins one time (failed)
5. Copy & Paste Python File and XML File
6. **Modify XML File to create a new test suite.**
7. Run Jenkins
8. Check the Jenkins Output Console
9. Check the eNB/EPC log files
## Define Your Test Cases

### Test Case List

<table>
<thead>
<tr>
<th>testCase id</th>
<th>class</th>
<th>desc</th>
<th>Option</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td></td>
<td>Initialize</td>
<td>Initialize_eNB</td>
<td>right mode off, wait for maximum 180 sec until mStateConnectedState becomes 2.</td>
</tr>
<tr>
<td>02</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/C/0MHz/Info)</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/10MHz/Info)</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/10MHz/Info)</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/10MHz/Info)</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/10MHz/Info)</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/10MHz/Info)</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td></td>
<td>Initialize_eNB</td>
<td>Initialize_eNB (FDD/Band1/10MHz/Info)</td>
<td></td>
</tr>
</tbody>
</table>

### Diagram

The diagram illustrates the process of attaching and detaching a UE, along with perf tests. The perf tests include scenarios such as `iperf3` and `ping` operations with various parameters like `iperf3 -s` in UE before initializing `iperf3` and `iperf3 -s` in UE after initializing `iperf3`. The diagram also shows the interaction with eNB and EPC networks.
ToDo List for CI
Update our workflow

- Couple of test cases will be automatically executed immediately after Merge Request, which helps reviewers. **Update will be expected at the end of July**
- Nightly tests will be executed to improve quality / stability of OAI.

Integrate with various tools.

- Slack / Mattermost
- Code Coverage Tool
- Code Static Analysis Tool

Support Simulators

- Manual (Documentation)
Summary
Summary
What you have learned today

- The reason why we need CI
- CI’s concept and architecture
- CI’s technical advantages
- How CI works with Jenkins and Python file and XML file
- How you can setup CI
- How you can modify and customize CI
- Upcoming features