871780 — MonB5G — ICT-20-2019-2020

Deliverable D6.3
Demonstration of zero touch multi-domain service management

Document Summary Information

Grant Agreement No	871780	**Acronym**	MonB5G
Full Title	Distributed Management of Network Slices in beyond 5G		
Start Date	01/11/2019	**Duration**	42 months
Project URL	https://www.monb5g.eu/		
Deliverable	D6.3 – Demonstration of zero touch multi-domain service management		
Work Package	WP6		
Contractual due date	M42	**Actual submission date**	07/06/2023
Nature	Report	**Dissemination Level**	Public
Lead Beneficiary	CTTC		

TABLE OF CONTENTS

1 Video Release and PoC-1 Summary

MonB5G project has prepared two videos for the first proof of concept, one for each scenario.

1.1 PoC1- Scenario 1

The MonB5G demo architecture consists of a management and orchestration layer and an infrastructure layer. The management layer includes domain management orchestrators, while the infrastructure layer comprises three domains: Radio Access Network, Core Network, and Application Domain. The MonB5G monitoring system gathers information on network slices across domains using containerized components deployed in a cloud-native manner. The demo showcases federated learning for improving virtual reality streaming performance and anomaly detection for early detection and network troubleshooting. The federated learning process involves interactions between administrators, aggregation servers, and analytics engines, with real-time metrics monitored and converged upon completion. Anomaly detection utilizes Docker containers and Long Short-Term Memory models to detect unusual traffic changes across multiple variables. Overall, MonB5G PoC-1 Scenario-1 offers two solutions: Federated learning-based Resource Predictor and anomaly detection for network adaptation.

In the MonB5G demo, a user device connects to a gNodeB, providing access to a Virtual Reality streaming server. MonB5G components, including the monitoring system, analytics engine, decision engine, and actuator, are deployed near the server to predict CPU utilization. The visualization platform utilizes Elasticsearch, Logstash, and Kibana pods to display the federated learning training process. The demo demonstrates the effectiveness of MonB5G forecasting in adapting to virtual reality streaming metrics and how it outperforms a Kubernetes-only solution by triggering scaling actions when CPU usage is about to exceed the pod's limit. The anomaly detection solution offers early detection of unusual traffic changes, providing additional time for network adaptation or troubleshooting.

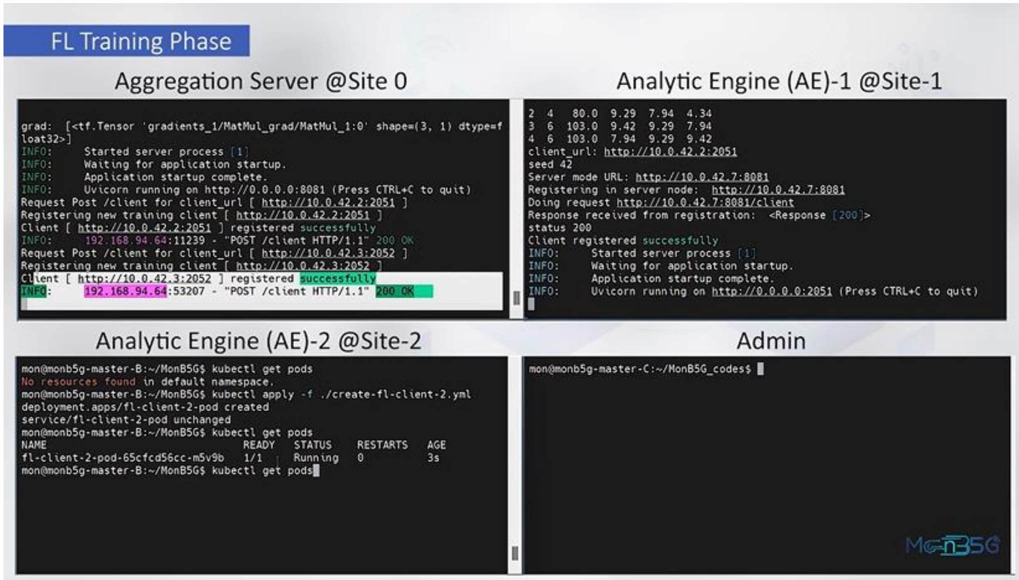
FL Training Phase
Aggregation Server @Site 0
grad: [<tf.Tensor 'gradients_1/MatMul_grad/MatMul_1:0' shape=(3, 1) dtype=float32>]
INFO: Started server process [1]
INFO: Waiting for application startup.
INFO: Application startup complete.
INFO: Uvicorn running on http://0.0.0.0:8081 (Press CTRL+C to quit)
Request Post /client for client_url [http://10.0.42.2:2051]
Registering new training client [http://10.0.42.2:2051]
Client [http://10.0.42.2:2051] registered successfully
INFO: 192.168.94.64:11239 - "POST /client HTTP/1.1" 200 OK
Request Post /client for client_url [http://10.0.42.3:2052]
Registering new training client [http://10.0.42.3:2052]
Client [http://10.0.42.3:2052] registered successfully
INFO: 192.168.94.64:53207 - "POST /client HTTP/1.1" 200 OK
Analytic Engine (AE)-1 @Site-1
2 4 80.0 9.29 7.94 4.34
3 6 103.0 9.42 9.29 7.94
4 6 103.0 7.94 9.29 9.42
client_url: http://10.0.42.2:2051
seed 42
Server mode URL: http://10.0.42.7:8081
Registering in server node: http://10.0.42.7:8081
Doing request http://10.0.42.7:8081/client
Response received from registration: <Response [200]>
status 200
Client registered successfully
INFO: Started server process [1]
INFO: Waiting for application startup.
INFO: Application startup complete.
INFO: Uvicorn running on http://0.0.0.0:2051 (Press CTRL+C to quit)
Analytic Engine (AE)-2 @Site-2
mon@monb5g-master-B:~/MonB5G$ kubectl get pods
No resources found in default namespace.
mon@monb5g-master-B:~/MonB5G$ kubectl apply -f ./create-fl-client-2.yml
deployment.apps/fl-client-2-pod created
service/fl-client-2-pod unchanged
mon@monb5g-master-B:~/MonB5G$ kubectl get pods
NAME READY STATUS RESTARTS AGE
fl-client-2-pod-65cfcd56cc-m5v9b 1/1 Running 0 3s
mon@monb5g-master-B:~/MonB5G$ kubectl get pods
Admin
mon@monb5g-master-C:~/MonB5G_codes$


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Figure 1-1: Video PoC1- Scenario 1 Screen shots

The video can be found on the following link at MonB5G YouTube Channel:

https://www.youtube.com/watch?v=F02zLyhBkpA

1.2 PoC1- Scenario 2

MonB5G PoC-1 Scenario-2 aims to optimize the allocation of radio resources. The Decision Engine sublayer hosts AI-enabled decision agents responsible for resource orchestration in the Radio Access Network. The Monitoring system provides real-time monitoring of key performance indicators and works closely with the Decision Engine in a closed-loop fashion. Each decision agent uses local monitoring information to make resource allocation decisions based on a slice's states. The framework utilizes deep reinforcement learning, with the Double Deep Q-Network agent learning the best resource allocation policy for each slice.

To address the challenge of predicting resource allocation for distributed slices across different gNodeBs, the summary introduces Federated Learning. This approach allows Machine Learning models to be trained across multiple decentralized entities, with each agent having access to limited data realization and statistics. An experiment involving enhanced Mobile Broadband slices and gNodeBs demonstrates the effectiveness of Federated Learning. The visualization dashboard provides real-time metrics for the test scenario, including key performance metrics and agent-specific metrics such as instantaneous reward, allocation gap, and allocated radio resources. The performance of federated slices in gNodeB1 and gNodeB2 outperforms that of non-federated slices. The proposed zero-touch scheme enables OPEX reduction by automating resource allocation for service management without human intervention.

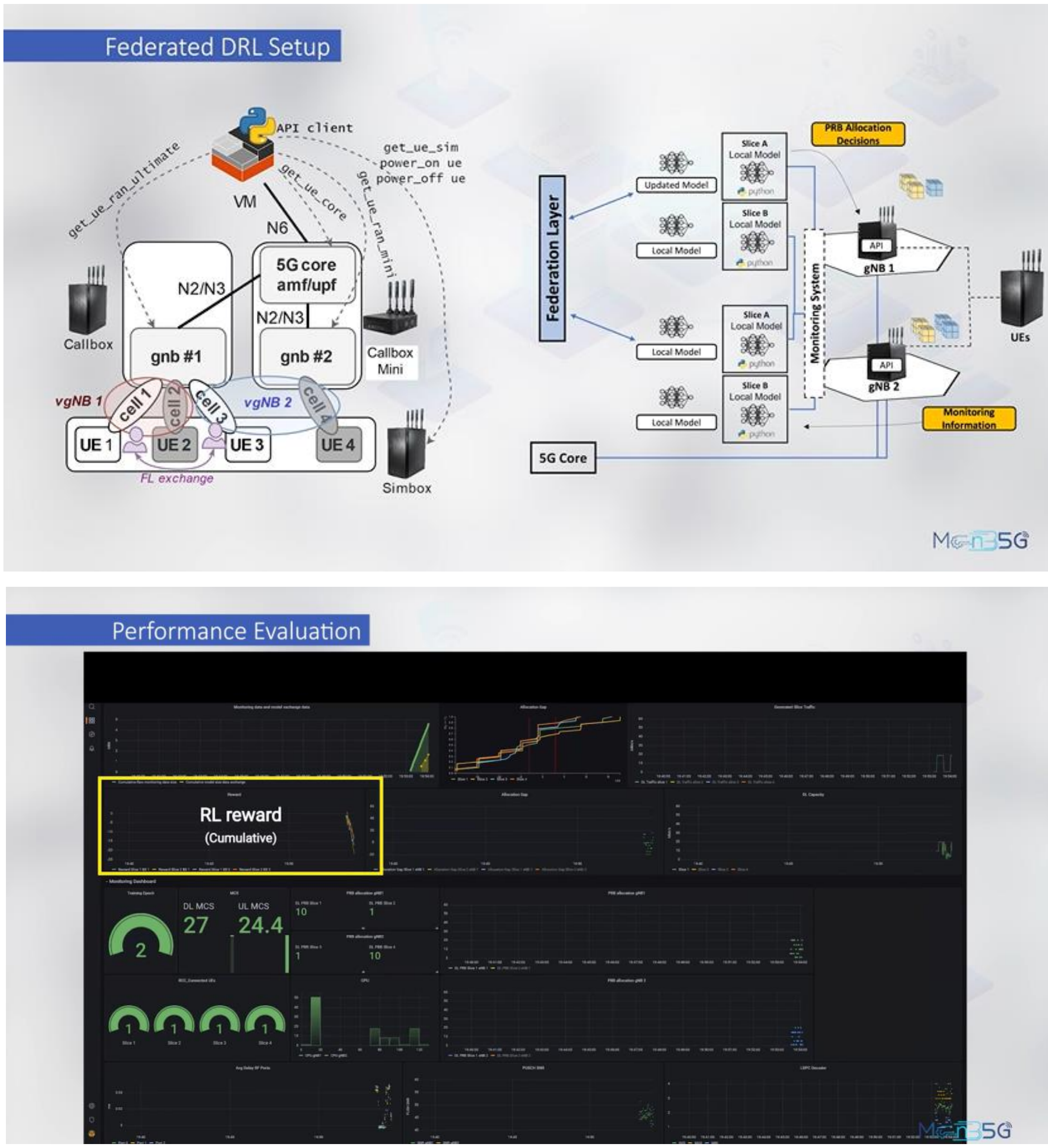

Figure 1-2: Video PoC1- Scenario 1 Screen shots

The video can be found on the following link at MonB5G YouTube Channel:

https://www.youtube.com/watch?v=kOrNwMtXjfg