19-21 JULY 2022, VOLOS, GREECE
SLICES-SC Summer School

SD-Core and Aether Projects An Overview

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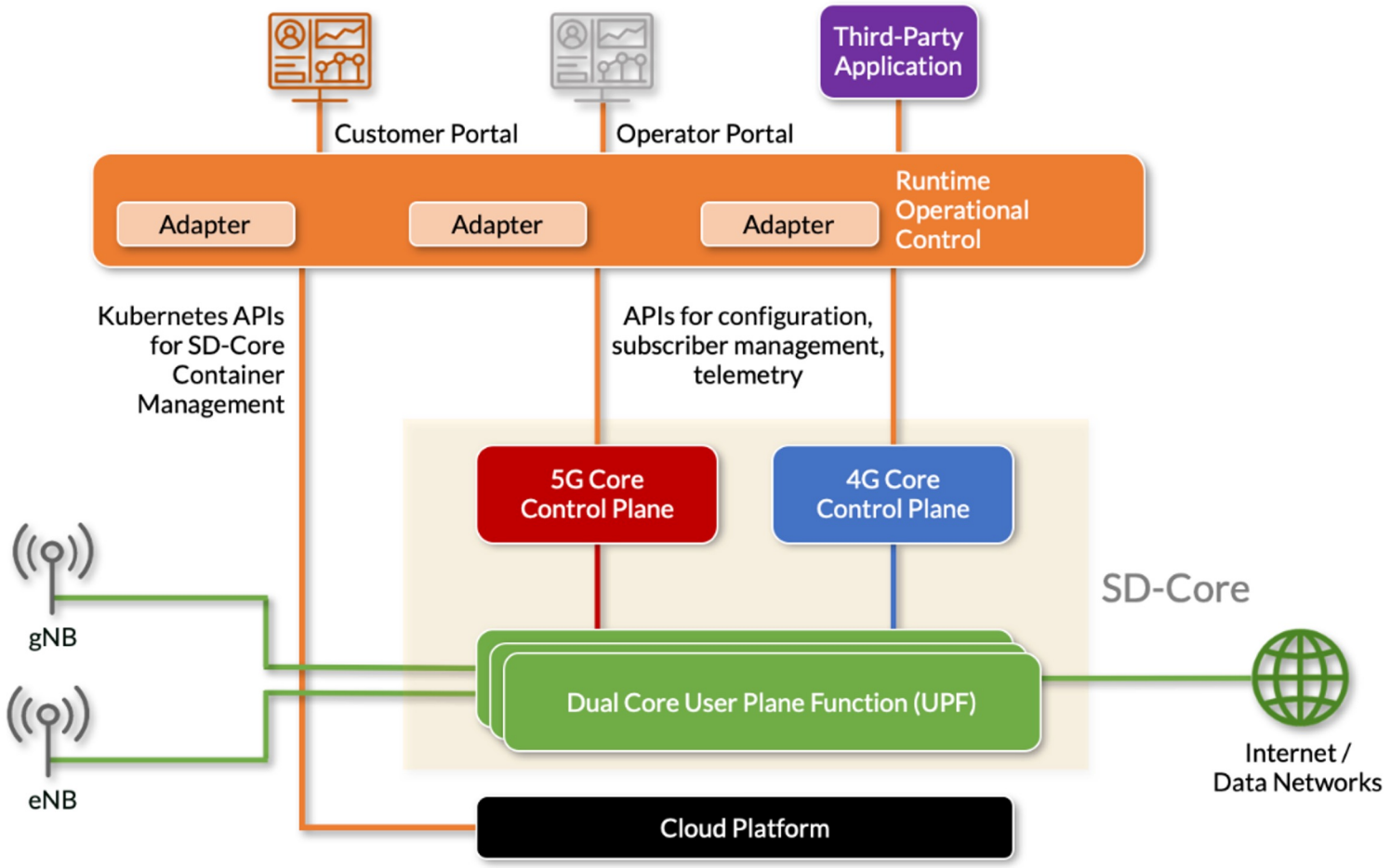
Introduction

A compilation of resources from different presentations
Thanks to all the SD-CORE and Aether teams!

SD-CORE

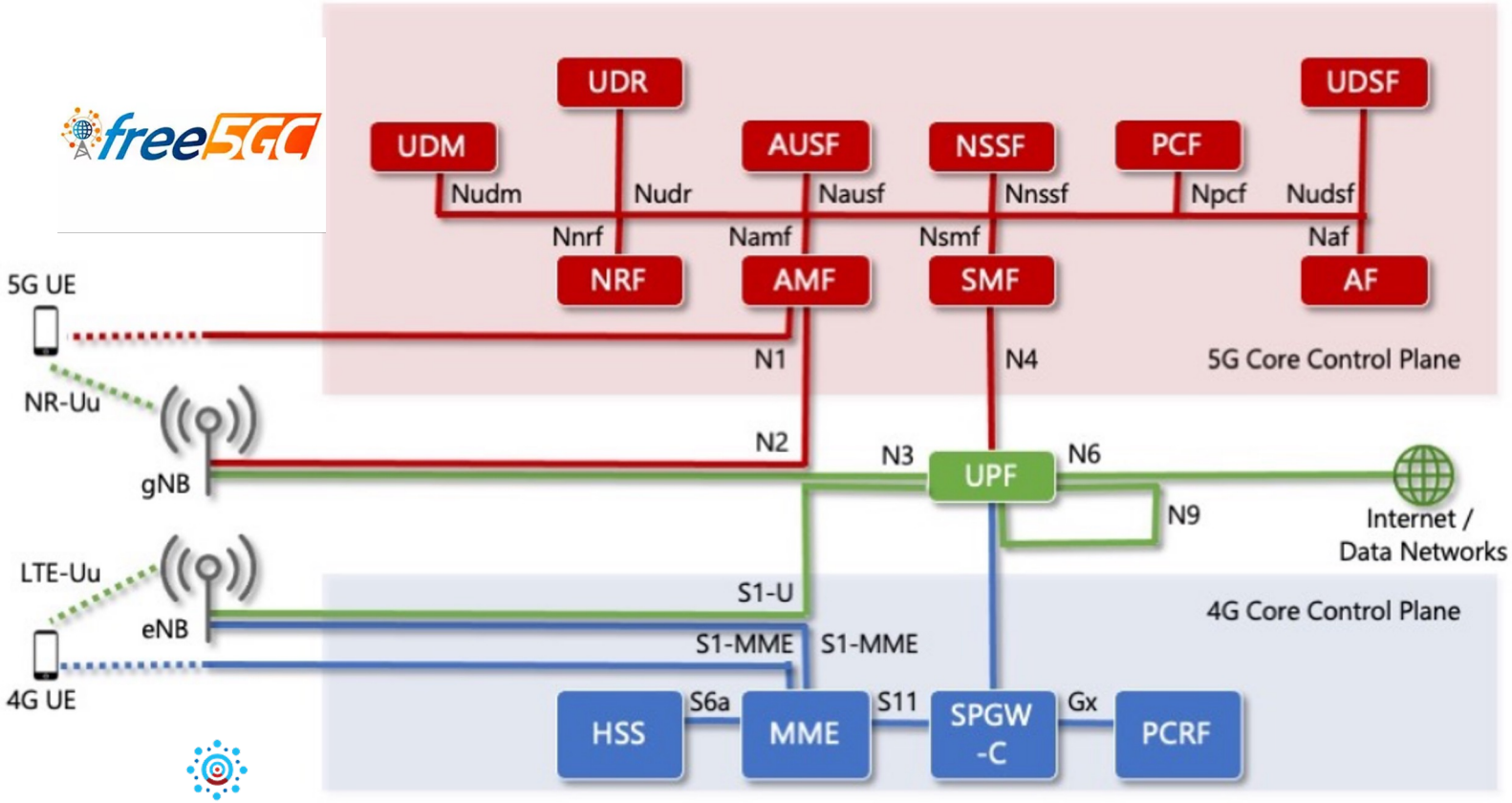
Open Source Dual-Mode 4G/5G Mobile Core
Enabling Connectivity-as-a-Service

Architecture



- Fully disaggregated, composed of containerized components
  4G, 5G Standalone (SA) and 5G Non-Standalone (NSA)
- Configurable in runtime via an extensible set of APIs
- Consumable as a cloud-managed service
- All SD-Core components follow 3GPP standards, i.e., can be consumed independently and be used as part of a multi-vendor mobile core deployment

Detailed Overview

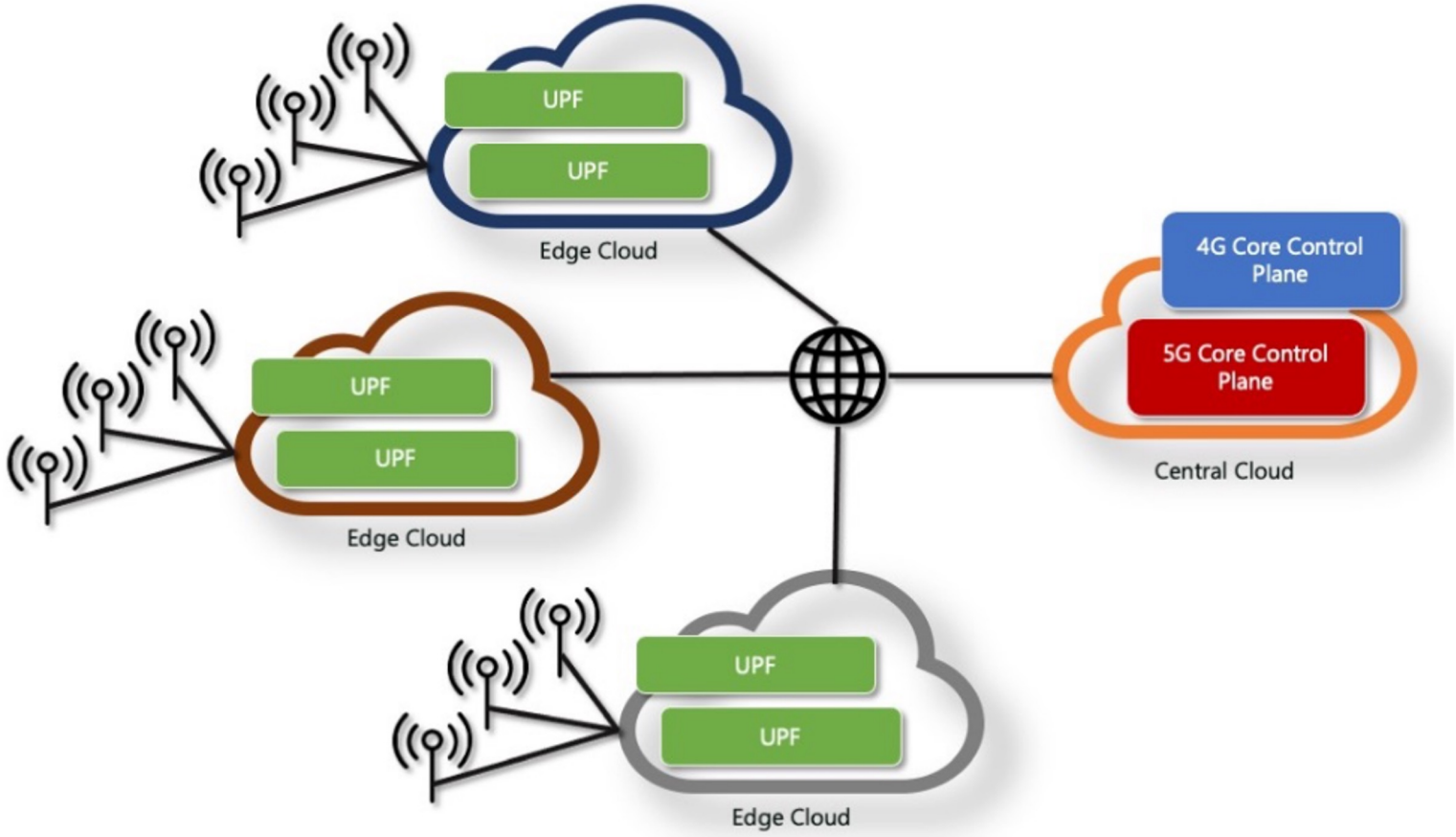


- 4G - Release 13 compliant and selective features from further releases
- 5G - Release 15 compliant and selective features from further releases
- Containerized network functions deployed on K8s using helm charts.

SD-CORE Releases

- SD-Core Releases - 1.0 and 1.1
- SD-Core 1.0 was released December 17, 2021 and was validated on Production
- New documentation site with comprehensive details about SD-Core project
  - Configuration guide
  - Helm Chart versions for releases
  - Developer Guide
  - 3gpp Compliance
  - Release notes
- Detailed release notes
- SD-Core Configuration APIs (4G & 5G)
- Delivering solutions like Application filtering & multi-level QoS metering
- 5G stable version available on Aether Network
- gNB Simulator available for 5G testing

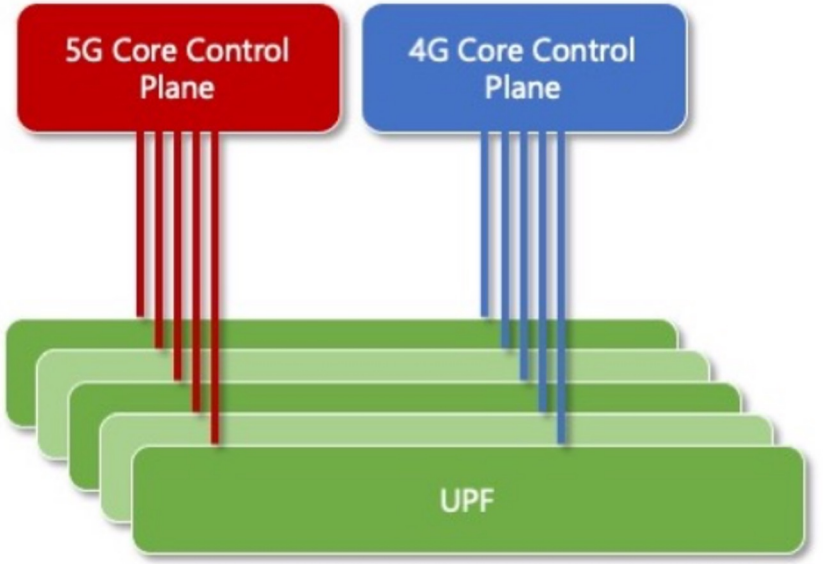
Deployment Options



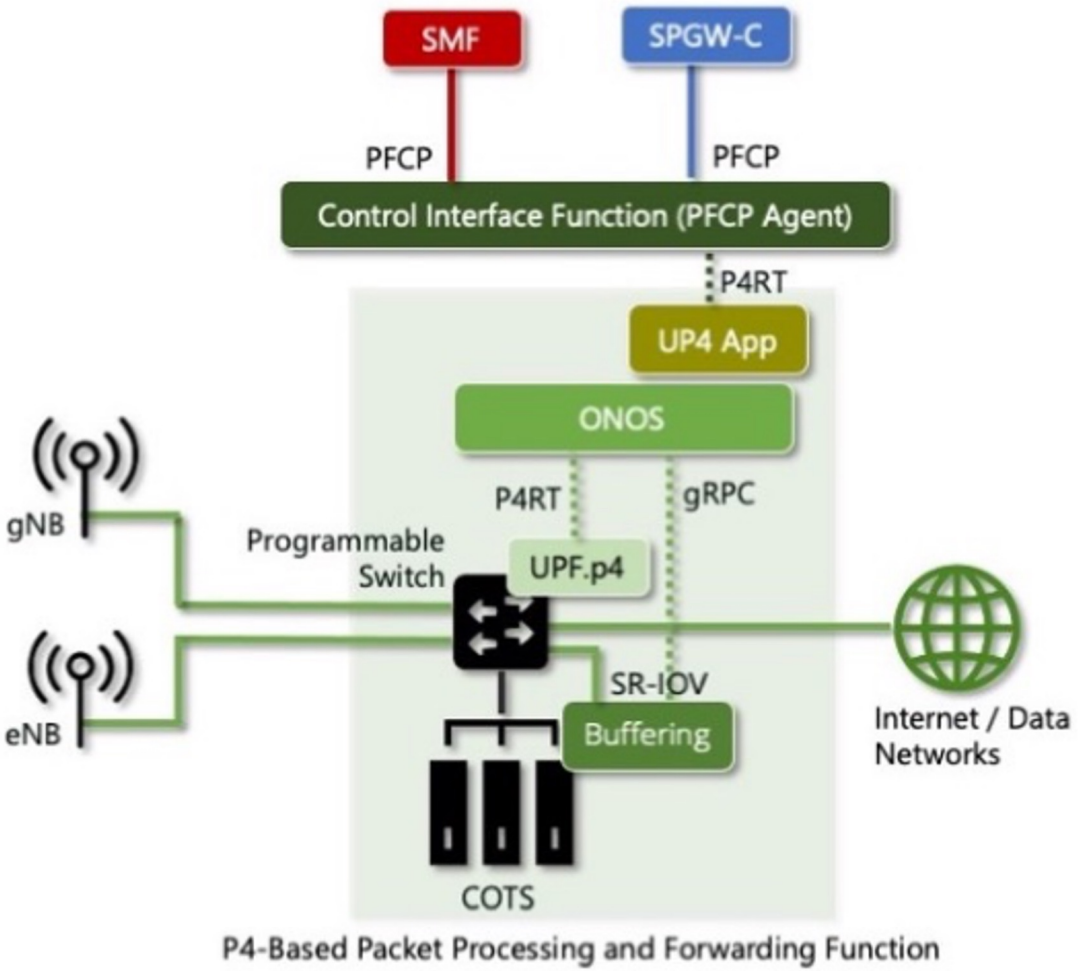
- Control Plane can be deployed on any Public Cloud or at edge
- Each Site has one or more UPFs dedicated for use case.
- CUPS compliant implementation.
- Control Plane & User plane communicate over PFCP protocol.
- Error handling - timeout, retransmission support
- UPFs can be added during runtime and UP/CP form PFCP association
- Edges can go away at any time and appropriate error handling available at control plane
- Edges can run on different versions of UPF.
- Change are always backward compatible
- Option to Install only 4G or 5G or both

Deployment Options

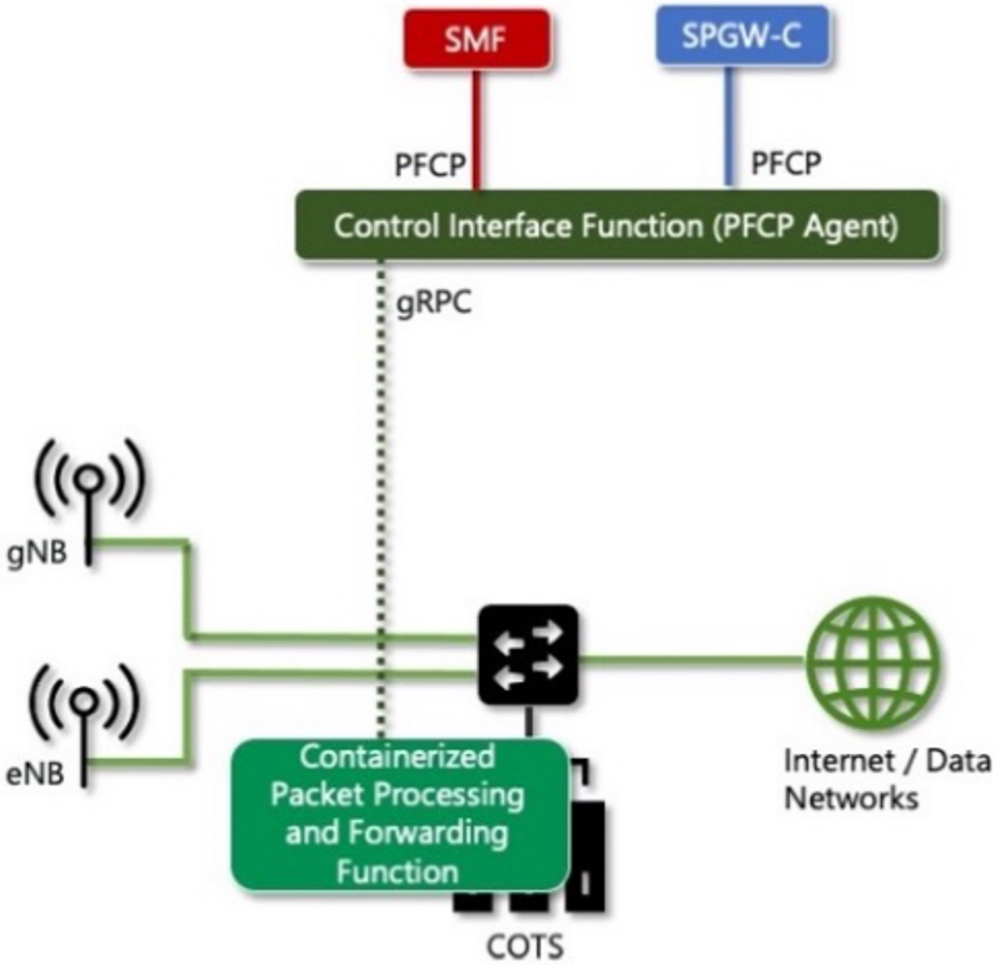
- Multiple UPF (user plane function) options available to meet the needs of different applications
- BESS-UPF, P4-UPF
- BESS UPF can be deployed at the Public Cloud if latency is not the concern or remotely located at edge site. Throughput in 100+ Gbps
- P4 UPF has very high throughput in Tbps
- Many UPFs can connect to same control plane.
- Control Plane selects UPF based on various criteria - DNN/Slice (5G), Apn, IMSI, Slice IDs
- IP address allocation supported at Control plane and also at UPF
- UPF initiated association, PFCP Echo, Session Report
- UPF project is part of ONF's SD-Fabric project



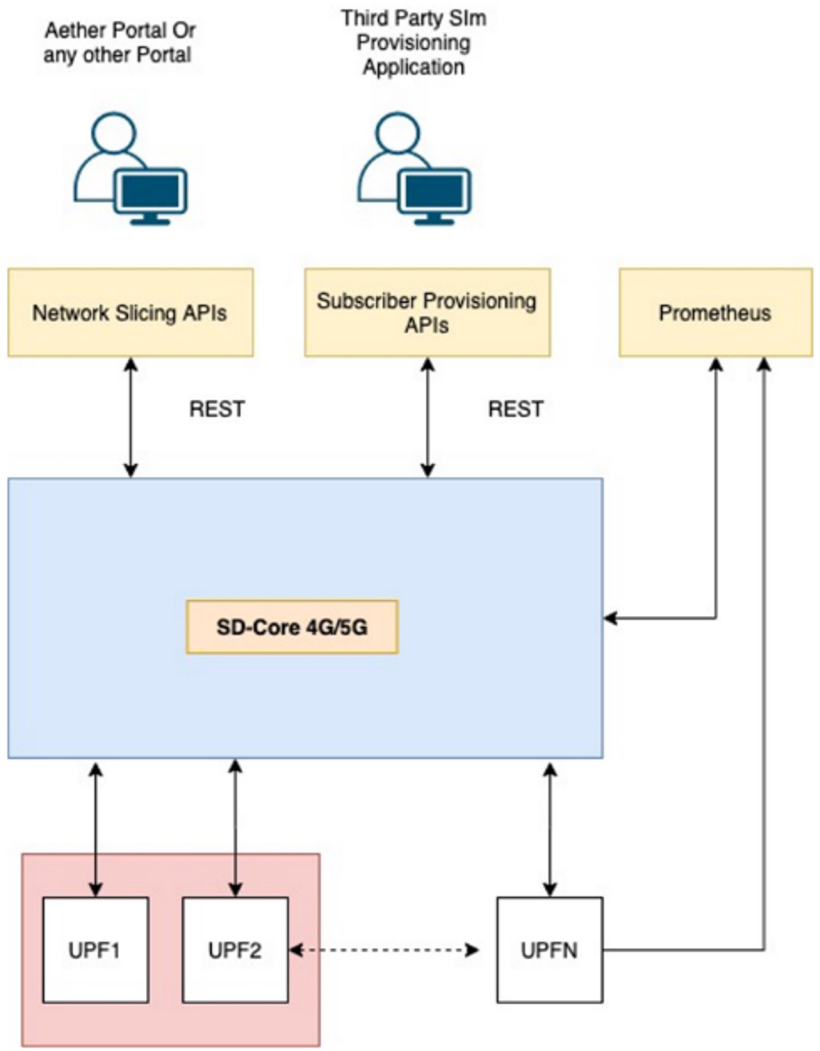
UPF Architecture



P4-Based Packet Processing and Forwarding Function



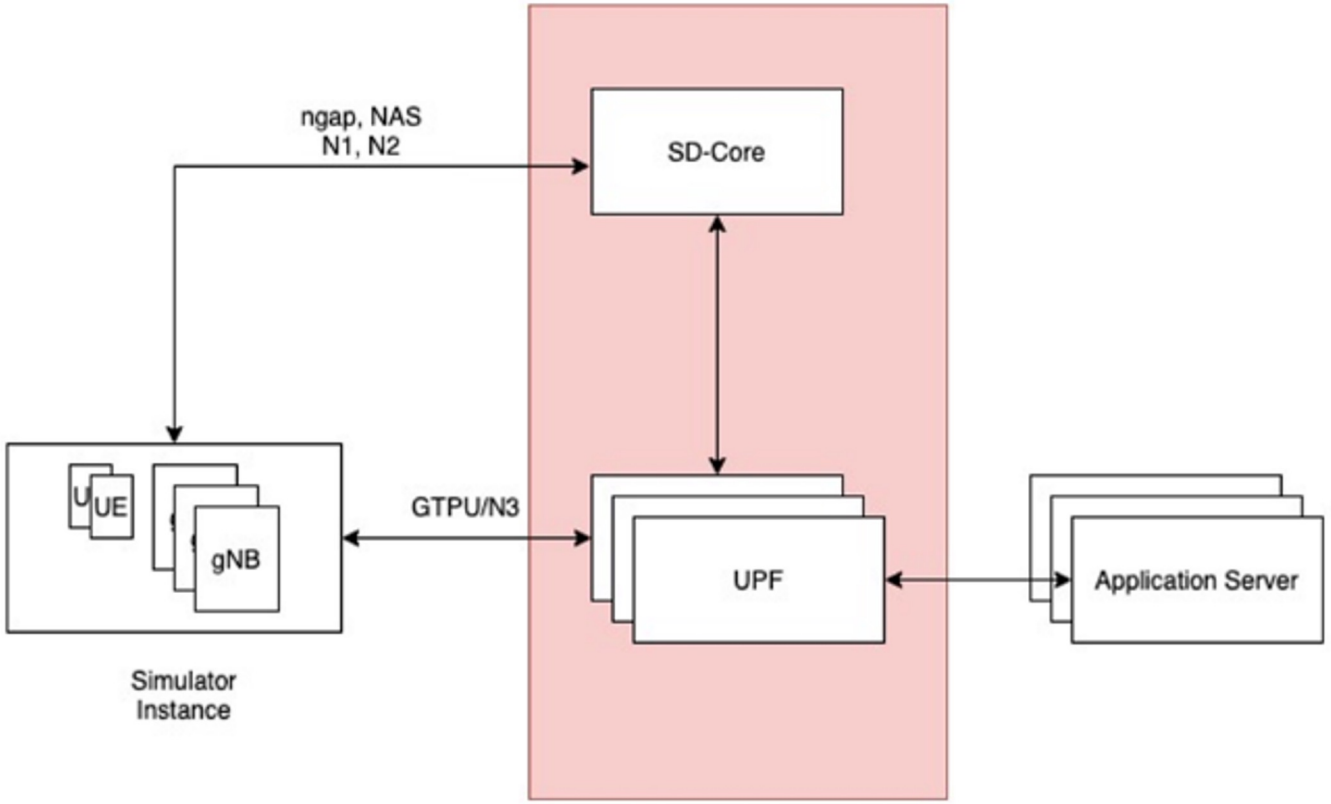
Block Diagram



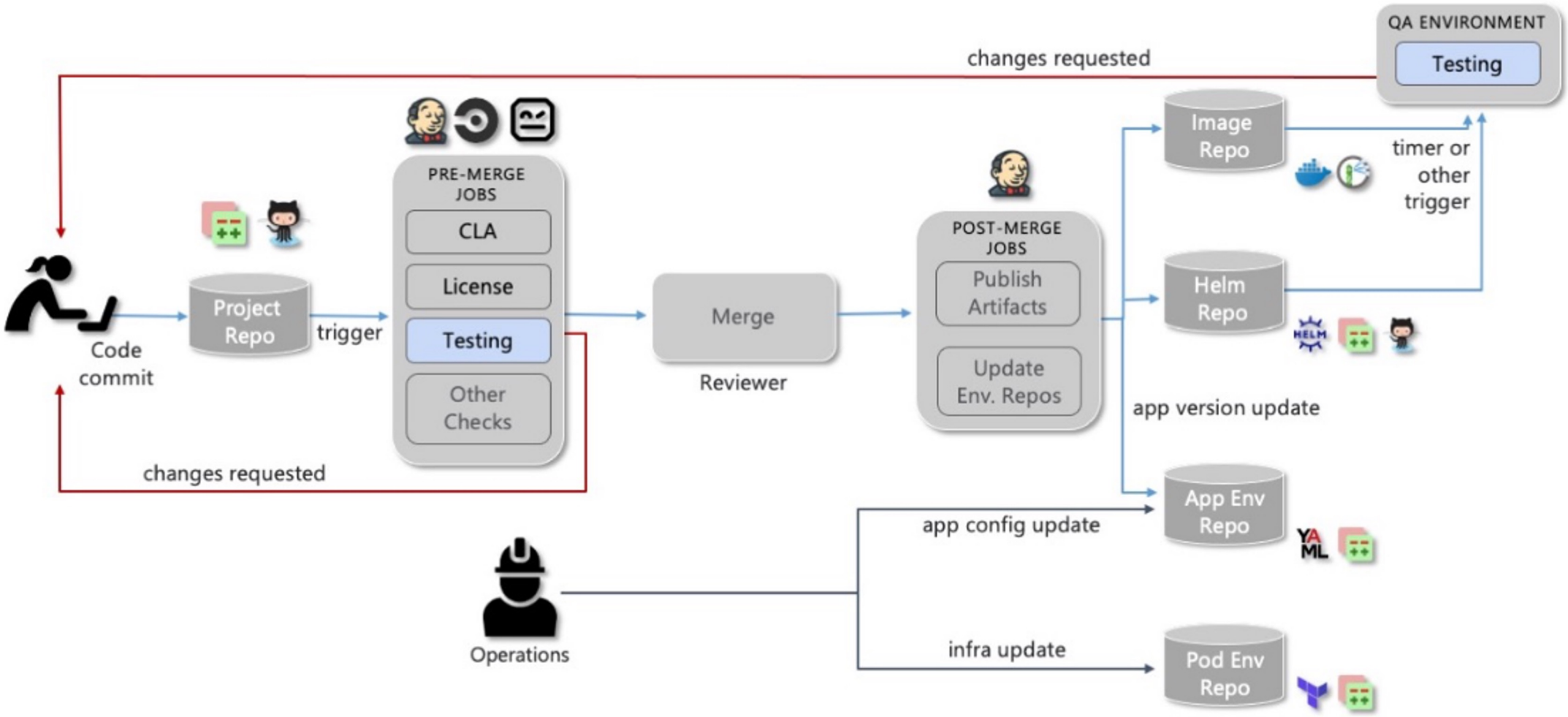
- Subscriber Config API - Add/Remove/Modify subscription
- N/W slice Configuration APIs
  - Add/Update/Delete Slice
  - Same APIs for 4G & 5G
- UPF Attach/detach to SD-Core
  - UPF Pools created based on enterprise need. Work-in-progress on adding/remove UPF PODs while we add/remove slice
- Slice selection to select one of the UPF
- Telemetry KPIs

gNodeB Simulator

- Simulates - UE + gNodeB (control and data plane)
- Containerized
- Easy to run multiple instances
- Designed for automation
- Inbuilt sanity traffic test
- Simulates following 3gpp procedures
  - Registration
  - UE initiated PDU Session Establishment
  - UE Initiated De-registration.
  - AN Release
  - Service Request
  - ICMP Data flow Testing
- Complete documentation available on SD-Core documentation website



CI/CD


QA ENVIRONMENT
Testing
changes requested
Image Repo
timer or other trigger
PRE-MERGE JOBS
CLA
License
Testing
Other Checks
POST-MERGE JOBS
Publish Artifacts
Update Env. Repos
Helm Repo
Project Repo
trigger
Code commit
Merge
Reviewer
app version update
changes requested
App Env Repo
app config update
Operations
infra update
Pod Env Repo

Overall

- Seed Code - free5gc 3.0.5 Version
- Additions by SD-Core
  - Configuration APIs to configure all network functions
  - 5000 subscribers with 10 calls per second stability achieved (Single Instance)
  - Error cases with UPF connectivity fixed
  - Error cases with Network functions restarts fixed
  - Stability issues on NGAP interfaces and N1 interfaces fixed
  - 100+ code commits to achieve code stability
  - 3GPP compliance of 5G core is added in SD core documentation
- Deployment
  - 5G core now available in Aether Network
    - Two edge networks connected to 5G core (FET and NTT)
  - 5G Deployed in SD-RAN trial with 2 Network Slices
    - ORAN compliant RAN + 5G Core

Community and Resources

SD-Core Home Page

SD-Core Whitepaper

SD-Core Wiki

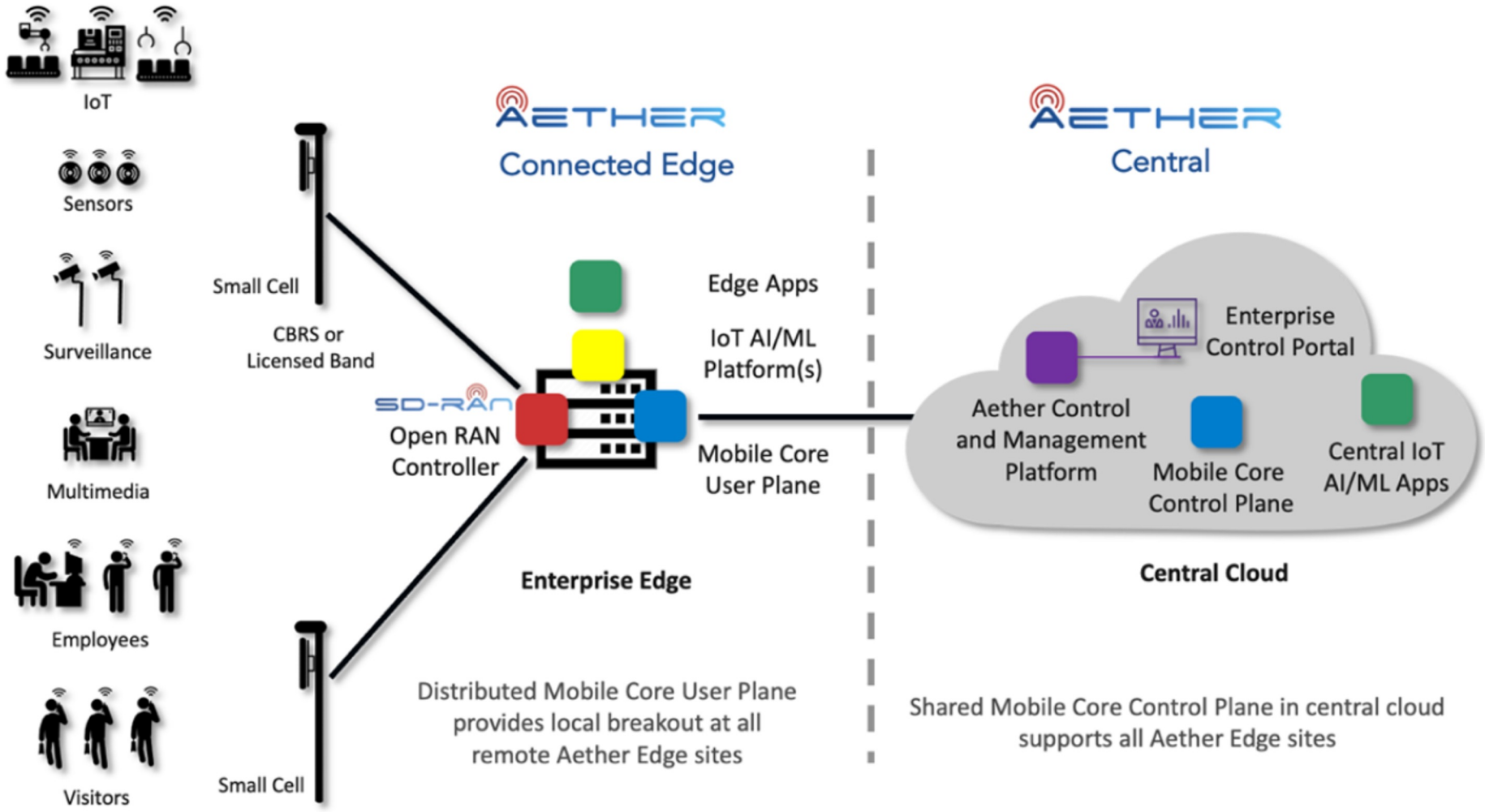
SD-Core 2021 Review

#sdcore-dev channel in ONF Community Slack

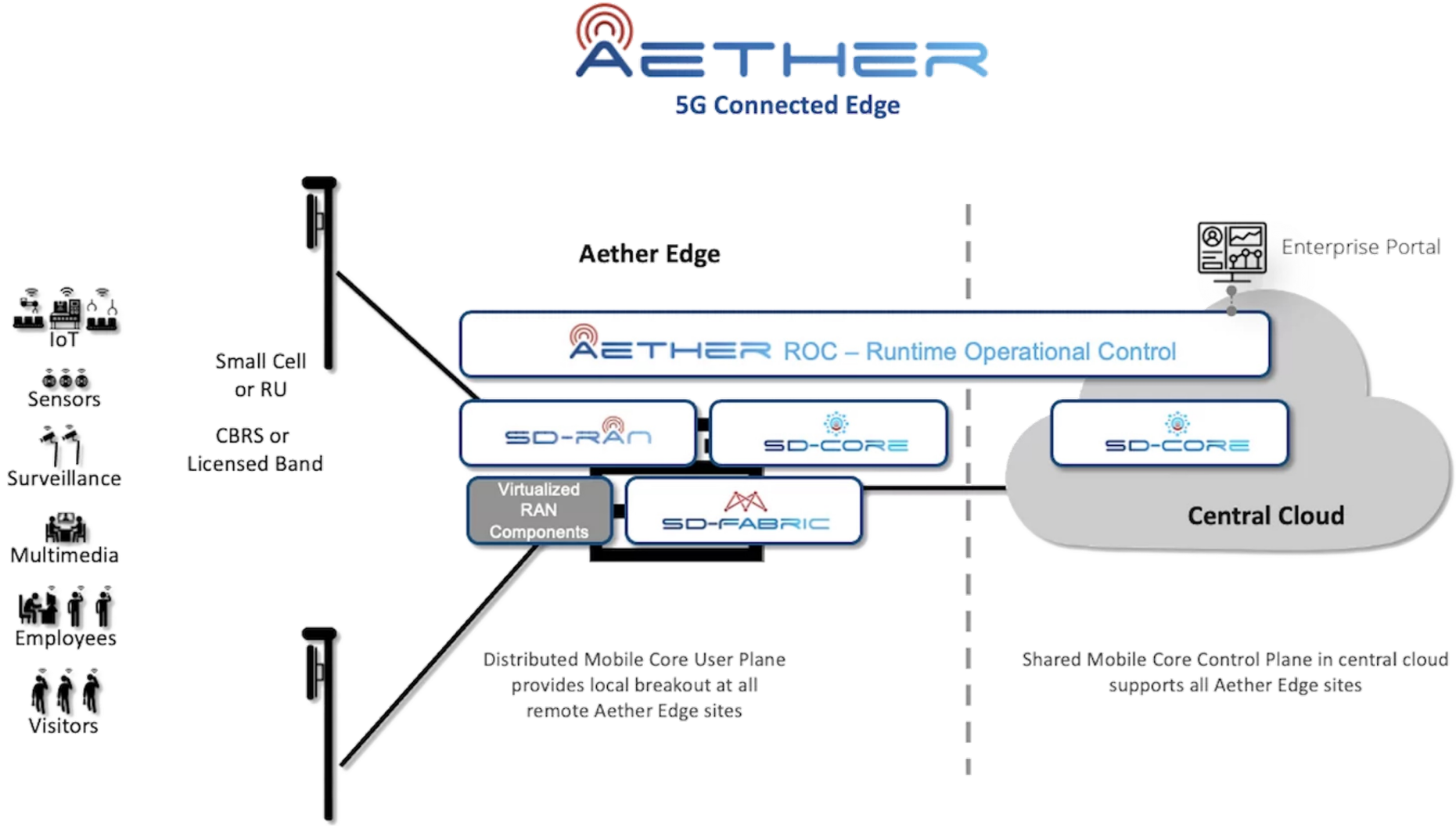
Aether

Enterprise 5G/LTE Edge-Cloud-as-a-Service

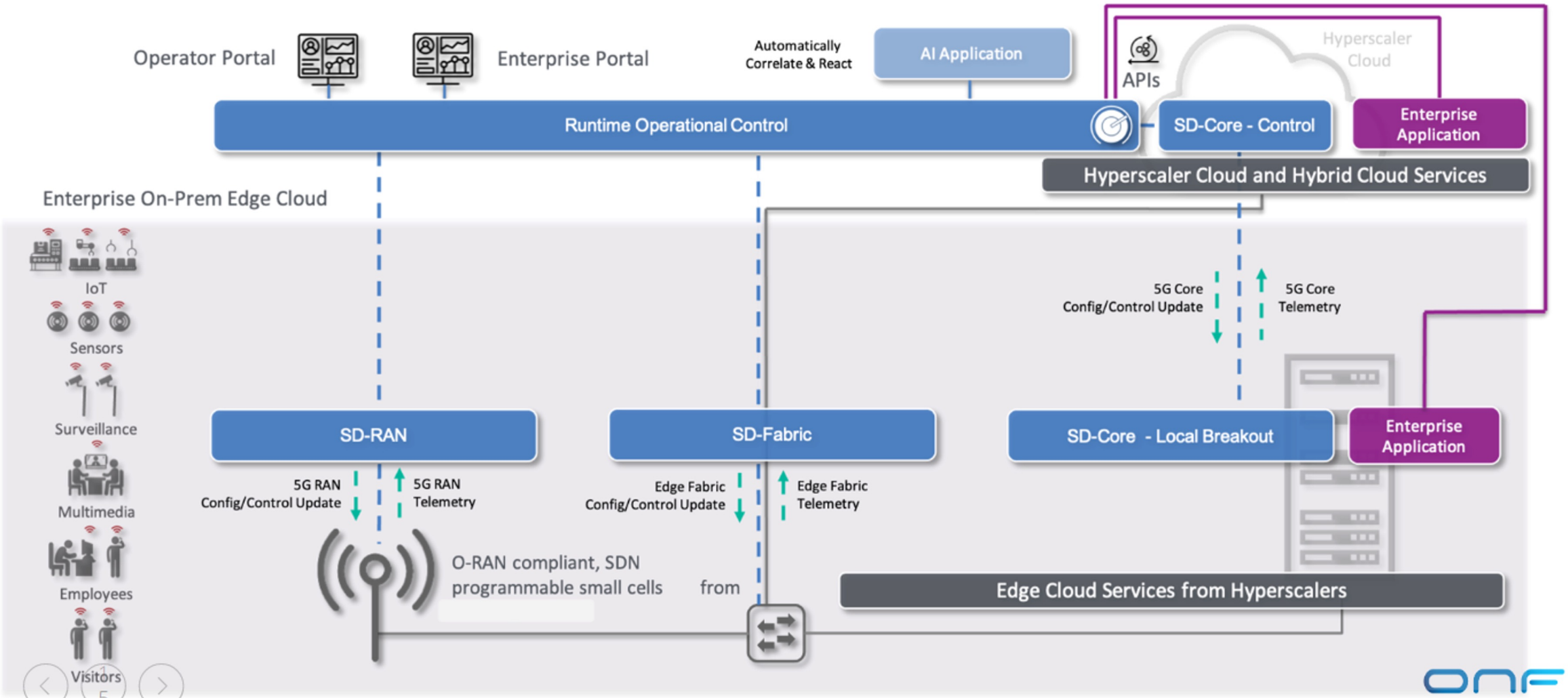
Aether Overview



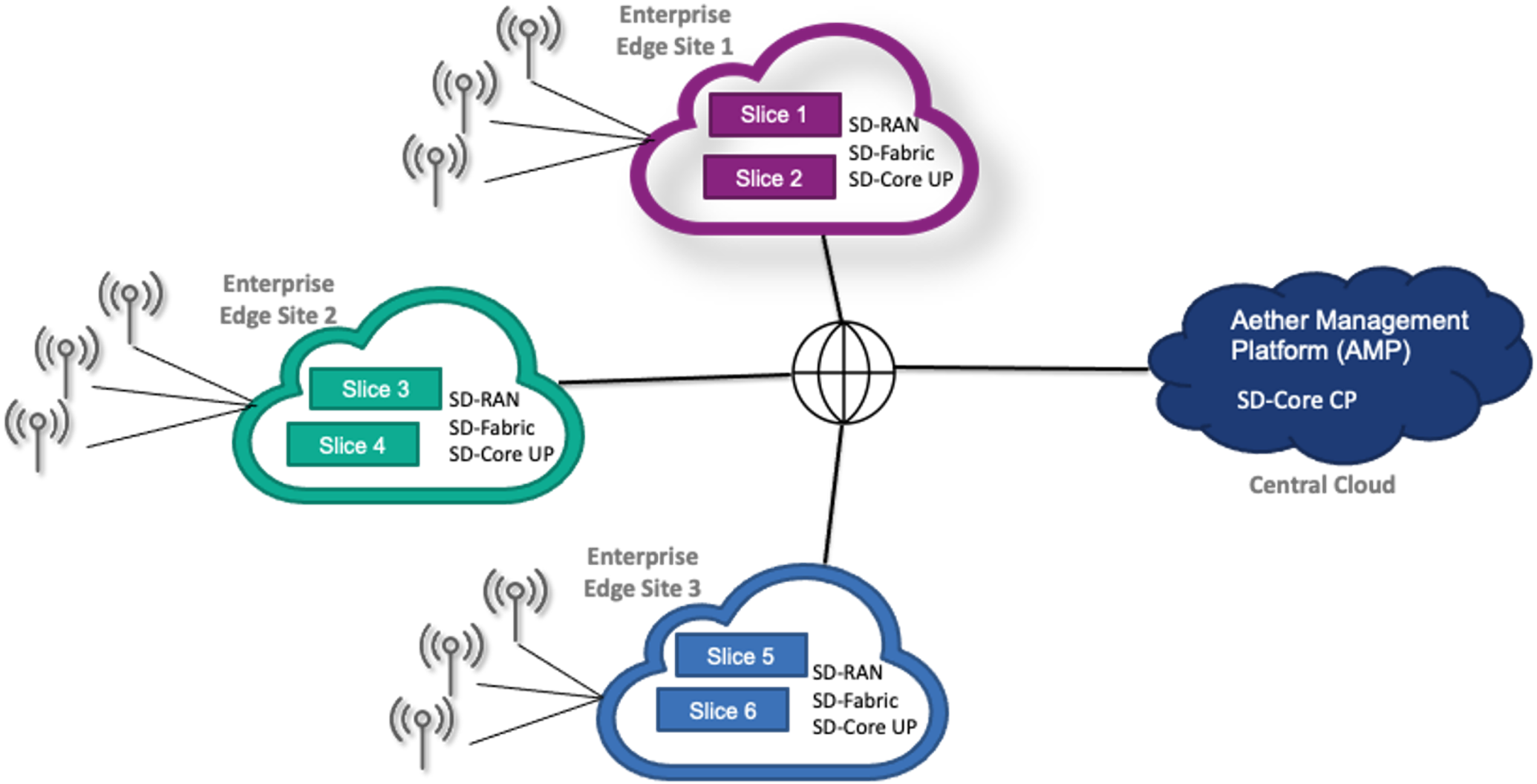
Aether Overview



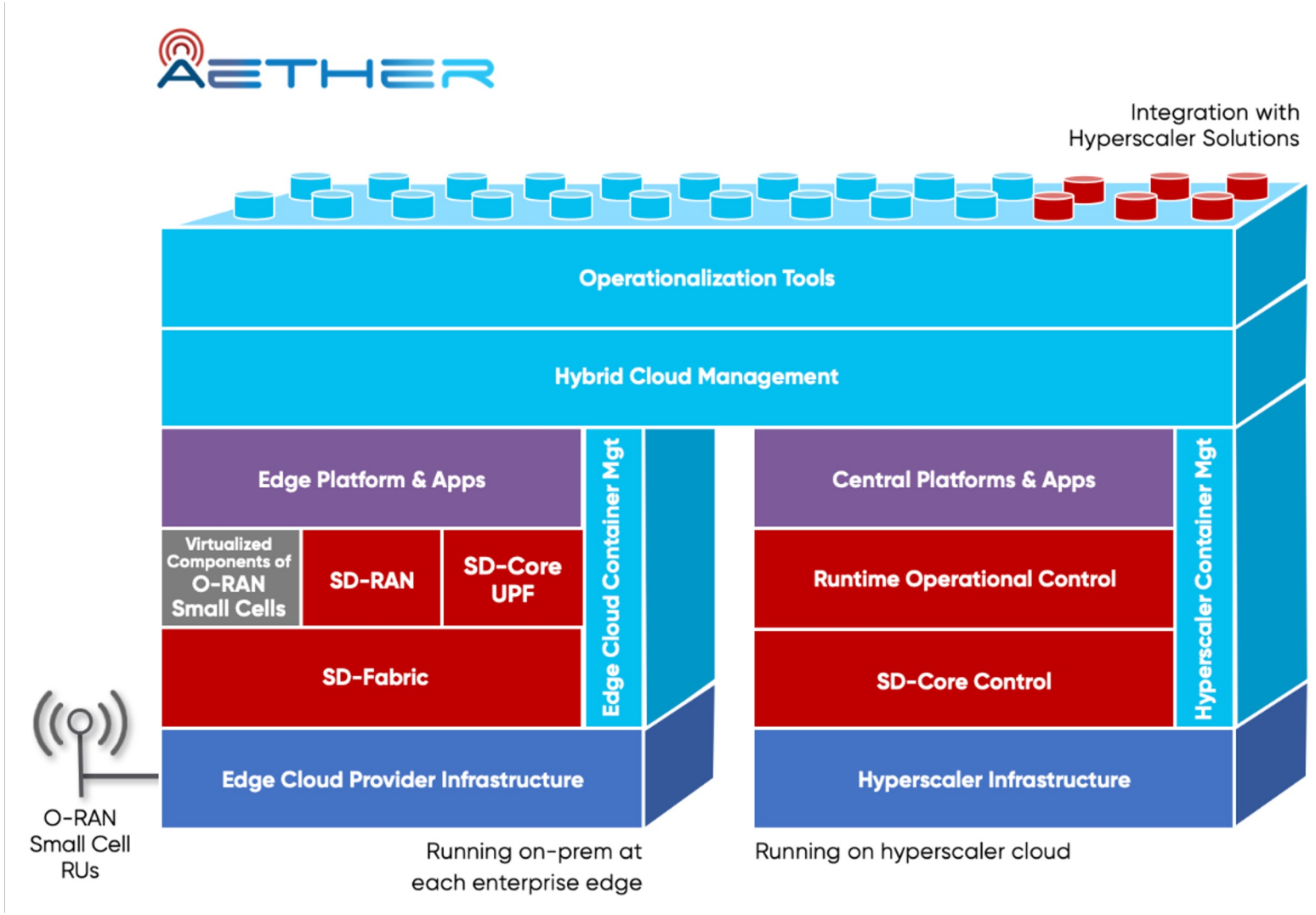
Aether Architecture



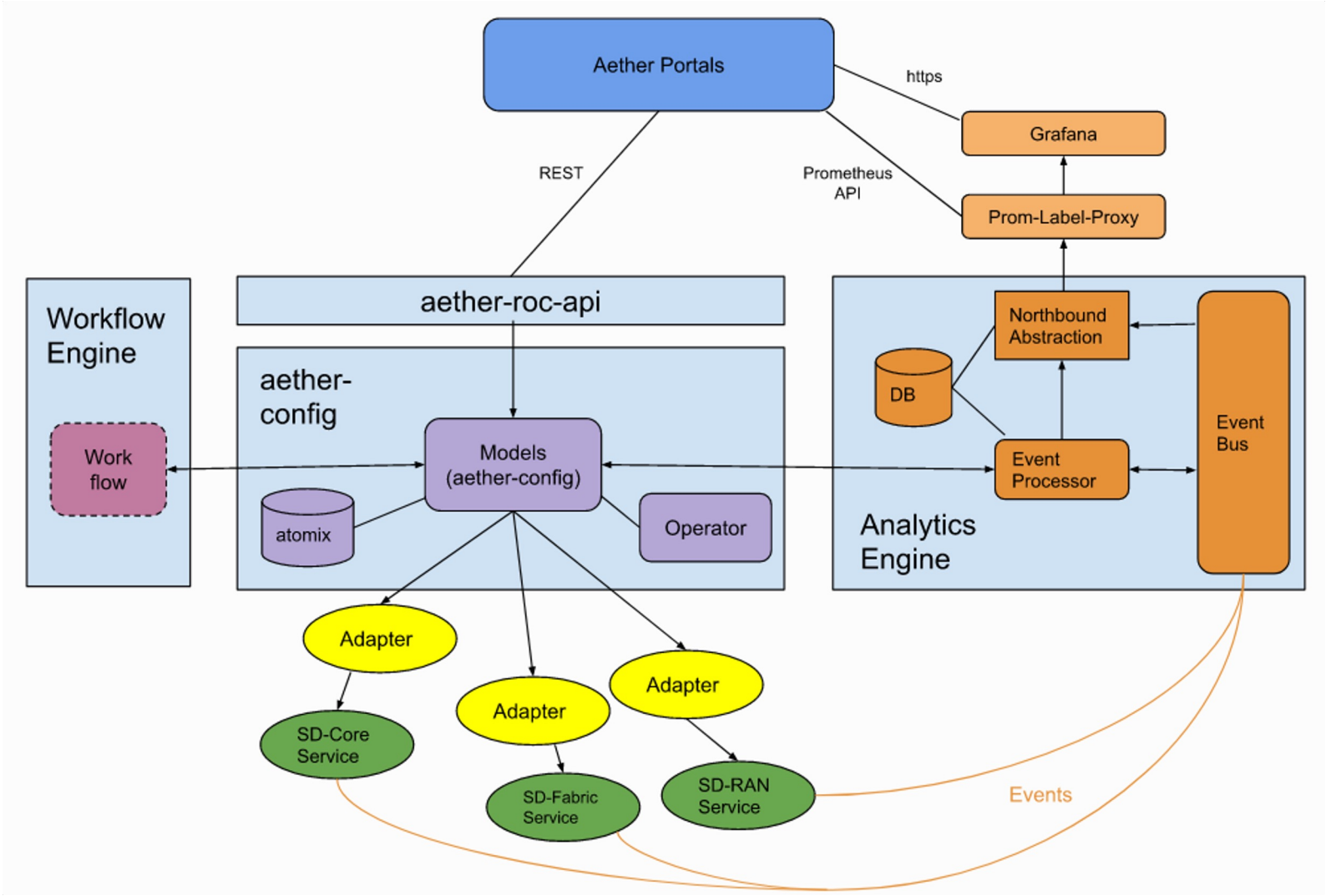
Aether Deployment



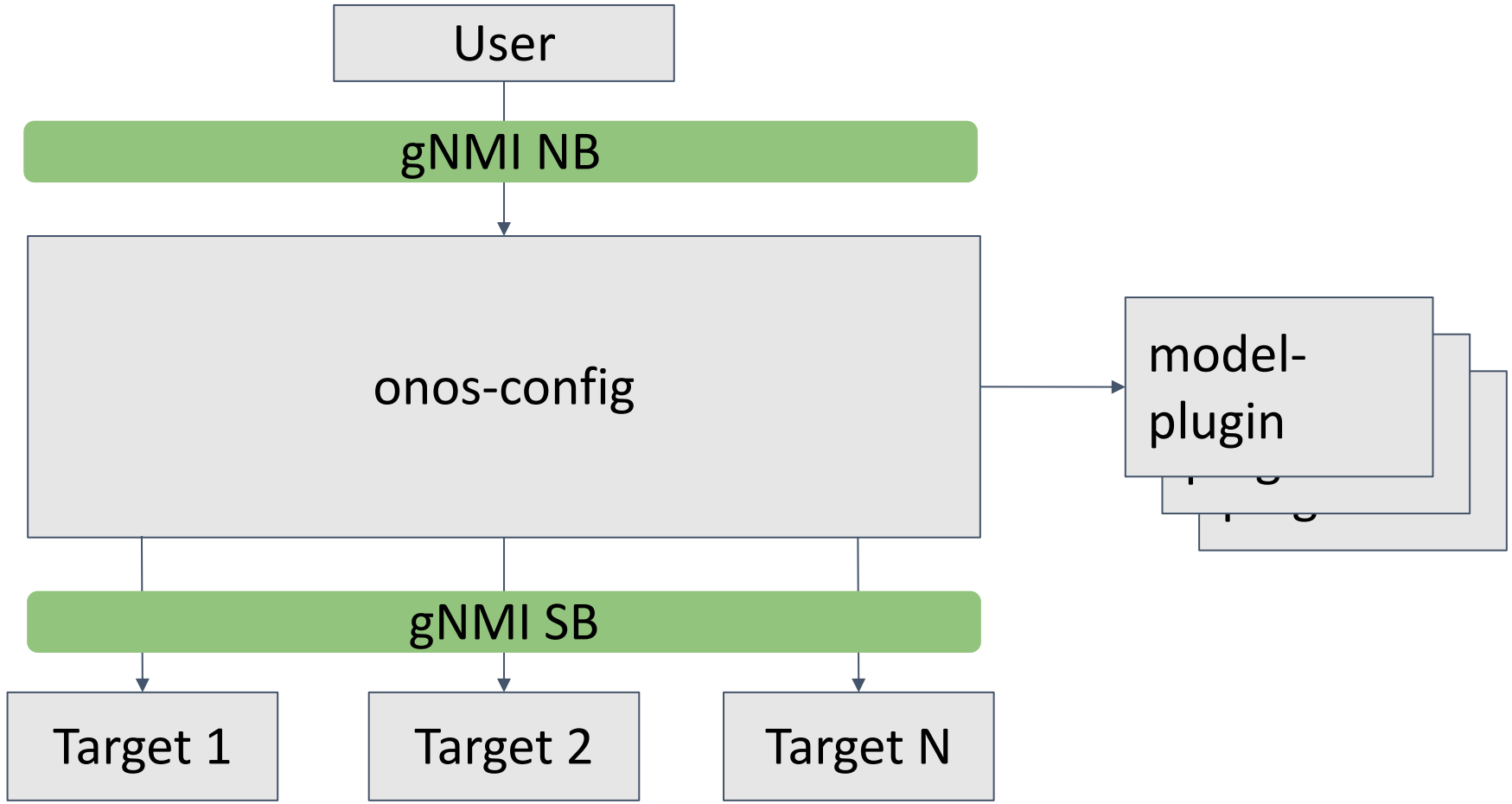
SD-Core and Aether



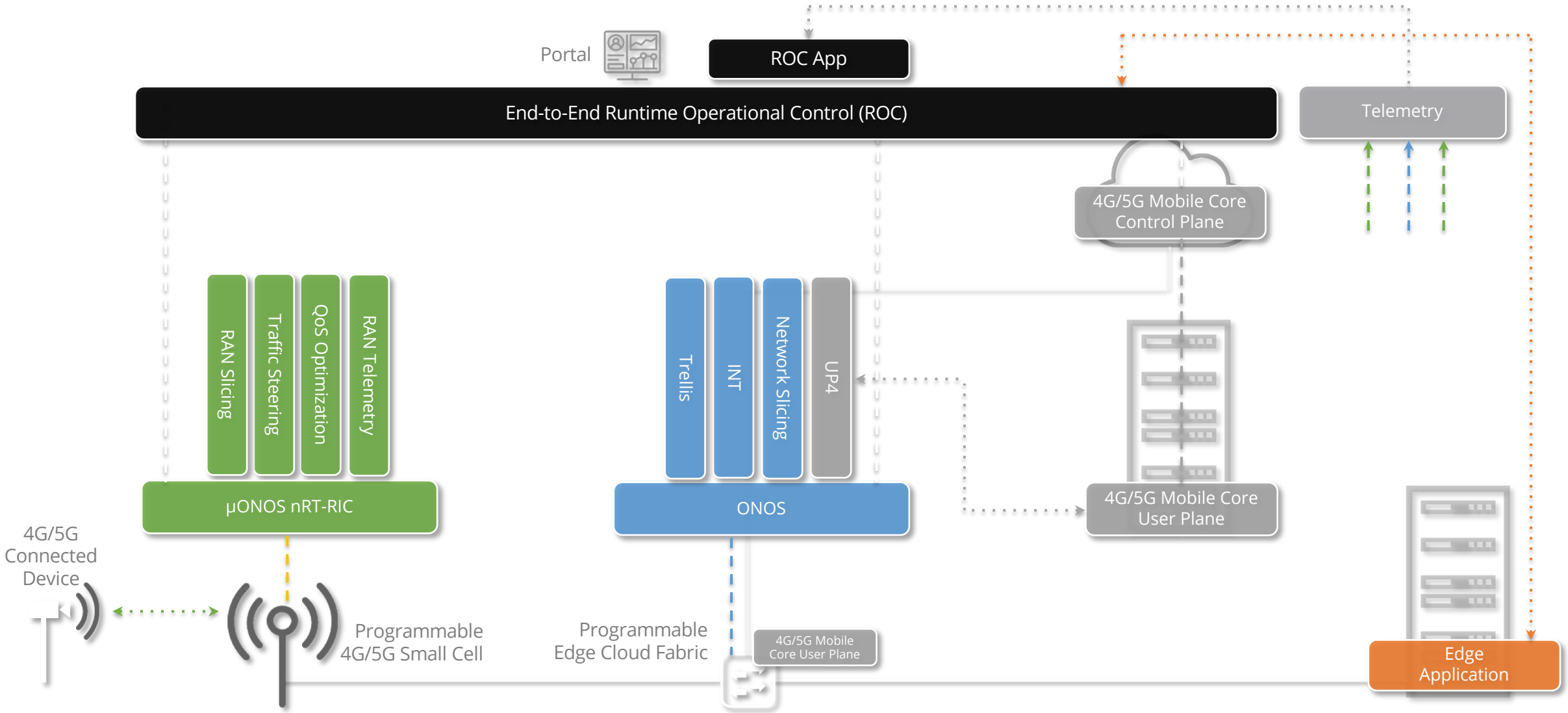
Runtime Operational Control (ROC)



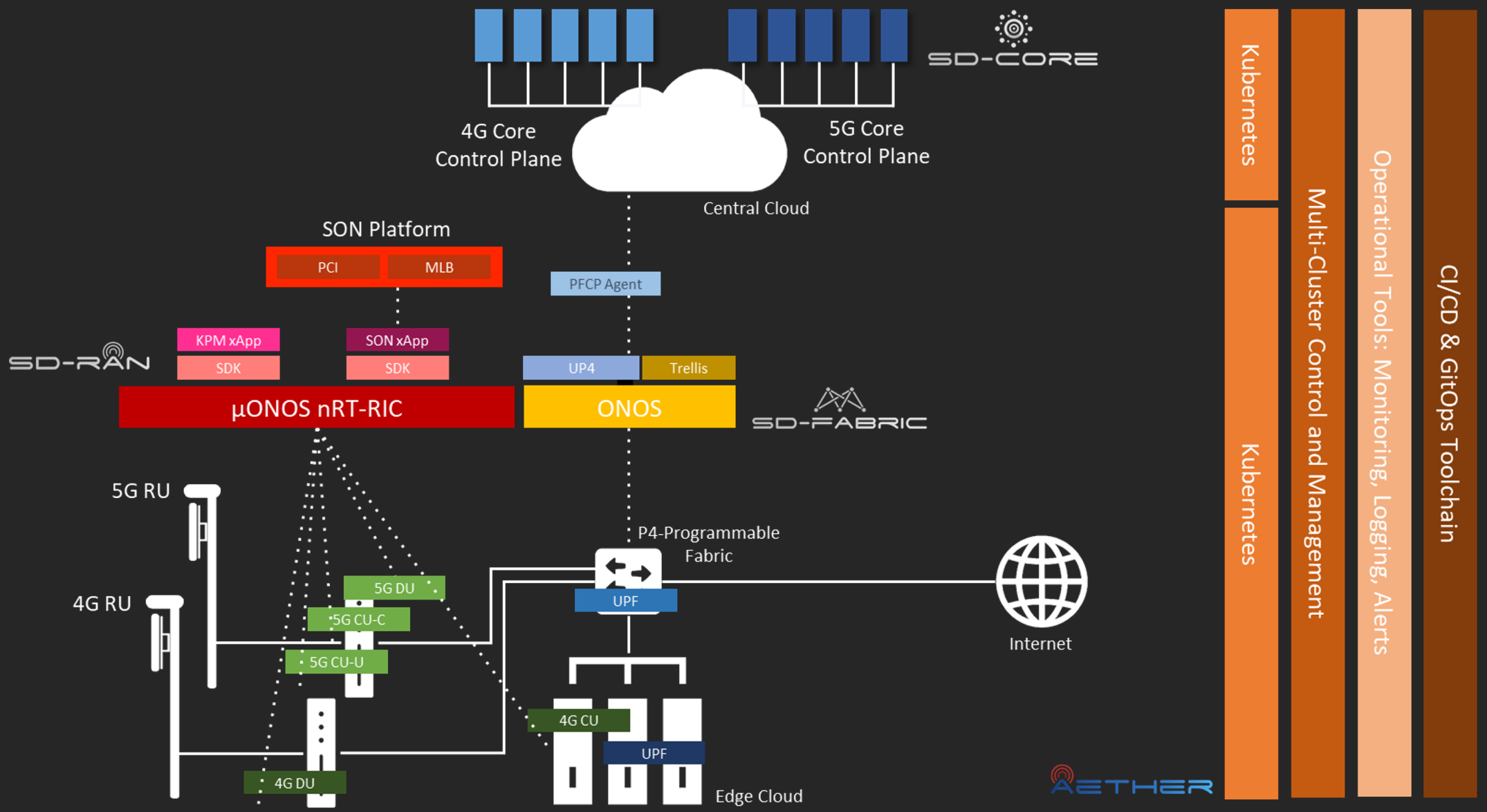
Architecture (aether/onos-config)



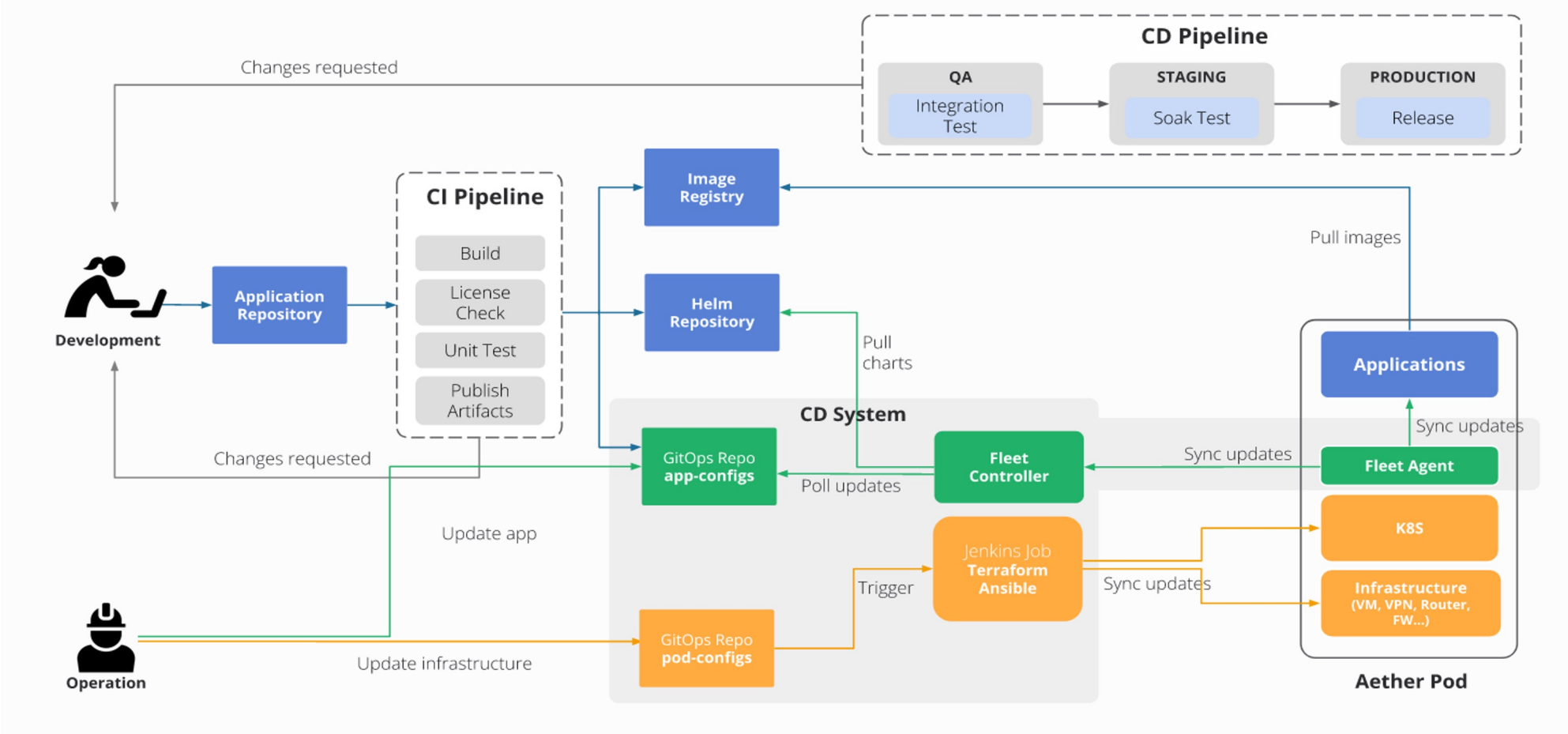
Aether Deployments


Portal
ROC App
End-to-End Runtime Operational Control (ROC)
Telemetry
4G/5G Mobile Core Control Plane
RAN Slicing
Traffic Steering
QoS Optimization
RAN Telemetry
µONOS nRT-RIC
Trellis
INT
Network Slicing
UP4
ONOS
4G/5G Mobile Core User Plane
4G/5G Connected Device
Programmable 4G/5G Small Cell
Programmable Edge Cloud Fabric
4G/5G Mobile Core User Plane
Edge Application

Berlin SD-RAN Outdoor Field Trial



CI/CD Pipeline



[Aether: Test Automation Infrastructure - Open Networking Foundation]

[Aether: Automated CI/CD Systems Increase Reliability and Operational Efficiencies - Open Networking Foundation]

Aether-in-a-Box

Experimental deployments

Aether-in-a-Box (AiaB)

Aether-in-a-Box (AiaB) for developers provides an easy way to deploy Aether's SD-CORE and ROC components, and then run basic tests to validate the installation.

Aether-in-a-Box (AiaB) with a eNodeB and connect real devices (e.g., 4G phones), suitable for laboratory experiments and proof-of-concept deployments.

Thanks!

Questions?