

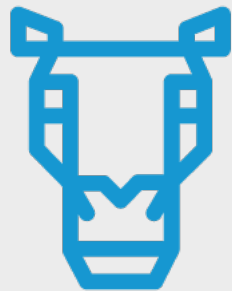


Private 5G as a Managed Cloud Service

Larry Peterson

Open Networking Foundation

Princeton University



PRONTO

Securing the Internet Using Verifiable Closed-Loop Control
(A DARPA Research Project at Stanford, Cornell, Princeton, ONF)

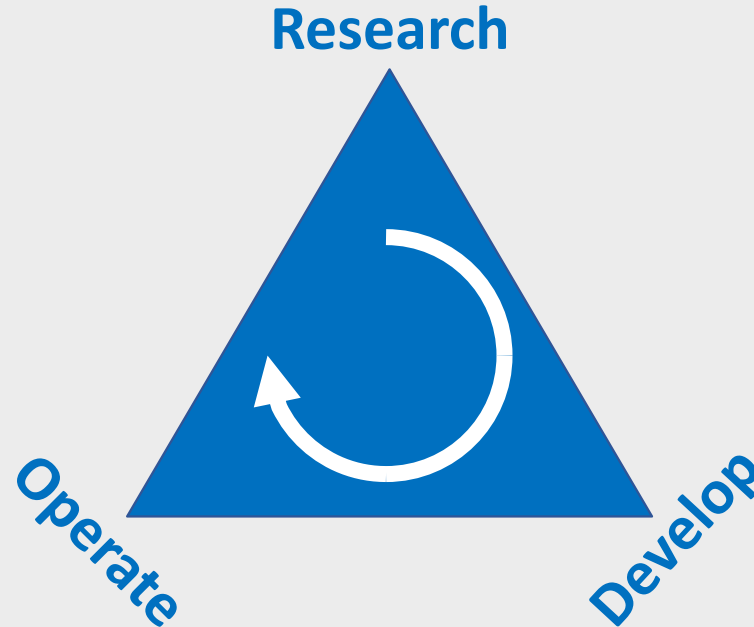
PRONTO'S OBJECTIVE

*“We will create and deploy the first network—including 5G—under **verifiable closed-loop control** as an exemplar for others in government, industry, and education to replicate.”*

*“Pronto will be an **operational network** that is deployed in a production environment, carries real traffic, and runs innovative edge services.”*

PRONTO'S APPROACH

Edge AI using cellular-controlled drones
Real-time closed-loop control (DDoS, hijacking)
Formal verification of programs and packets

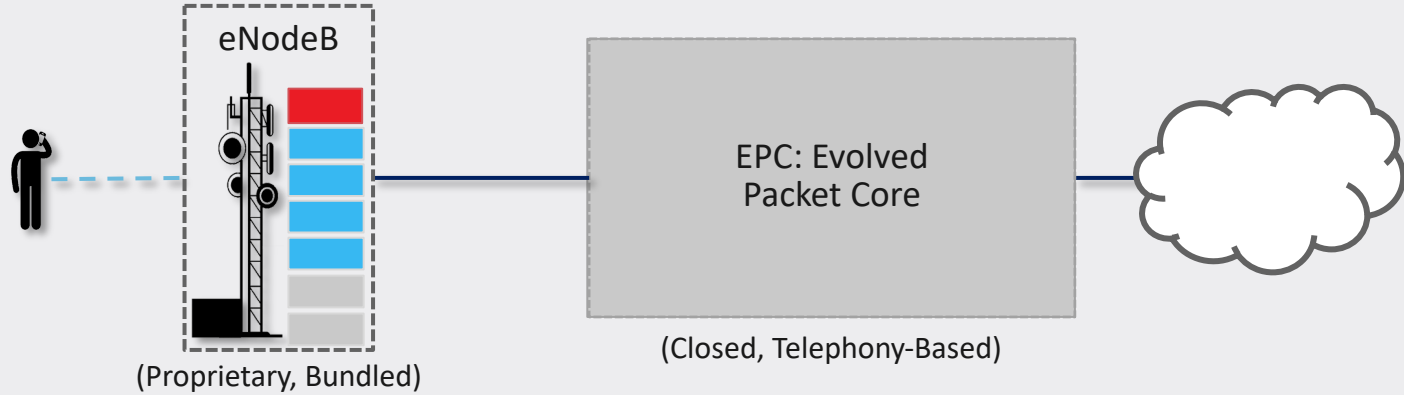


Deploy & operate a Private 5G network at Universities, ONF, Intel, and elsewhere

Aether: Edge cloud with Software-Defined Core, RAN, and Fabric (P4)

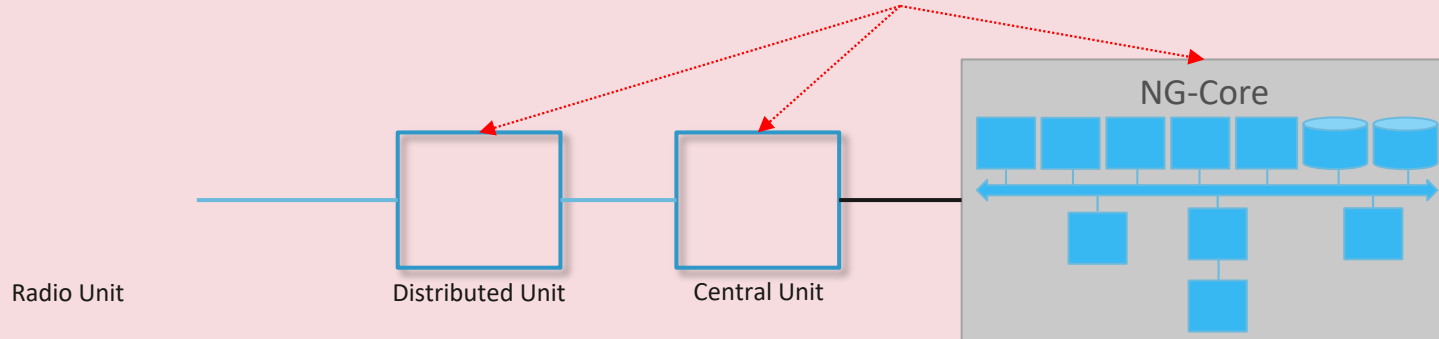
PRONTO'S OPPORTUNITY

4G



Open Source + Cloud Native + SDN Principles

5G



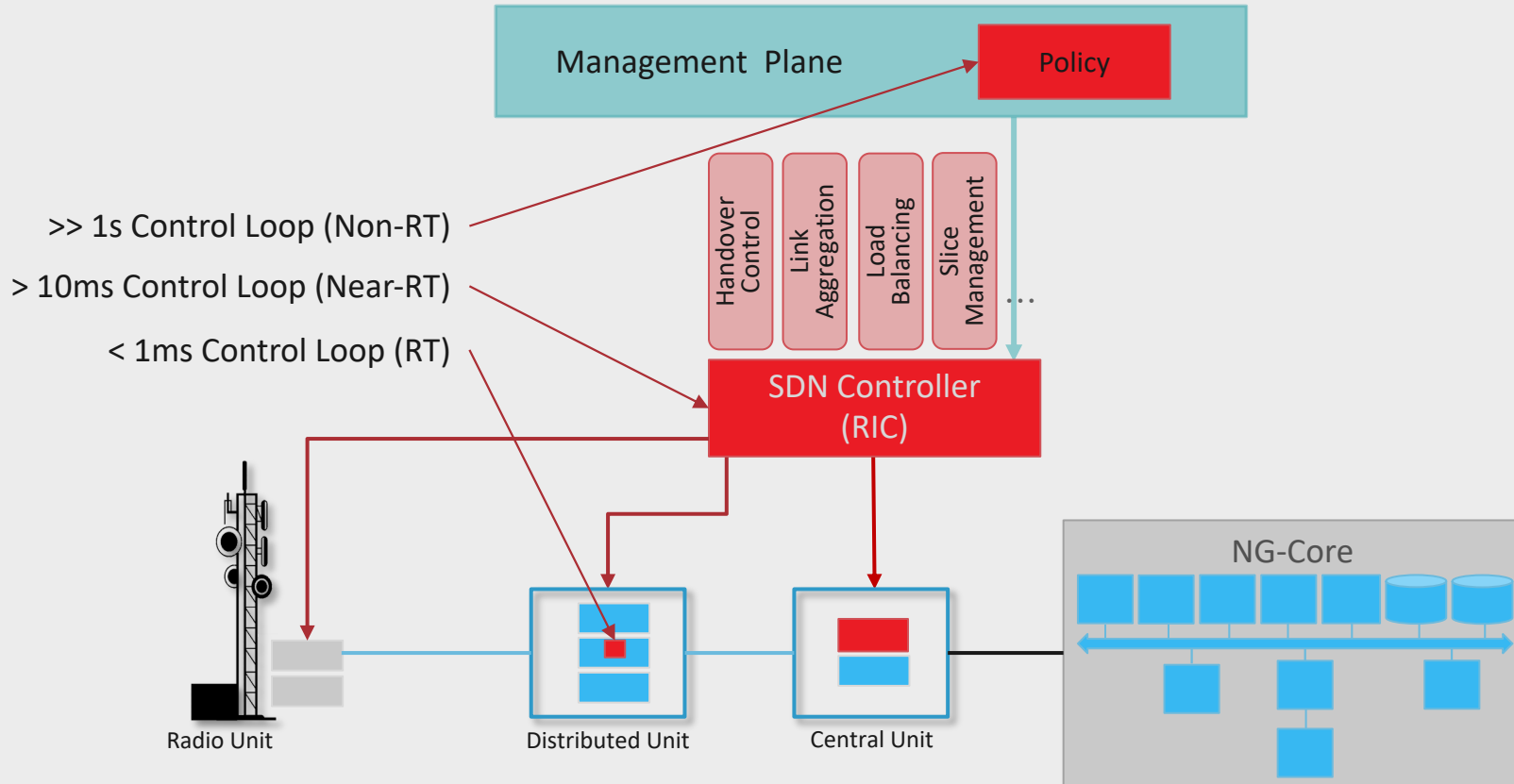
Radio Unit

Distributed Unit

Central Unit



NG-Core

PROGRAMMABLE END-TO-END & TOP-TO-BOTTOM



OPERATIONAL DEPLOYMENT SINCE DECEMBER '19

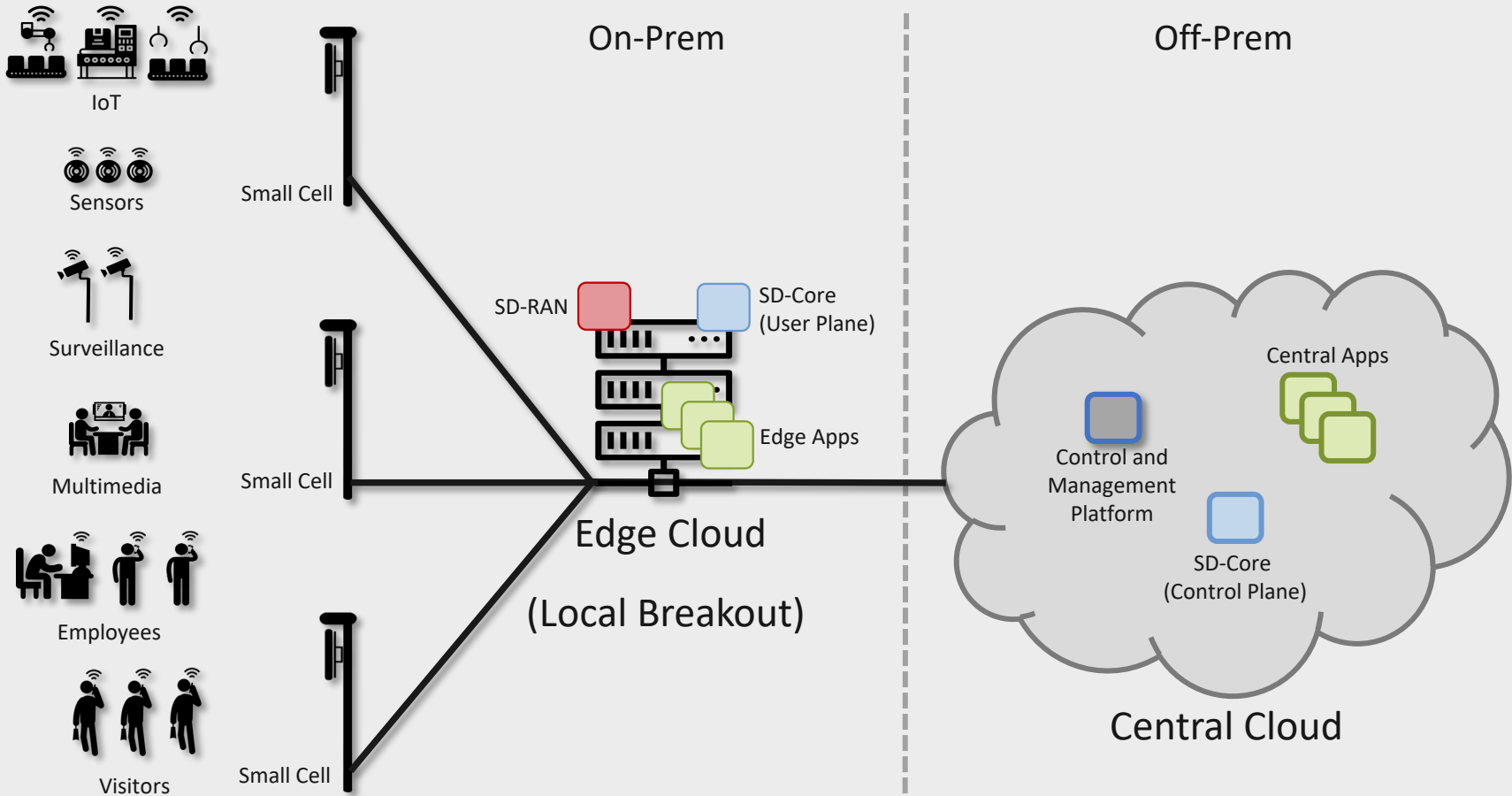


-  Edge Sites
-  Centralized Cloud Management

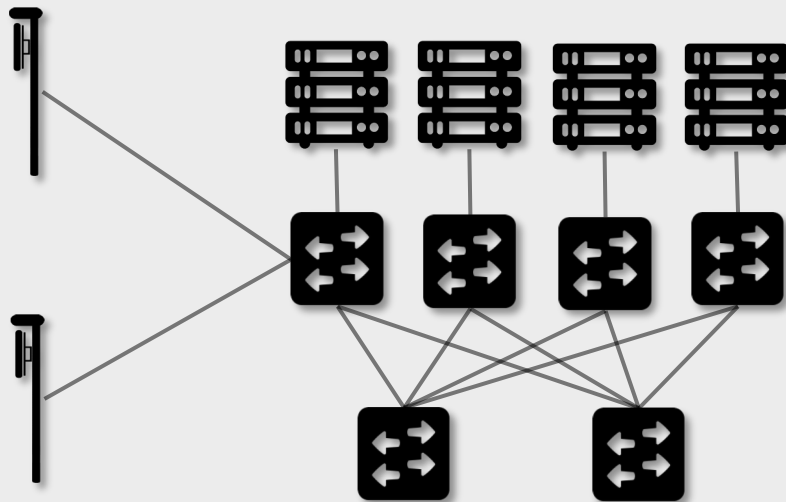


An Open Source Private 5G Platform

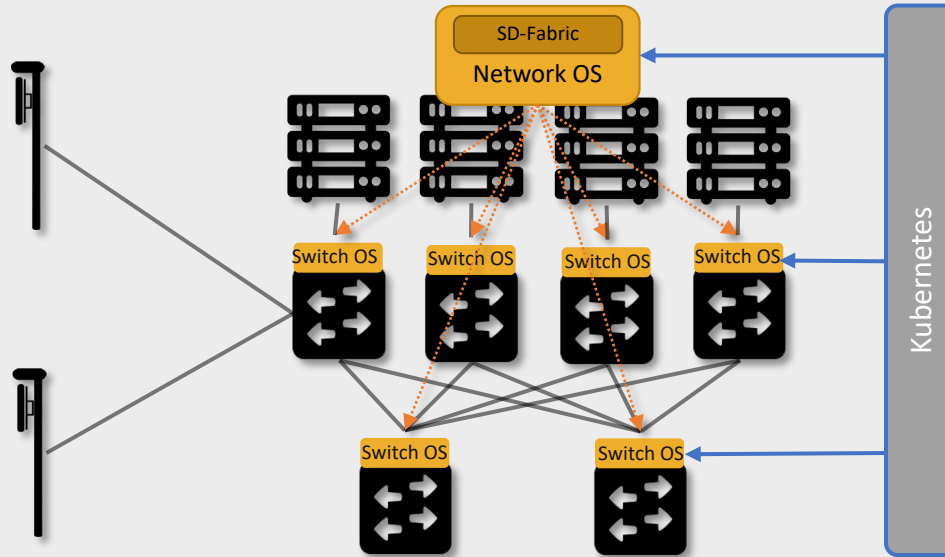
AETHER OVERVIEW



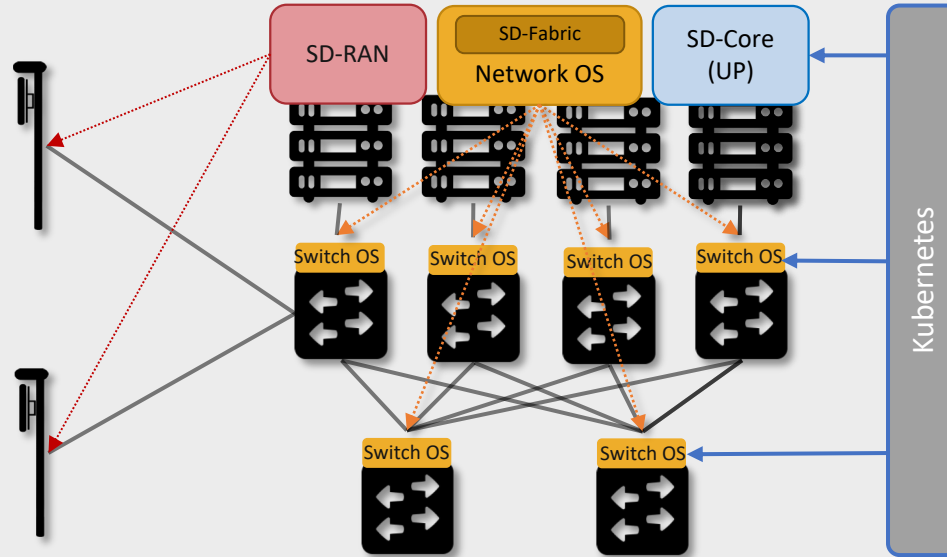
AETHER HARDWARE



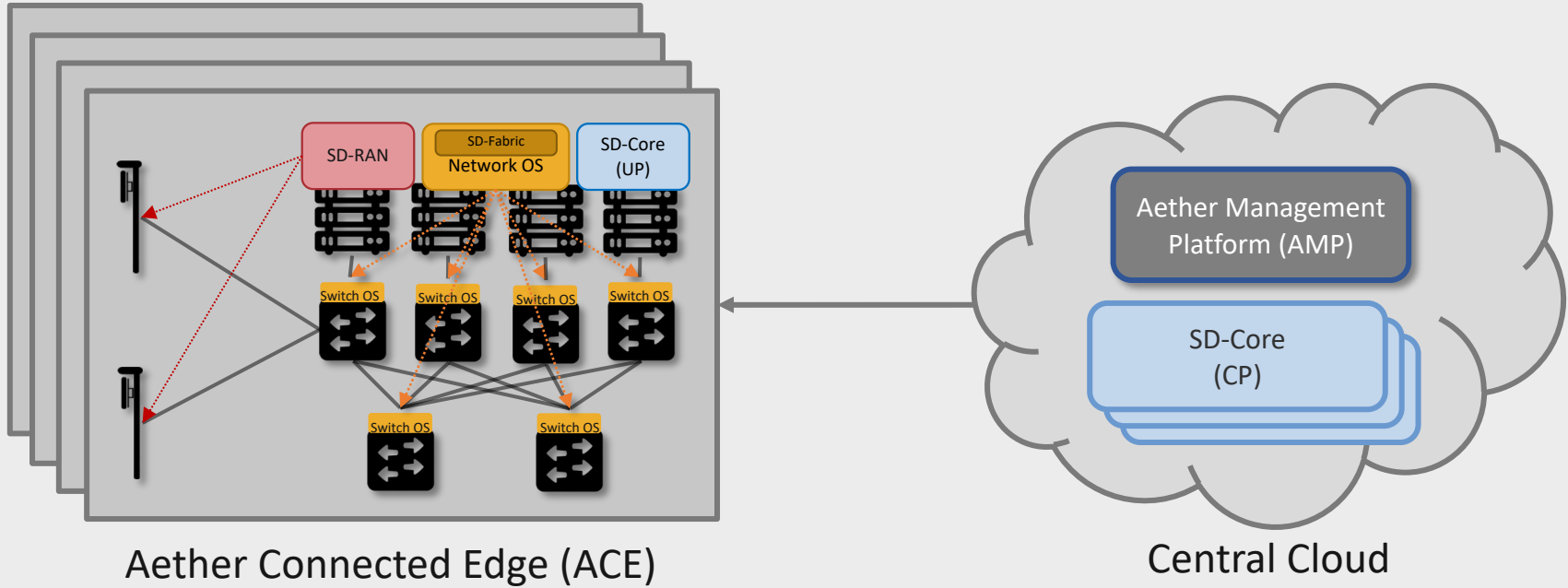
AETHER PLATFORM



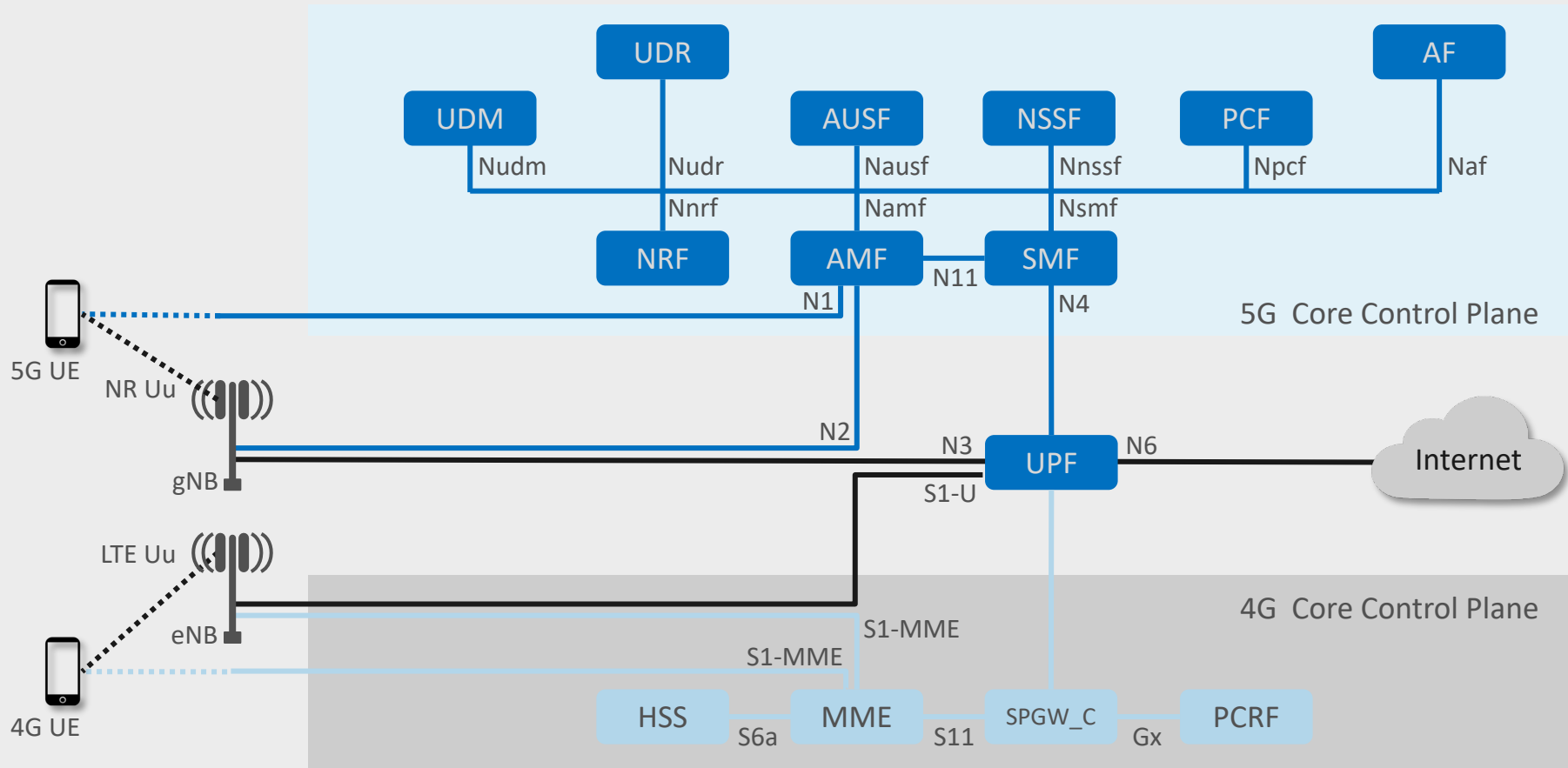
AETHER CONNECTIVITY SERVICE



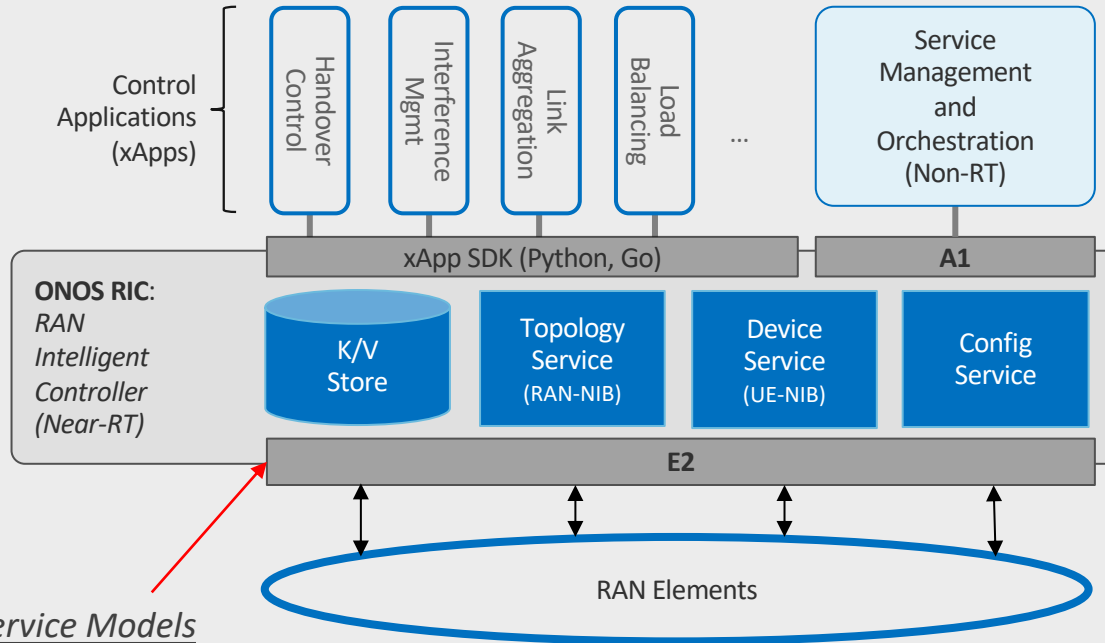
AETHER AS A MANAGED SERVICE



SD-CORE: CLOUD NATIVE CONTROL PLANE



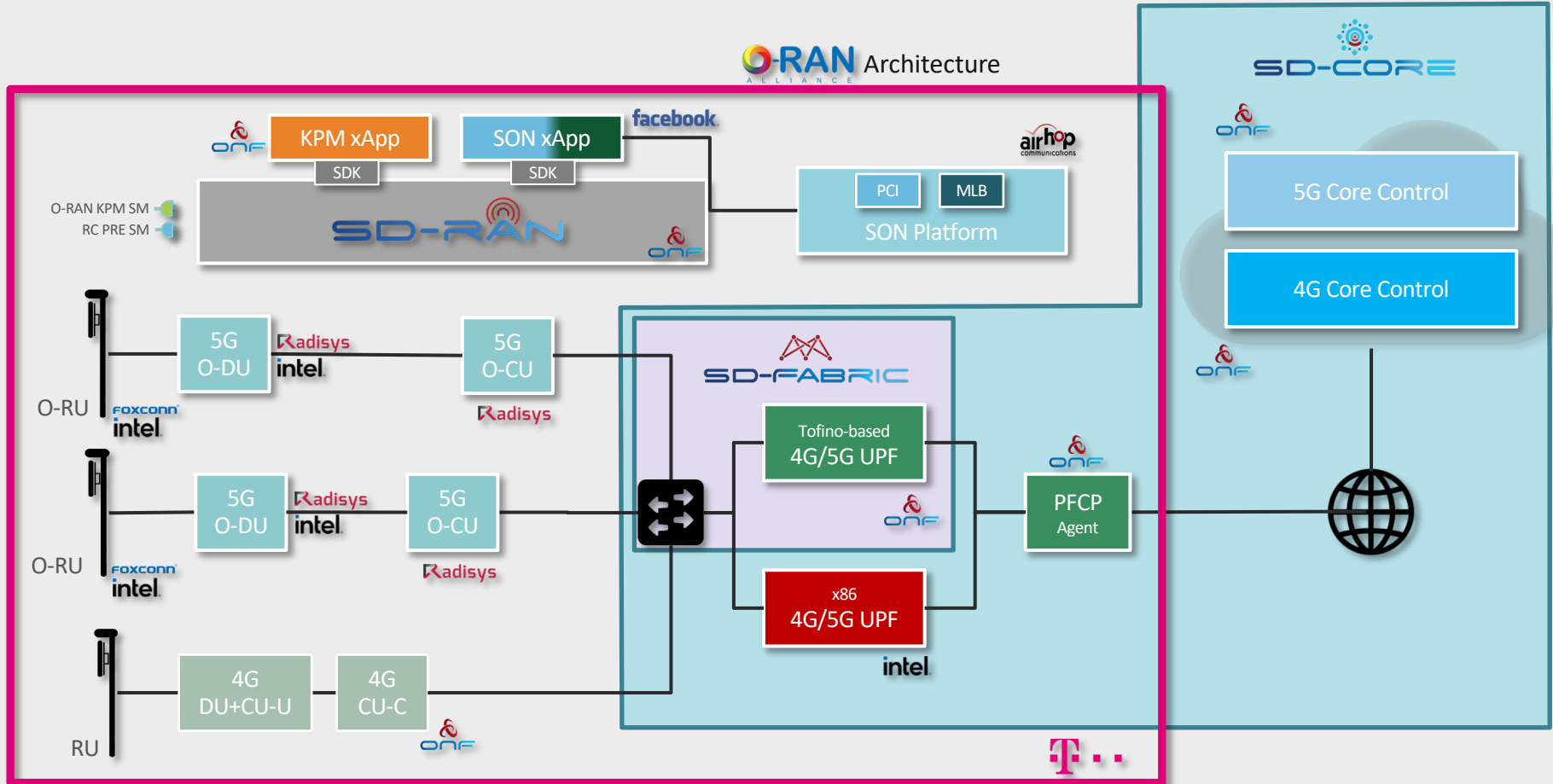
SD-RAN: SDN-BASED RAN CONTROL



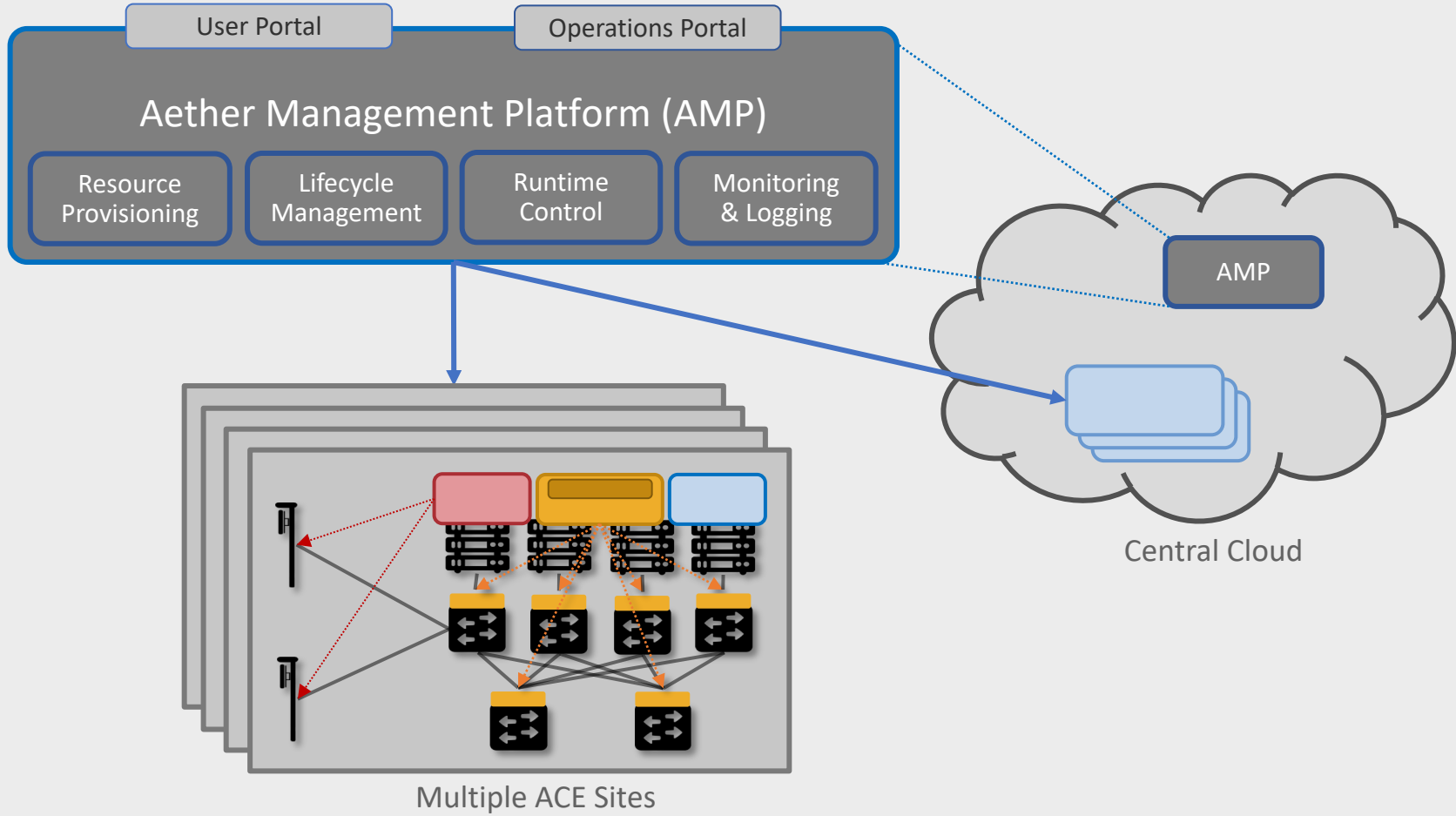
Supports O-RAN Service Models

- E2SM-KPM
- E2SM-RC

BERLIN OPEN RAN FIELD TRIAL



AETHER MANAGEMENT PLATFORM



MONITORING & LOGGING

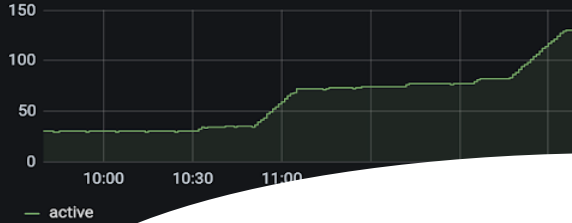
SD-CORE Metrics ☆ 🔗

📊 📄 ⚙️ 🖨️ 🕒 Last 3 hours 🔍 🔄 1m

SPGW: Active Subscribers...



SPGW: Active Subscribers



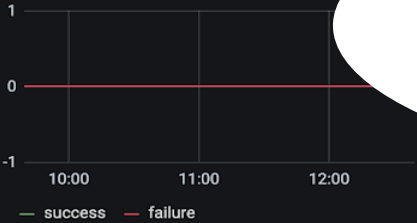
SPGW: Initial Attach Count



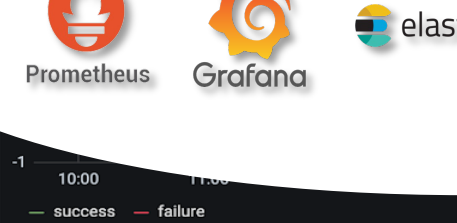
SPGW: UE / MME / HSS Detach Count



SPGW: S1 Release Count



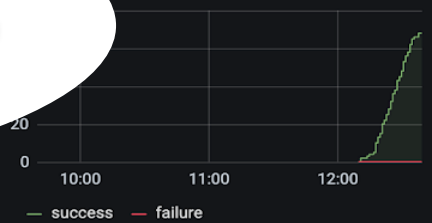
SPGW: S1 Release Count



SPGW: S1 Release Count



HSS: Update Location Count

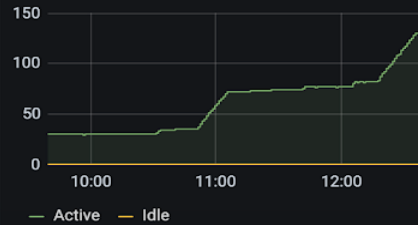


Prometheus Grafana Elasticsearch Kibana Fluentd

MME: Subscribers



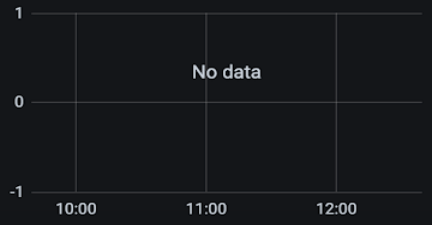
MME: Subscribers



MME: Attach Count



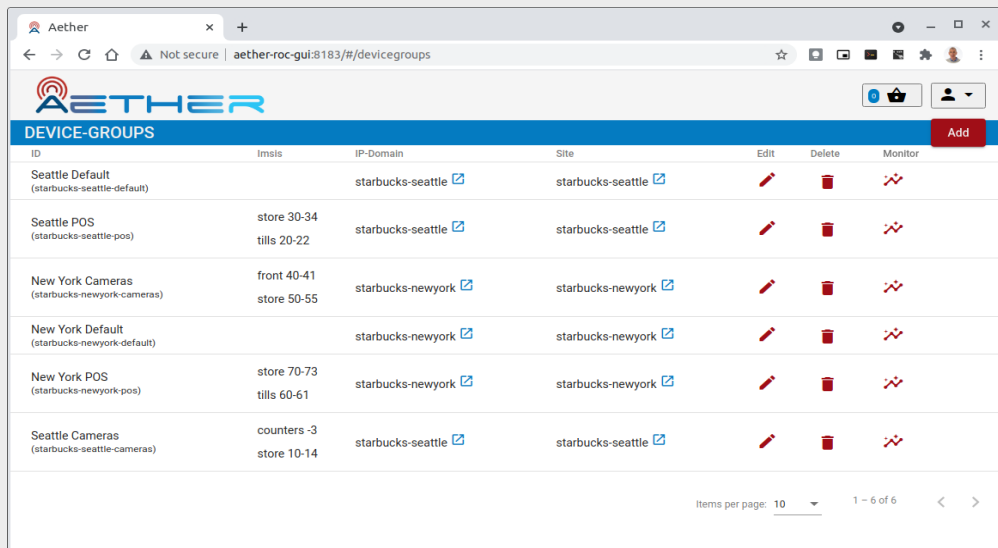
MME: Detach Count



RUNTIME CONTROL API

Programmatic API and Enterprise Portal to...

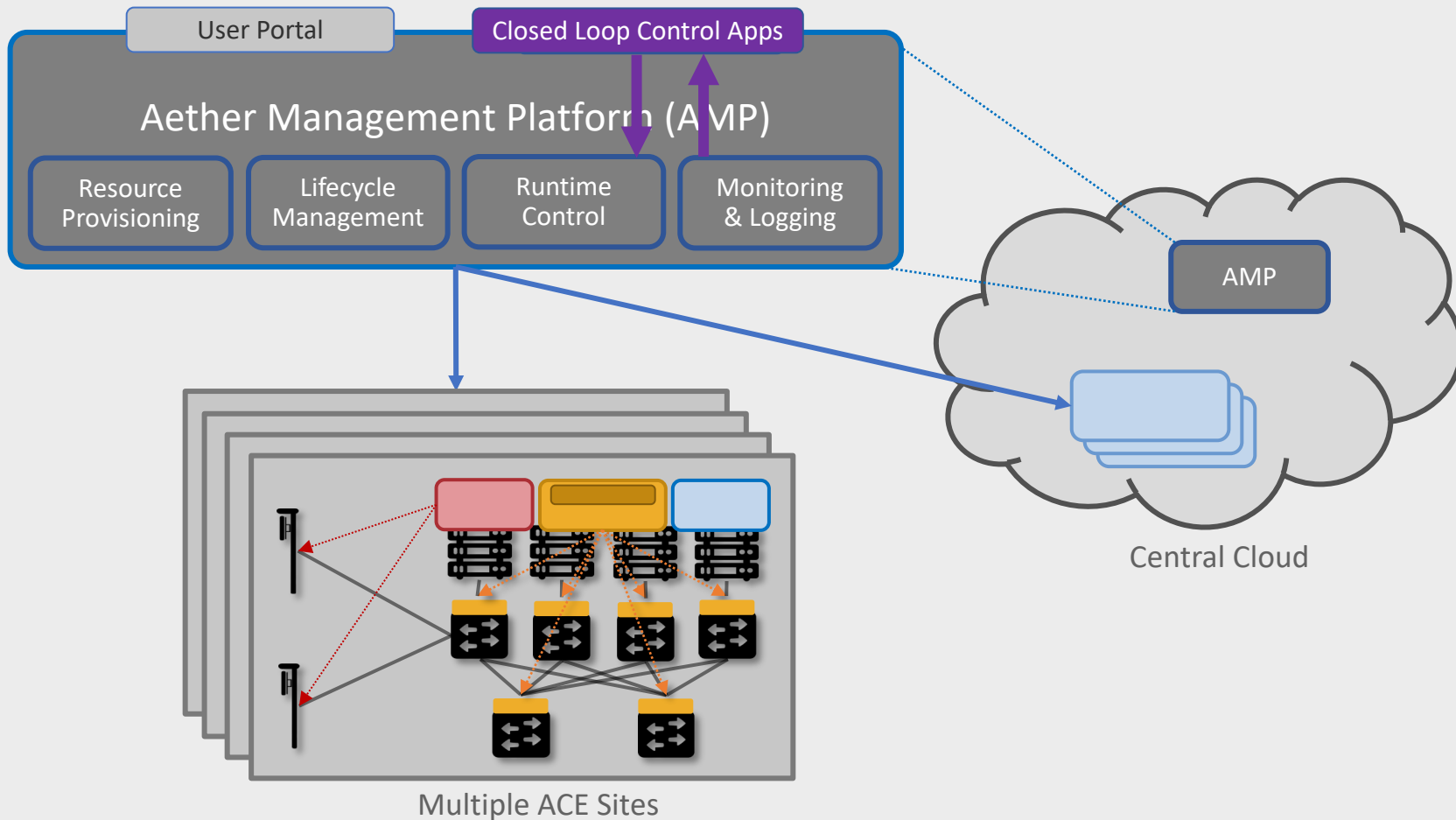
- *Manage Devices and Device Groups*
- *Define Slices to Isolate Traffic*
- *Set QoS Parameters for Slices*
- *Assign Device Groups & Applications to Slices*
- ...



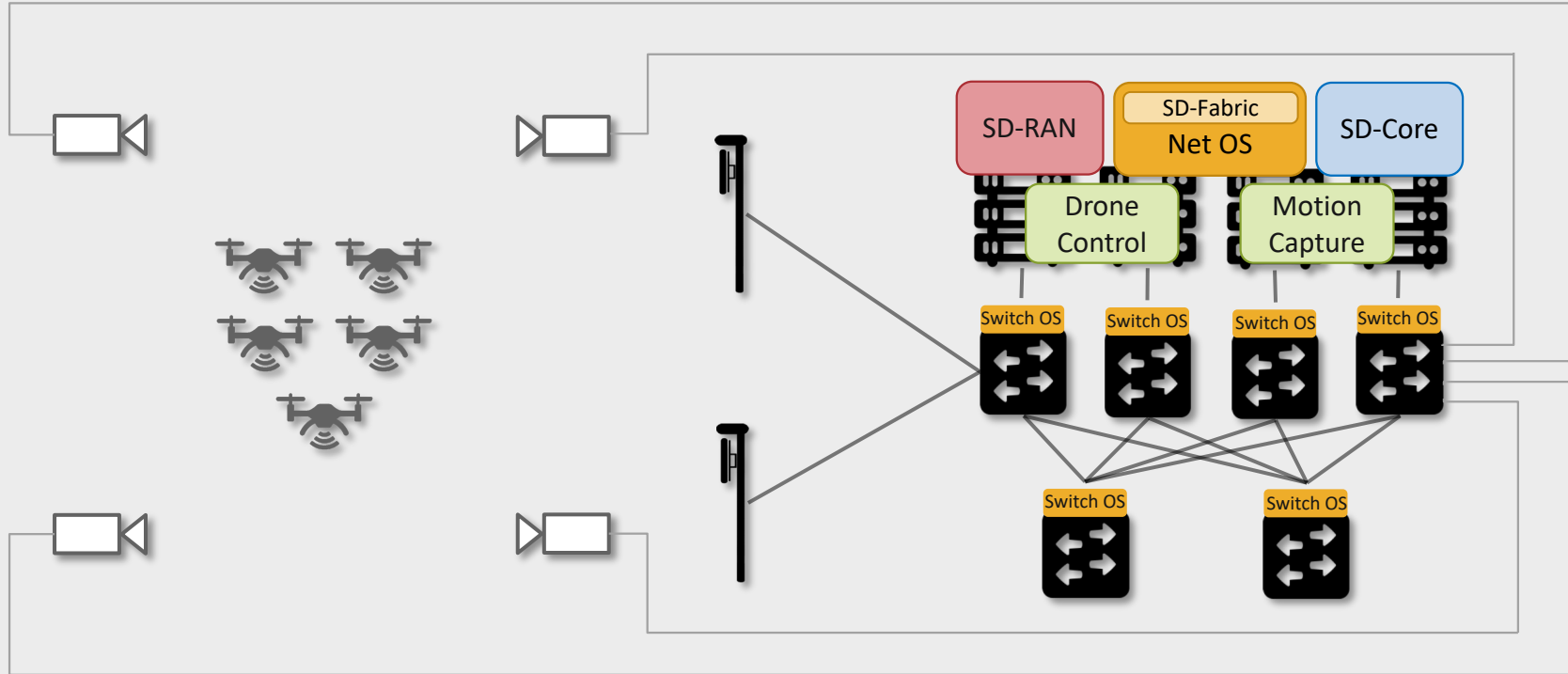
The screenshot shows a web browser window with the URL `aether-roc-gui:8183/#/devicegroups`. The page displays the AETHER logo and a table titled "DEVICE-GROUPS". The table has columns for ID, lmsis, IP-Domain, Site, Edit, Delete, and Monitor. There are 6 rows of data, each representing a device group with its associated lmsis, IP-Domain, and Site information. At the bottom right, there is a pagination control showing "Items per page: 10" and "1 - 6 of 6".

ID	lmsis	IP-Domain	Site	Edit	Delete	Monitor
Seattle Default (starbucks-seattle-default)		starbucks-seattle	starbucks-seattle			
Seattle POS (starbucks-seattle-pos)	store 30-34 tills 20-22	starbucks-seattle	starbucks-seattle			
New York Cameras (starbucks-newyork-cameras)	front 40-41 store 50-55	starbucks-newyork	starbucks-newyork			
New York Default (starbucks-newyork-default)		starbucks-newyork	starbucks-newyork			
New York POS (starbucks-newyork-pos)	store 70-73 tills 60-61	starbucks-newyork	starbucks-newyork			
Seattle Cameras (starbucks-seattle-cameras)	counters -3 store 10-14	starbucks-seattle	starbucks-seattle			

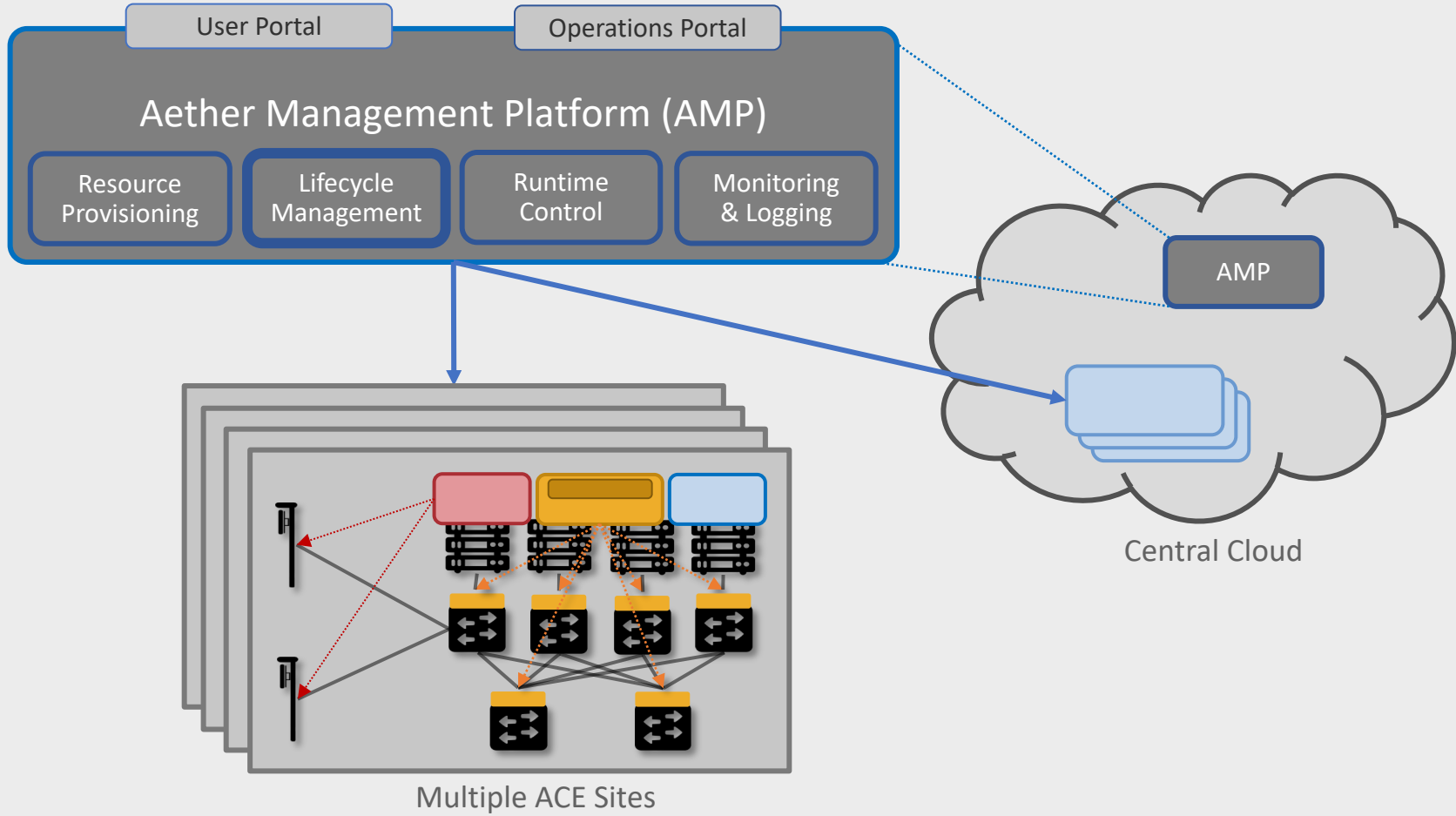
CLOSED-LOOP CONTROL



CLOSED-LOOP CONTROL DEMO

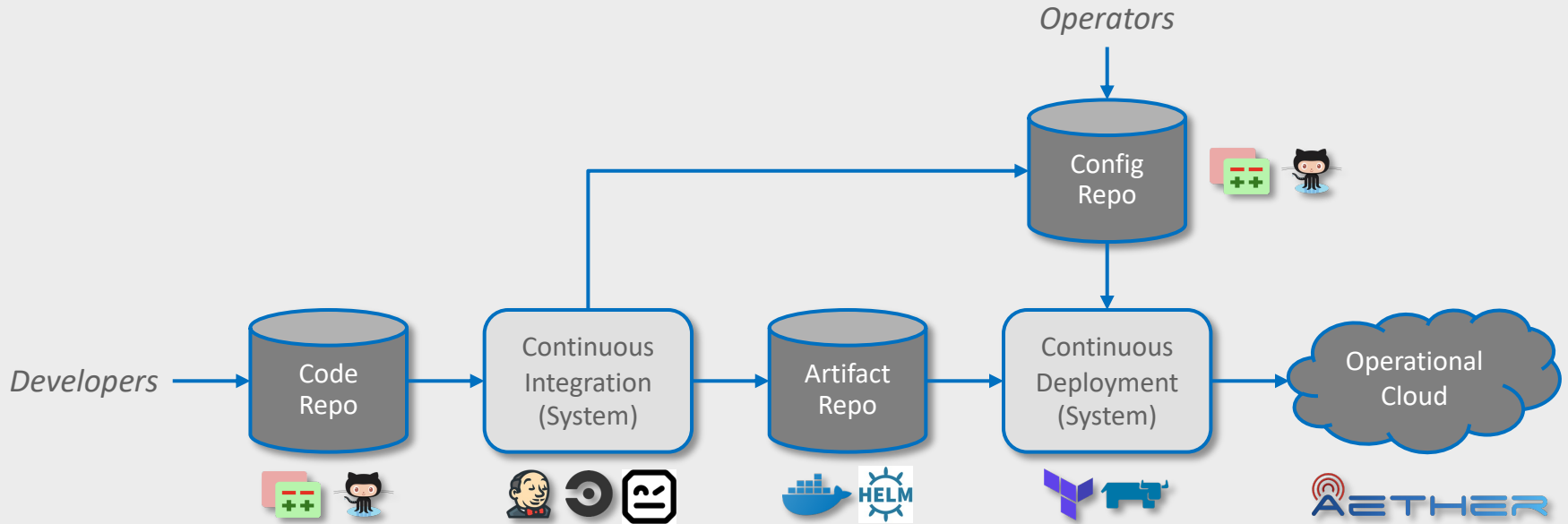


AETHER MANAGEMENT PLATFORM



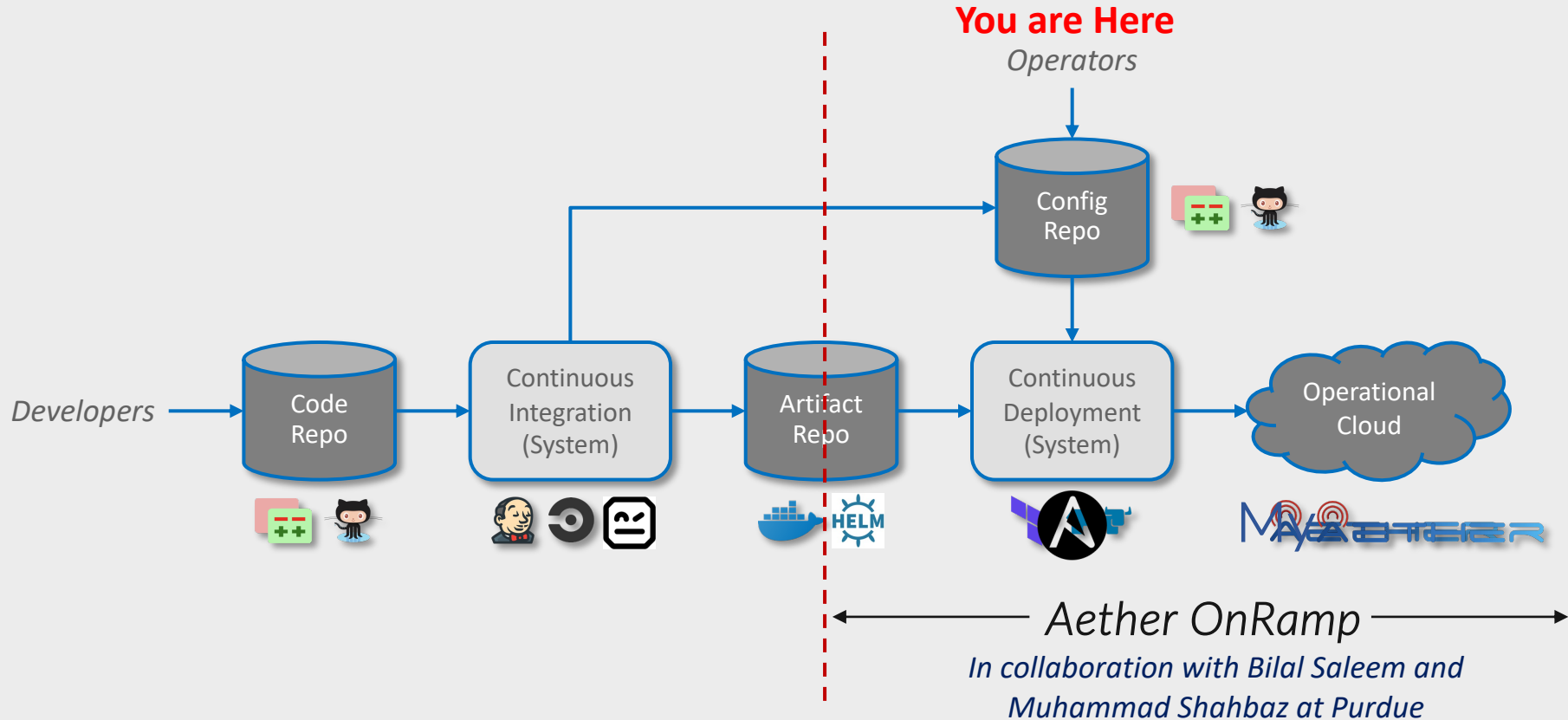
LIFECYCLE MANAGEMENT

(Continuous Integration / Continuous Deployment)



LIFECYCLE MANAGEMENT

(Continuous Integration / Continuous Deployment)



AETHER ONRAMP

Transitioning Aether: Managed Service → Deployable Platform

- *Includes tooling needed to run as a managed cloud service*
- *Overriding goal is to support users “owning” the configuration*
- *In support of Education, Research, Field Trials, Commercial Deployments*

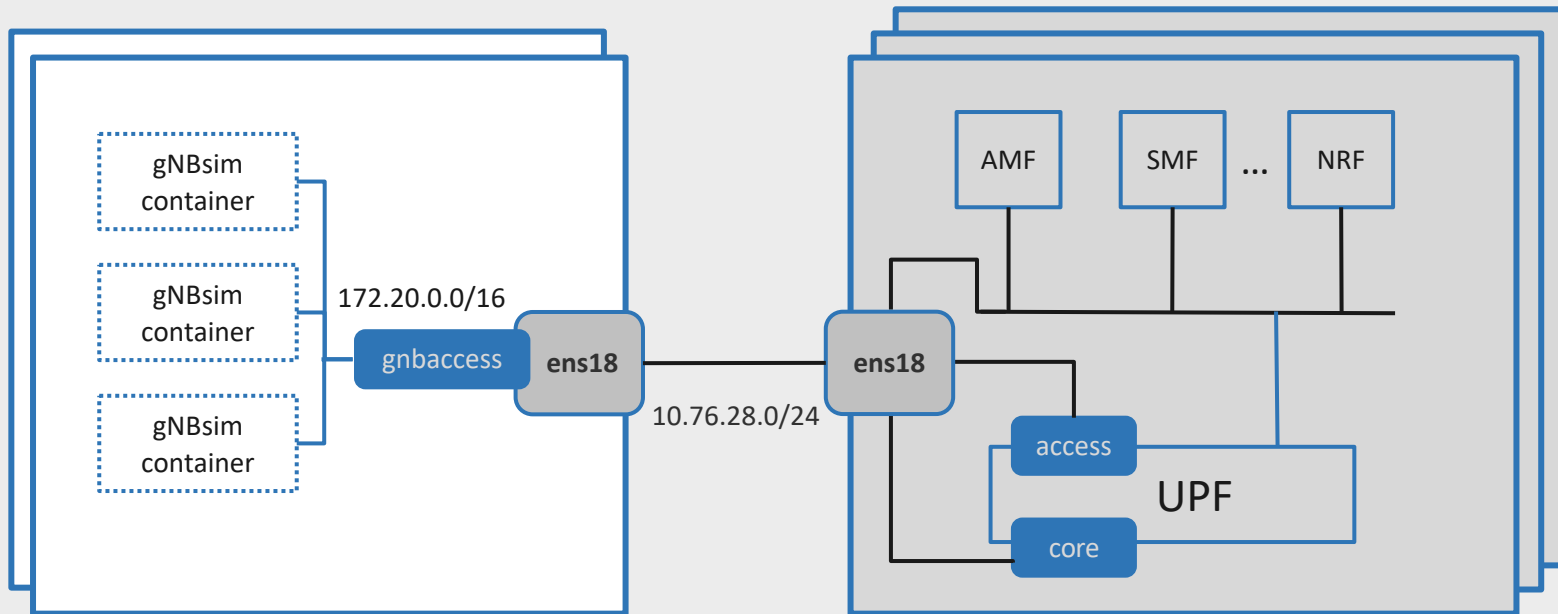
Designed to scale up for different target environments

- *Single Server / Emulated or Physical gNBs*
- *Single Site Cluster / Emulated or Physical gNBs*
- *Multi-Site Hybrid Cloud*

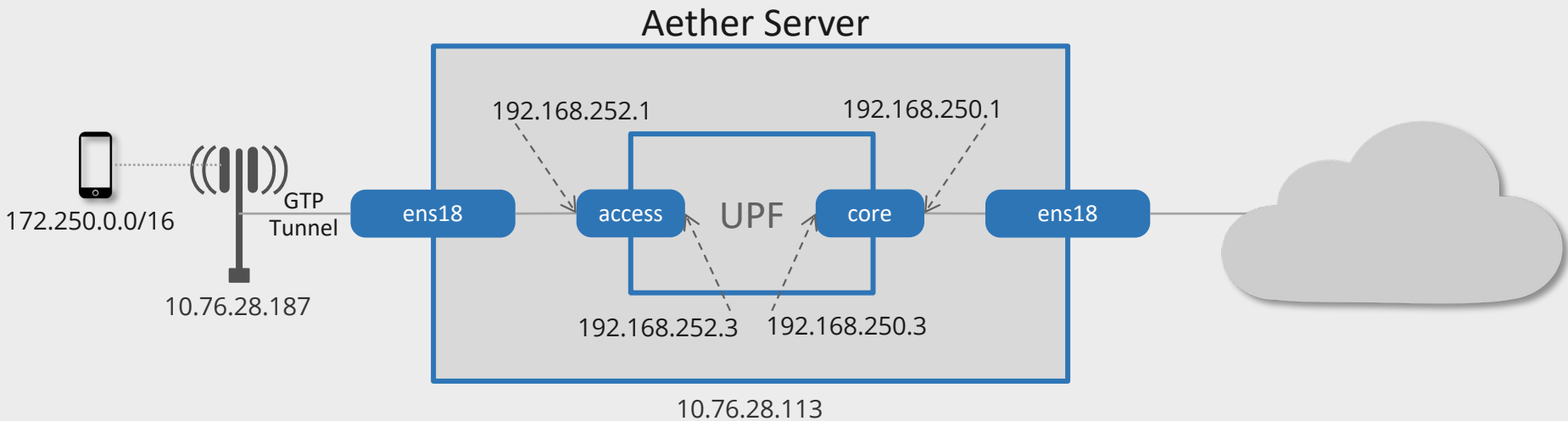
Designed to incrementally support additional features

- *Git Modules: `aether-k8s`, `aether-5gc`, `aether-gnbsim`, `aether-amp`, `aether-sdran`*
- *Ansible Roles: `5gc/roles/core`, `5gc/roles/route`, `5gc/roles/upf`*
- *Ansible Vars: `main-quickstart.yml`, `main-gNB.yml`, `main-eNB.yml`, `main-gnbsim.yml`*
 - » *Each defines a “blueprint” for deploying Aether*

ONRAMP: EMULATED RAN



ONRAMP: PHYSICAL RAN



ONRAMP: PHYSICAL RAN



Aether v2.2.0-dev - September 6, 2023



MOSO CANOPY 5G INDOOR SMALL CELL

Model #: Model SCD5164

Category: Small Cell

MosoLabs Canopy Indoor 5G Sub-6GHz radios are designed to improve coverage and capacity, enabling you to build a secure and resilient private network.

MORE INFORMATION

Aether OnRamp

- CODE: <https://github.com/opennetworkinglab/aether-onramp>
- GUIDE: <https://docs.aetherproject.org>
- SLACK: [#aether-onramp](https://onf-community.slack.com)
- ROADMAP: <https://github.com/opennetworkinglab/aether-onramp/wiki>

Aether Project

- WEB SITE: <https://opennetworking.org/aether>
- WIKI: <https://wiki.opennetworking.org/display/COM/Aether>
- TST MEETINGS: Tuesdays 10am PT (See Wiki for links)

Background Reading

- <https://5G.systemsapproach.org>
- <https://SDN.systemsapproach.org>
- <https://OPs.systemsapproach.org>