Agenda

• Team Introduction and Task Distribution
• Demo -- Task 1
  • Procedures and Issues faced
• Demo -- Task 2
  • Procedures and Issues faced
• Demo -- Task 3
  • Procedures and Issues faced
• Demo -- Task 4 and 5
  • Procedures and Issues faced
• Conclusion
Team Intro & Task Distribution
TEAM HAWK
## Team Intro & Task Distribution

<table>
<thead>
<tr>
<th>TEAM MEMBERS</th>
<th>TASK ORGANIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akshay Jain</td>
<td>Task 1, Task 5, Presentation</td>
</tr>
<tr>
<td>Alejandro Llorens-Carrodeguas</td>
<td>Task 3, Task 5, Presentation</td>
</tr>
<tr>
<td>Andrés Meseguer Valenzuela</td>
<td>Task 2, Presentation</td>
</tr>
<tr>
<td>Cristina Cervelló-Pastor</td>
<td>Task 3, Task 5, Presentation</td>
</tr>
<tr>
<td>Irian Leyva-Pupo</td>
<td>Task 3, Task 5, Presentation</td>
</tr>
<tr>
<td>Kashif Mehmood</td>
<td>Task 1, Task 4, Presentation</td>
</tr>
</tbody>
</table>

- Kindly note that this is just a broad description. Everyone was somehow involved in all the tasks as we helped each other out. Hence, in a way everyone worked equally.
Task - 1: OAI 5GC deployment using Helm Charts
TEAM HAWK
Demo - Task 1

Helm and Kubernetes Deployment

```
ubuntu@hackfest-microk8s-3:~$ helm list --namespace=oai
WARNING: Kubernetes configuration file is group-readable. This is insecure. Location: /home/ubuntu/.kube/config
WARNING: Kubernetes configuration file is world-readable. This is insecure. Location: /home/ubuntu/.kube/config
NAME      NAMESPACE  REVISION  UPDATED             STATUS   CHART            APP VERSION
amf       oai        1         2021-09-15 13:09:06.968108878 +0000 UTC deployed oai-amf-1.1.0 1.1.0
gnb       oai        1         2021-09-15 13:13:35.645824943 +0000 UTC deployed oai-gnb-0.1.1  v1
mysql     oai        1         2021-09-15 08:21:48.493250725 +0000 UTC deployed mysql-1.6.9  5.7.30
nr-ue      oai        1         2021-09-15 13:14:37.6303161968 +0000 UTC deployed oai-nr-ue-0.1.1 v1
nrf        oai        1         2021-09-15 13:07:07.570519836 +0000 UTC deployed oai-nrf-1.1.0 1.1.0
smf        oai        1         2021-09-15 13:09:51.241910295 +0000 UTC deployed oai-smf-1.1.0 1.1.0
spgwu     oai        1         2021-09-15 13:11:25.046298447 +0000 UTC deployed oai-spgwu-tiny-1.1.2 1.1.2
```

```
ubuntu@hackfest-microk8s-3:~$ kubectl get pods -n oai
NAME                      READY   STATUS      RESTARTS   AGE
oai-nrf-5bcd85fd69-pdlh7   2/2      Running    0          28h
oai-spgwu-tiny-5b5f5f9fd5-fm627 2/2      Running    0          28h
oai-amf-84cd7f6b4c-d262j   2/2      Running    0          28h
mysql-8657dbd58-zmv4r      1/1      Running    0          32h
oai-nr-ue-65957cb6b8-hj247 2/2      Running    0          28h
oai-gnb-ff506cd7-ws5f5    2/2      Running    0          28h
oai-smf-7dd7f99f9-nqlx6    2/2      Running    0          28h
```

© ETSI
Team Hawk -- OAI deployment through OSM hackfest presentation
Demo - Task 1 (Verification and Testing)

5GC Network Connectivity

IP routes under nr-ue pod

Ping test

UE Connectivity
Demo - Task 1 (Issues)

Static IP Configuration for gNB, and NR-UE

- Subnet from the calico network (10.1.115.x)
- Configuration in gNB, NR-UE values.yaml, deployment.yaml.
- Issue related to mismatch and conflict of IPs due to allocation to other CN elements
- Thanks to Sagar and many hours resolved.

RAN & E2E Connectivity

- The same issue with the conflict of IPs and also misconfigured IP in the NR-UE
- NR-UE not able to connect and oaitun_ue1 interface down
- Thanks to Sagar and many hours resolved.
Task 2: OAI 5GC deployment using JuJu-Charms
TEAM HAWK
Installation of Juju

```
$ sudo snap install charmcraft

$ sudo snap install lxd
$ sudo adduser $USER lxd
$ newgrp lxd
$ lxd init --auto

$ sudo snap install juju --classic
```
Get the charms and deploy

```bash
git clone https://github.com/charmed-osm/oai-bundle.git
cd oai-bundle
juju add-model oai-10
./build.sh
juju deploy ./bundle.yaml --trust
```
Demo - Task 2 *(Verification and Testing)*

**Check status**

```
ubuntu@hackfest-microk8s-3:~$/tmp/oai-bundle$ juju status

<table>
<thead>
<tr>
<th>Model</th>
<th>Controller</th>
<th>Cloud/Region</th>
<th>Version</th>
<th>SLA</th>
<th>Timestamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>oai-final-day</td>
<td>micro</td>
<td>microk8s/localhost</td>
<td>2.9.14</td>
<td>unsupported</td>
<td>08:21:47Z</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>App</th>
<th>Version</th>
<th>Status</th>
<th>Scale</th>
<th>Charm</th>
<th>Store</th>
<th>Channel</th>
<th>Rev</th>
<th>OS</th>
<th>Address</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>amf</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-amf</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.96</td>
<td></td>
</tr>
<tr>
<td>db</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-db</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.191</td>
<td></td>
</tr>
<tr>
<td>gnb</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-gnb</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.183</td>
<td></td>
</tr>
<tr>
<td>nr-ue</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-nr-ue</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.120</td>
<td></td>
</tr>
<tr>
<td>nrf</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-nrf</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.95</td>
<td></td>
</tr>
<tr>
<td>smf</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-smf</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.220</td>
<td></td>
</tr>
<tr>
<td>spgwu-tiny</td>
<td>active</td>
<td></td>
<td>1</td>
<td>oai-spgwu-tiny</td>
<td>local</td>
<td></td>
<td>0</td>
<td>kubernetes</td>
<td>10.152.183.196</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Workload</th>
<th>Agent</th>
<th>Address</th>
<th>Ports</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>amf/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>db/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gnrb/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nr-ue/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.109</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nrf/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>smf/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>spgwu-tiny/0*</td>
<td>active</td>
<td>idle</td>
<td>10.1.115.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
● There were no charms for gnb and nr-ue
● IP with ue: Detected a bug, and reported to @David. Also gave some ideas to solve it

ubuntu@hackfest-microk8s-3:~/tmp/oai-bundle$ microk8s.kubectl -n oai-09 logs amf-0 -c amf | less
2021-09-15T14:10:37.259Z [oai_amf] [2021-09-15T16:10:37.259104] [AMF] [amf_n1] [error] An error occurred while connecting to db: Unknown MySQL server host '10.1.115.89:3306' (0)
2021-09-15T14:10:37.259Z [oai_amf] [2021-09-15T16:10:37.259142] [AMF] [amf_n1] [error] Cannot connect to MySQL
0x0000000000000000
2021-09-15T14:10:37.260Z [oai_amf] [2021-09-15T16:10:37.260706] [AMF] [nas_mm] [warn] IE ie_eap_message is not available
2021-09-15T14:10:37.290Z [oai_amf] [2021-09-15T16:10:37.289789] [AMF] [amf_n2] [info] Encoding DOWNLINK NAS TRANSPORT message, sending
InitiatingMessage ::= {
procedureCode: 4
value: DownlinkNASTransport ::= {
protocolIEs: ProtocolIE-Container ::= {
DownlinkNASTransport-IEs ::= {
id: 10
criticality: 0 (reject)
value: 1
}
DownlinkNASTransport-IEs ::= {
id: 85
criticality: 0 (reject)
value: 1037432706
}
DownlinkNASTransport-IEs ::= {
id: 38
criticality: 0 (reject)
value: TE 00 56 02 02 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
}
InitiatingMessage ::= {
procedureCode: 46

Task-3: OAI 5GC deployment and scaling using OSM
TEAM HAWK
**nsd:**
- nsd:
  - df:
    - id: default-df
      vnf-profile:
      - id: oai_k8s_charm-vnf
        virtual-link-connectivity:
        - constituent-cpd-id:
          - constituent-base-element-id: oai_k8s_charm-vnf
            constituent-cpd-id: mgmt-ext
            virtual-link-profile-id: osm-ext
        vnfdf-id: oai_k8s_charm-vnf
    id: oai_k8s_charm-ns
  name: oai_k8s_charm-ns
  version: '1.0'
  virtual-link-desc:
  - id: osm-ext
    mgmt-network: true
  vnfdf-id:
  - oai_k8s_charm-vnf

**vnfd:**
- df:
  - id: default-df
  
  - Scaling aspects
  - ext-cpd:
    - id: mgmt-ext
      k8s-cluster-net: osm-ext
      id: oai_k8s_charm-vnf
    k8s-cluster:
      nets:
      - id: osm-ext
    kdu:
      - name: oai-kdu
      juju-bundle: bundle.yaml
      mgmt-cp: mgmt-ext
      product-name: oai_k8s_charm-vnf
Demo - Task 3 (Procedures)

<table>
<thead>
<tr>
<th>ns instance name</th>
<th>id</th>
<th>date</th>
<th>ns state</th>
<th>current operation</th>
<th>error details</th>
</tr>
</thead>
<tbody>
<tr>
<td>test</td>
<td>7d98dacd-cb37-4060-b8a4-85f605a6f788</td>
<td>2021-09-16T15:58:41</td>
<td>READY</td>
<td>IDLE (None)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

```bash
ubuntu@hackfest-microk8s-3:~$ kubectl get pods -n oai-kdu-7d98dacd-cb37-4060-b8a4-85f605a6f788

<table>
<thead>
<tr>
<th>NAME</th>
<th>READY</th>
<th>STATUS</th>
<th>RESTARTS</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>modeloperator-68b766fffc-5m5bs</td>
<td>1/1</td>
<td>Running</td>
<td>0</td>
<td>92m</td>
</tr>
<tr>
<td>db-0</td>
<td>2/2</td>
<td>Running</td>
<td>0</td>
<td>92m</td>
</tr>
<tr>
<td>nrf-0</td>
<td>3/3</td>
<td>Running</td>
<td>0</td>
<td>91m</td>
</tr>
<tr>
<td>nr-ue-0</td>
<td>3/3</td>
<td>Running</td>
<td>0</td>
<td>91m</td>
</tr>
<tr>
<td>amf-0</td>
<td>3/3</td>
<td>Running</td>
<td>0</td>
<td>91m</td>
</tr>
<tr>
<td>gnb-0</td>
<td>3/3</td>
<td>Running</td>
<td>0</td>
<td>91m</td>
</tr>
<tr>
<td>spgwu-tiny-0</td>
<td>3/3</td>
<td>Running</td>
<td>0</td>
<td>91m</td>
</tr>
<tr>
<td>smf-0</td>
<td>3/3</td>
<td>Running</td>
<td>0</td>
<td>91m</td>
</tr>
</tbody>
</table>
```
 Demo - Task 3 (Procedures)

kdu-resource-profile:
- id: oai5g
  kdu-name: oai-kdu
  resource-name: gnb
  min-number-of-instances: 1
  max-number-of-instances: 3

scaling-aspect:
- id: scale-kdu
  name: scale-kdu
  max-scale-level: 10
  aspect-delta-details:
    deltas:
      - id: kdu-delta
        kdu-resource-delta:
          - id: oai5g
            number-of-instances: 1

```
osm vnf-scale [ns_name] [vnf_name] --scaling-group scale-kdu --scale-out/in
```

```
NAME       READY STATUS  RESTARTS  AGE
modeloperator-68b766fff-5m5bs  1/1   Running  0  8m3s
db-0       2/2   Running  0  7m51s
nrf-0       3/3   Running  0  7m19s
nr-ue-0     3/3   Running  0  7m9s
amf-0       3/3   Running  0  6m59s

```

```
gnb-0     3/3   Running  0  6m49s
spgwu-tiny-0     3/3   Running  0  6m49s
smf-0       3/3   Running  0  6m49s

```

```
gnb-1     3/3   Running  0  76s

```

```
NAME       READY STATUS  RESTARTS  AGE
modeloperator-68b766fff-5m5bs  1/1   Running  0  29m
db-0       2/2   Running  0  19m
nrf-0       3/3   Running  0  19m
nr-ue-0     3/3   Running  0  19m
amf-0       3/3   Running  0  18m

```

```
gnb-0     3/3   Running  0  18m
spgwu-tiny-0     3/3   Running  0  18m
smf-0       3/3   Running  0  18m

```
Demo - Task 3 (Issues)

**Error:** Stage 2/5: deployment of KDUs, VMs and execution environments. 1/2. Errors: Deploying KDU oai-kdu: [Errno 2] No such file or directory: ".". VIM: (progress 0/1)

**Cause:** We were trying to use a k8s repo from OSM.

**Solution:** Include the Juju Bundles inside the VNF package.
TASK 4-5: Automatic Parameter change and scaling
TEAM HAWK
Task 4 and 5: Actions taken

- We explored several options to perform automatic scaling and parameter changes.

- One of the aspects we explored was the part of “scaling policy” in the vnfd, similar to vdus

```
scaling-group-descriptor:
  - name: "cpu_autoscaling_descriptor"
    min-instance-count: 0
    max-instance-count: 10
    scaling-policy:
      - name: "cpu_scaling_policy"
        scaling-type: "automatic"
        cooldown-time: 120
        scaling-criteria:
          - name: "cpu_autoscaling_criteria"
            scale-in-threshold: 20
            scale-in-relational-operation: "LT"
            scale-out-threshold: 80
            scale-out-relational-operation: "GT"
            vnf-monitoring-param-ref: "vnf61_cpu_util"

vdus:
  - count: 1
    vdu-id-ref: vdu01
```

Upon further exploration we did not see that the OSM vnfd model supports similar scaling properties for the kdus.

Is that supposed to be available in a future release?

- Another aspect was to look charms.py and create new actions in the actions.yaml file. The relationship on how the actions.yaml helps in auto-scaling and param change is quite unclear.
Task 4 and 5: Actions taken

- We used David’s scripts to do the oai-gnb scaling

There are two gNBs after executing a scale-out action

Two gNBs connections in the AMF logs
Task 4 and 5: Actions taken

We can see that two gNBs have been scaled -- OSM view
CONCLUSION

TEAM HAWK
CONCLUSIONS

- Achievements: We finished Tasks 1, 2, 3, and 5.
- We learnt quite a bit collectively about deploying a 5GC and testing it, using k8s, juju-charms, and OSM.
- We also learnt to identify the issues and solve them collectively. We would like to mention @Sagar @Maciej @DavidGarcia @Endika specially for helping us throughout this process.
- We identified certain issues as well as suggestions during this entire process:
  - Probably an initial survey on the level of the participants can help in better planning of the resources that need to be made available for the hackfest.
  - The nr-ue has some connectivity issues when deployed through juju-charms and through OSM, we already raised this issue with David and would love to help in anyway possible.
  - We believe that kdu scaling at present is a bit cumbersome. Scaling policy needs to be extended to the kdu similar to vdu, and hence, monitoring params also need to be defined for kdu.
- The most amazing part was: we collaborated and learnt how to function as a team in such a short space of time!
THANK YOU

TEAM HAWK