City Scale Testbed for Emergency Orchestration with ONAP/ORAN

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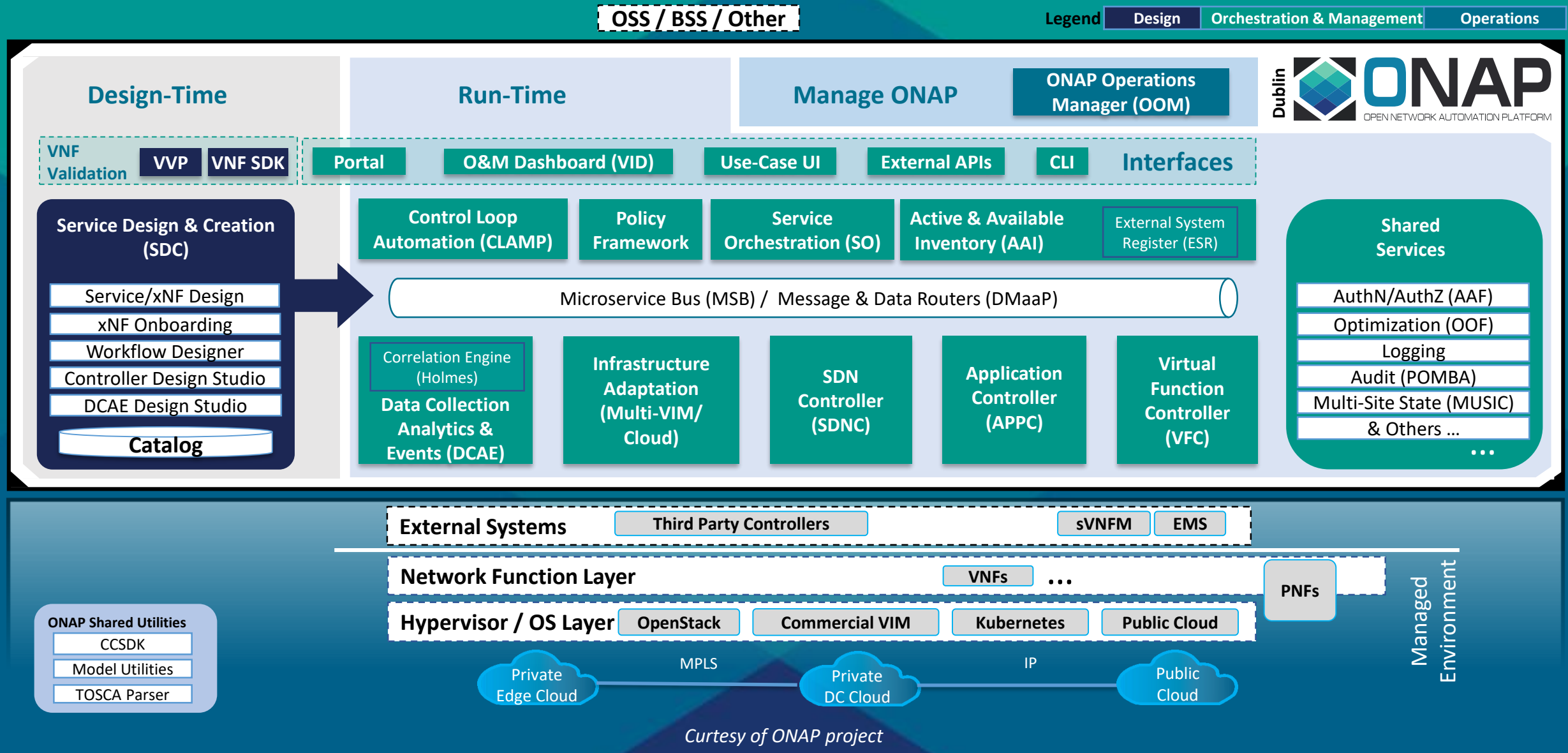
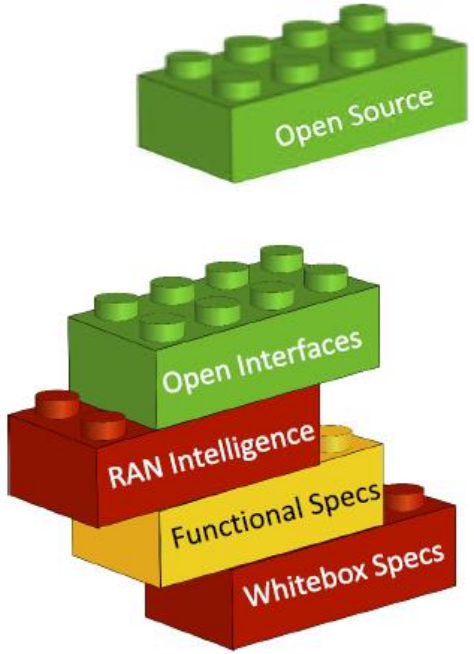
ONAP Architecture

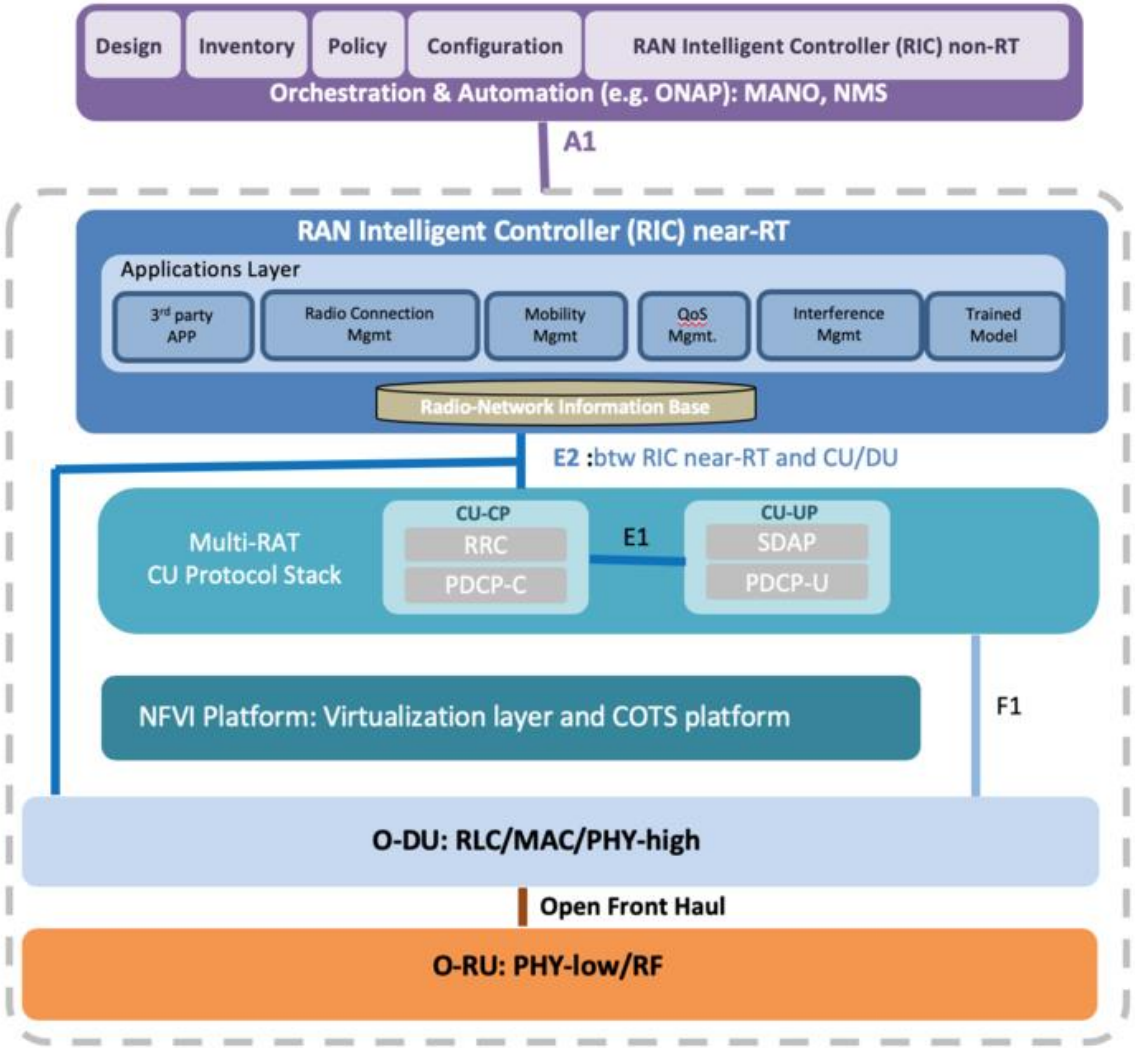
Version 4.0.10 (Date: May 16th, 2019)



Curtesy of ONAP project

O-RAN Alliance

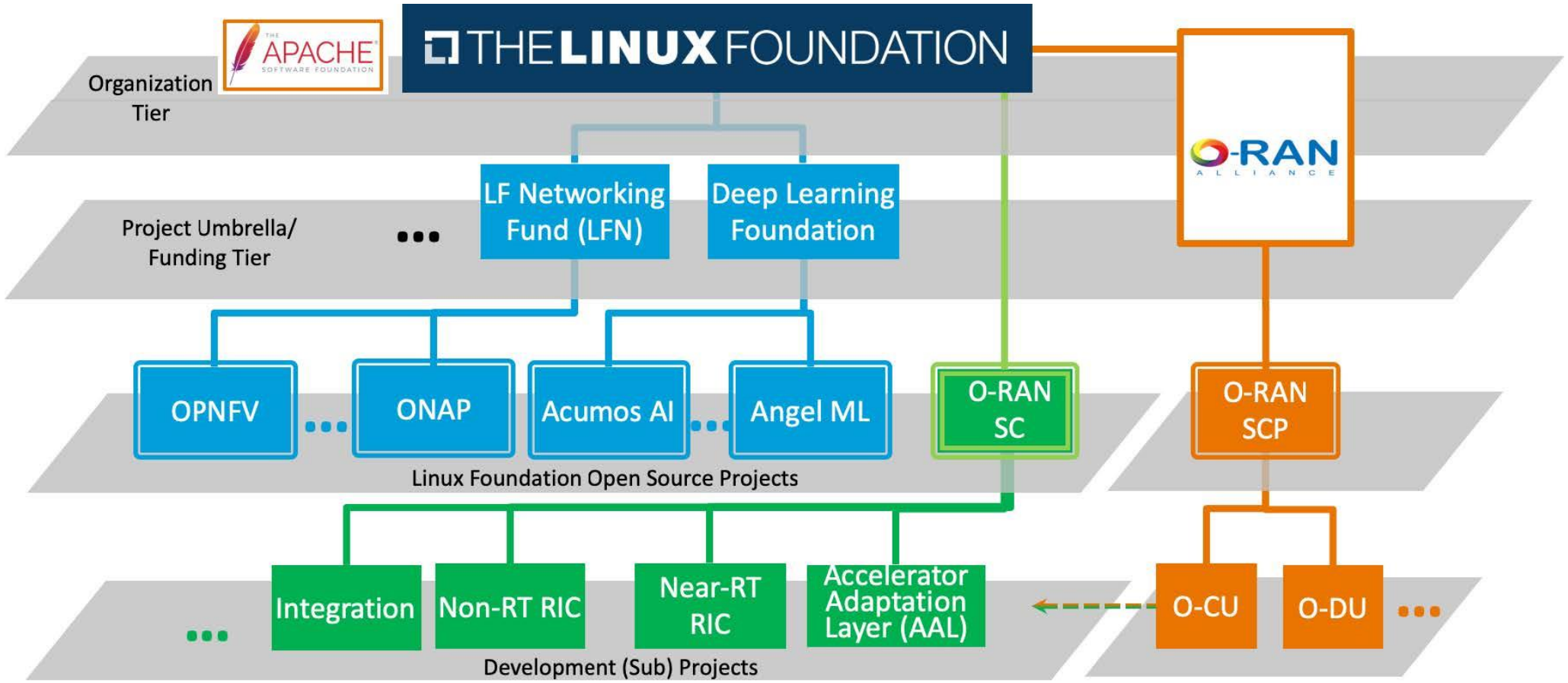




O-RAN Alliance is aiming at building an "Open" and "Smart" Radio Access Network (RAN) for future wireless systems

Curtesy of O-RAN Alliance

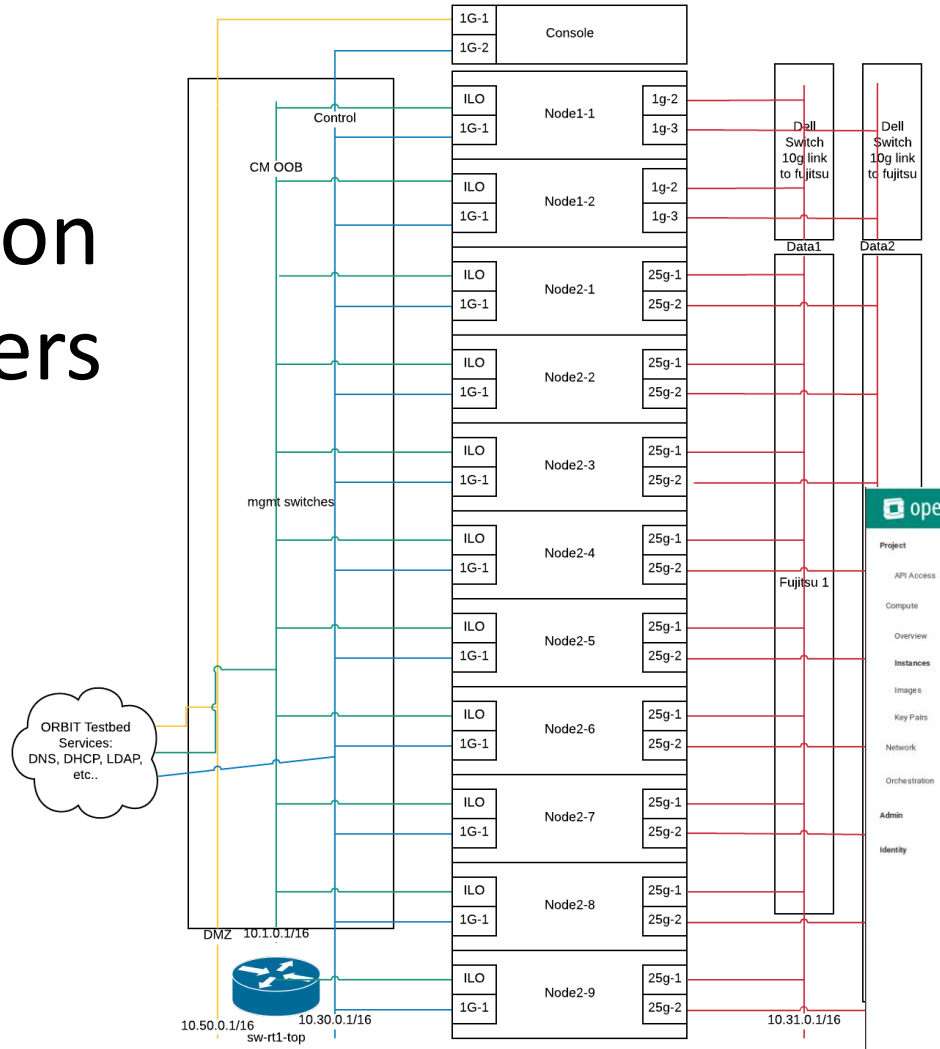
Linux Foundation Networking Projects

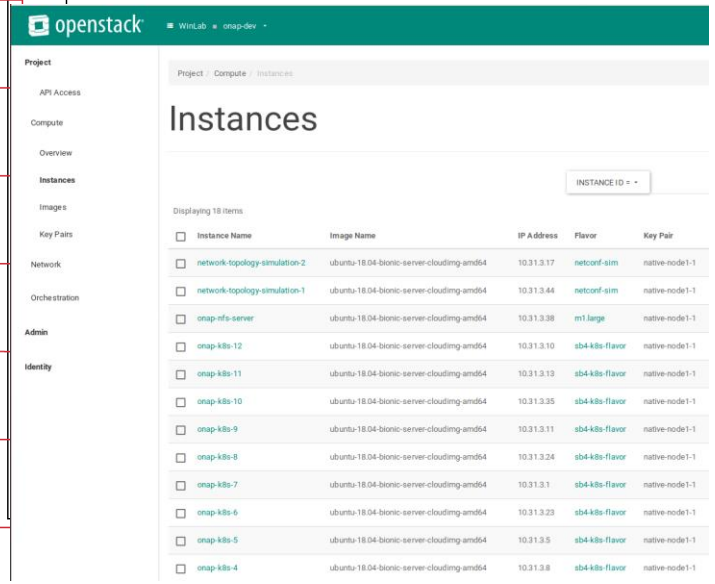


Curtesy of O-RAN Alliance

Open Wireless Lab (OWL) at ORBIT

- OpenStack Pike installation
- ONAP Dublin Installation
  - Three Rancher servers
  - Twelve Kubernetes nodes
  - One NFS server
  - Two VMs hosting 10,000 NETCONF simulators





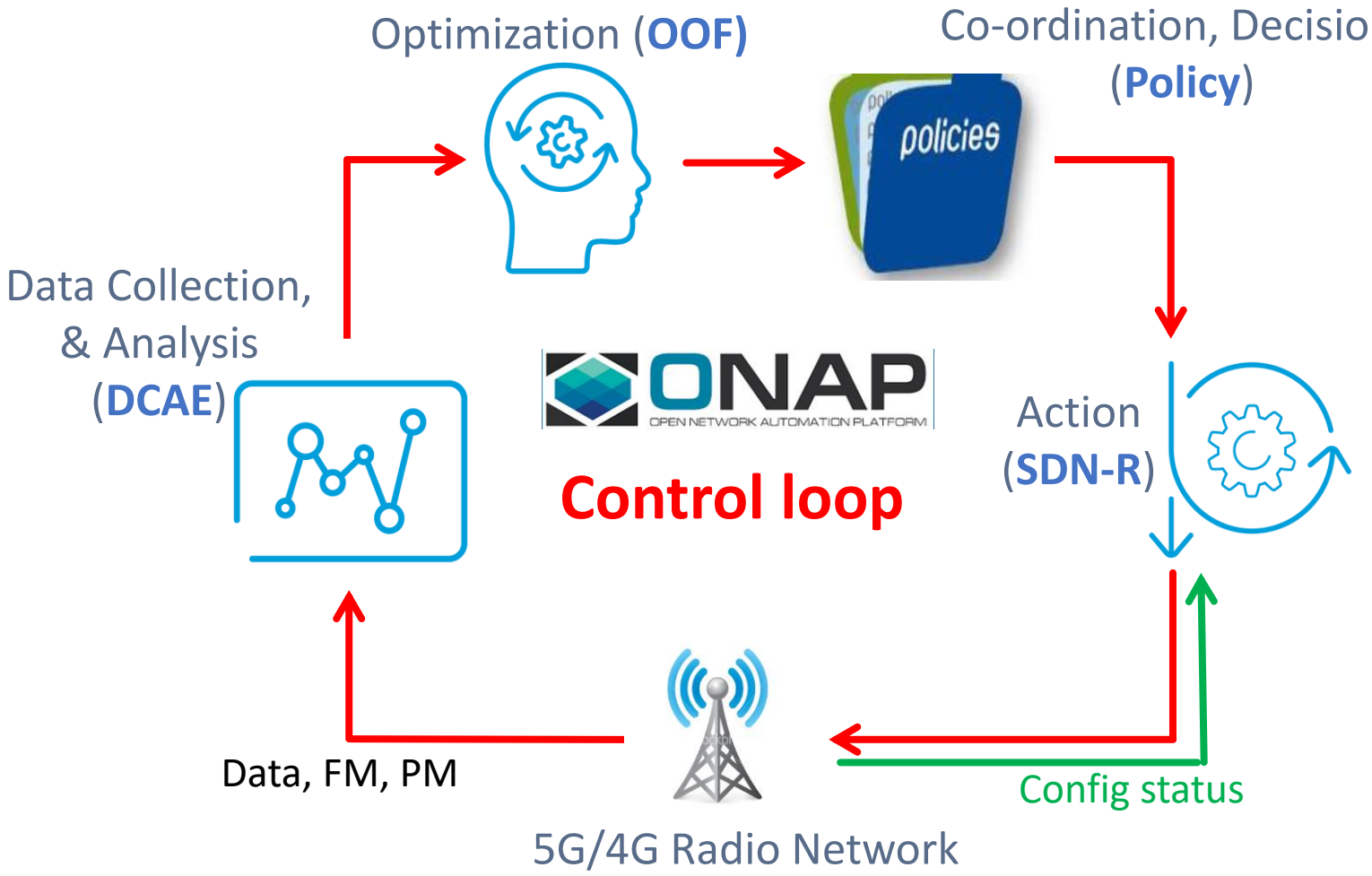
- 10 Ubuntu servers managed by OpenStack

Deployed ONAP modules at OWL

- Currently deployed ONAP components at OWL:
  - aaf
  - aai
  - consul
  - dcaegen2
  - dmaap
  - log
  - msb
  - oof
  - policy
  - portal
  - robot
  - sdnc
  - SNIRO Emulator
  - so

```
ubuntu@onap-control-1:~$ helm ls
NAME                    REVISION        UPDATED                         STATUS          CHART
demo                    1               Mon Jul 15 13:36:02 2019        DEPLOYED        onap-4.0.0
demo-aaf                1               Mon Jul 15 13:36:02 2019        DEPLOYED        aaf-4.0.0
demo-aai                1               Mon Jul 15 13:36:04 2019        DEPLOYED        aai-4.0.0
demo-cassandra          1               Mon Jul 15 13:36:12 2019        DEPLOYED        cassandra-4.0.0
demo-consul             1               Mon Jul 15 13:36:13 2019        DEPLOYED        consul-4.0.0
demo-dcaegen2           1               Tue Jul 16 05:55:34 2019        DEPLOYED        dcaegen2-4.0.0
demo-dmaap              1               Mon Jul 15 13:36:18 2019        DEPLOYED        dmaap-4.0.1
demo-log                1               Mon Jul 15 13:41:54 2019        DEPLOYED        log-4.0.0
demo-mariadb-galera     1               Mon Jul 15 13:41:55 2019        DEPLOYED        mariadb-galera-4.0.0
demo-msb                1               Mon Jul 15 13:41:57 2019        DEPLOYED        msb-4.0.0
demo-oof                1               Mon Jul 15 13:41:59 2019        DEPLOYED        oof-4.0.0
demo-policy             1               Mon Jul 15 13:42:03 2019        DEPLOYED        policy-4.0.0
demo-portal             1               Mon Jul 15 13:42:06 2019        DEPLOYED        portal-4.0.0
demo-robot              1               Mon Jul 15 13:42:08 2019        DEPLOYED        robot-4.0.0
demo-sdnc               1               Mon Jul 15 13:42:09 2019        DEPLOYED        sdnc-4.0.0
demo-sniro-emulator     1               Mon Jul 15 13:42:13 2019        DEPLOYED        sniro-emulator-4.0.0
demo-so                 1               Mon Jul 15 13:42:13 2019        DEPLOYED        so-4.0.0
ubuntu@onap-control-1:~$
```

ONAP-Based SON (Self Organizing Networks) (July 2019)



- SON ⇔ Control Loop (CL)
- ONAP: Open-source platform, with basic open-source code
- Companies can use framework to add proprietary SON solutions
- OOF-PCI Casablanca –
  - First ONAP SON PCI use case
  - PoC Demo in Dec 2018
- OOF-PCI Dublin
  - Added SON function: ANR
  - More SON data flows: FM, PM
  - More ONAP code integration

COSMOS Testbed

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Partners: New York City, Silicon Harlem, City College of New York, University of Arizona

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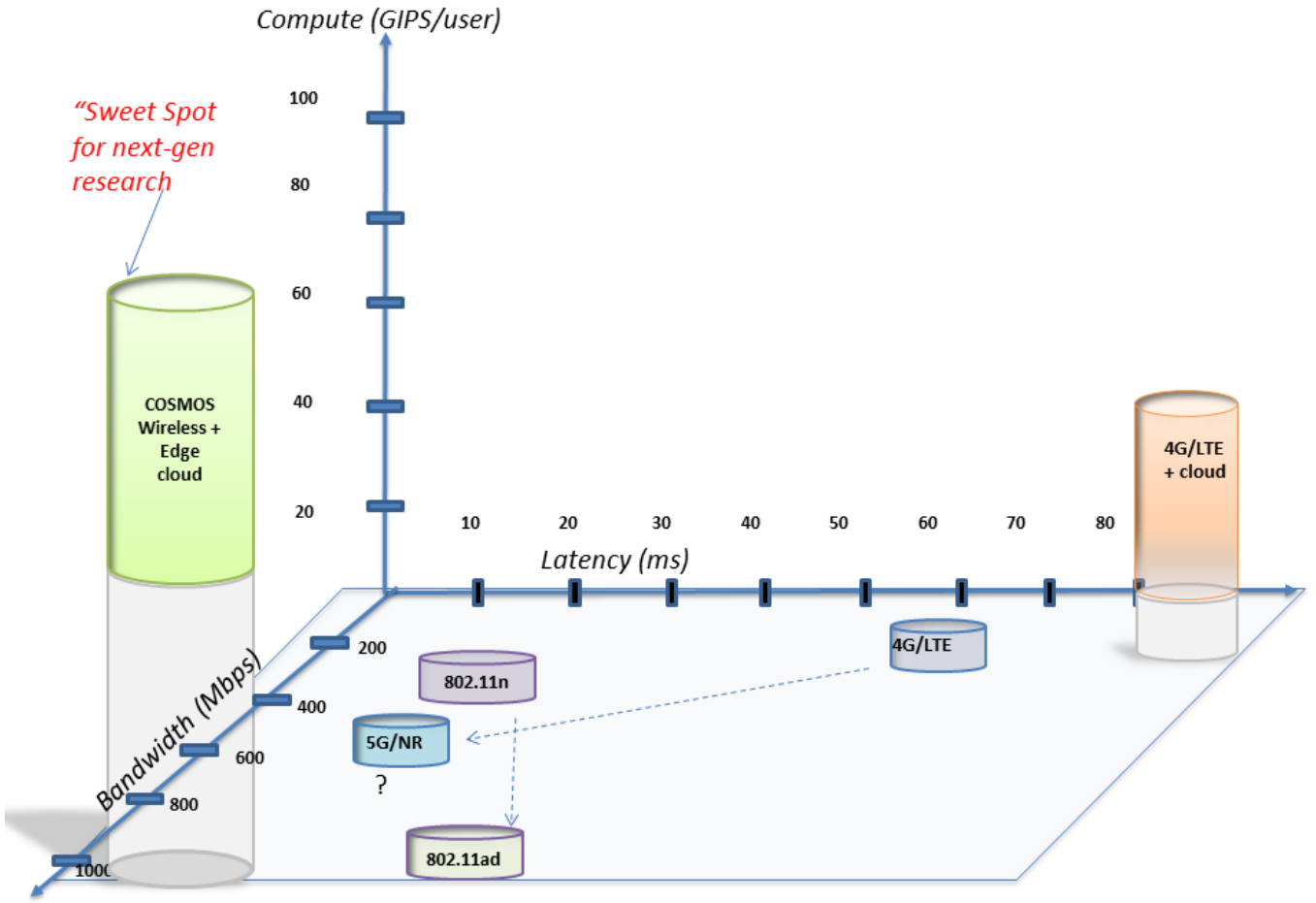
COSMOS Project Vision

- Latency and compute power are the two new dimensions for characterizing wireless access
- Latency for 4G cellular > 50 ms, while targets for 5G are <10 ms
- Edge computing is an enabler for real-time services
- COSMOS will enable researchers to investigate ultra-high speed (~Gbps), low latency (<5ms), and edge computing (~10-100 GIPS)
- COSMOS = Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment



COSMOS

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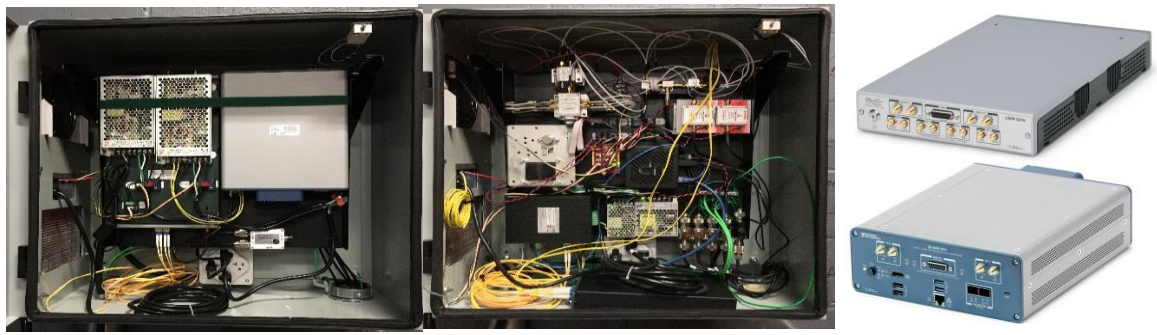
Key Technologies

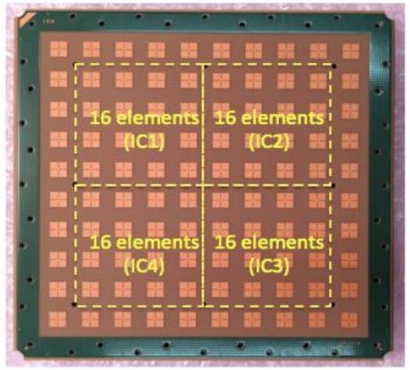
SDR

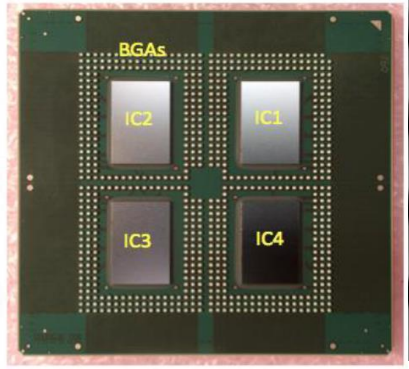
Design goal: 400 Mhz – 6 Ghz + 28 Ghz and 60 Ghz bands, ~500 Mhz BW, Gbps

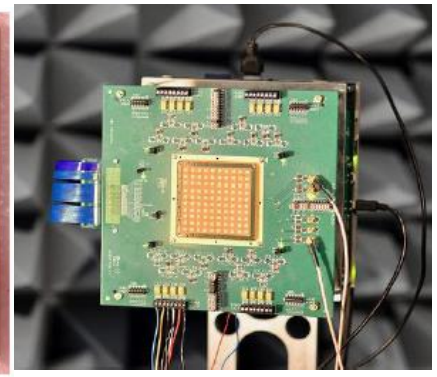


mmWave

IBM 28 GHz mmWave phased arrays (64 antennas with 1 or 8 beams)



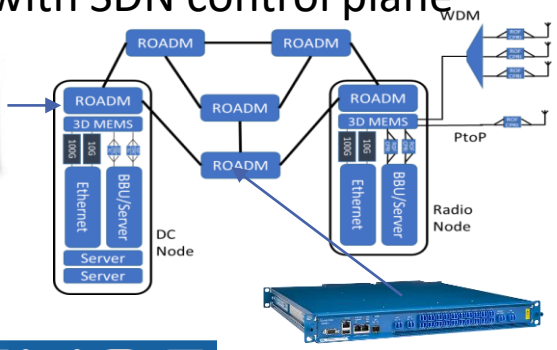




Optical Networking

Fast and low latency optical x-haul network using 3D MEMS switch and WDM ROADM - wide range of topologies with SDN control plane

MEMS Switch



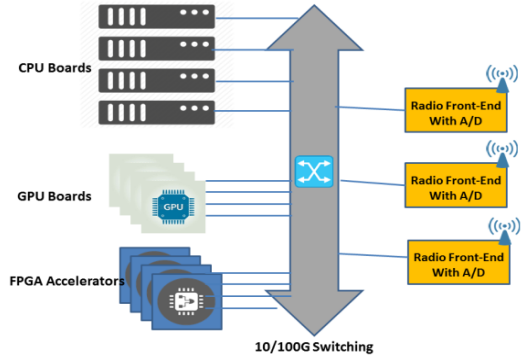
ROADM (whitebox)

fast front-haul/mid-haul/back-haul connectivity between radio nodes and edge cloud

SDN and (distributed) Cloud

Compute clusters with choice of CPU, GPU and FPGA proc.

SDN control plane used to control x-haul and (near) cloud server connectivity



Access to regular (far) cloud racks over L3

COSMOS

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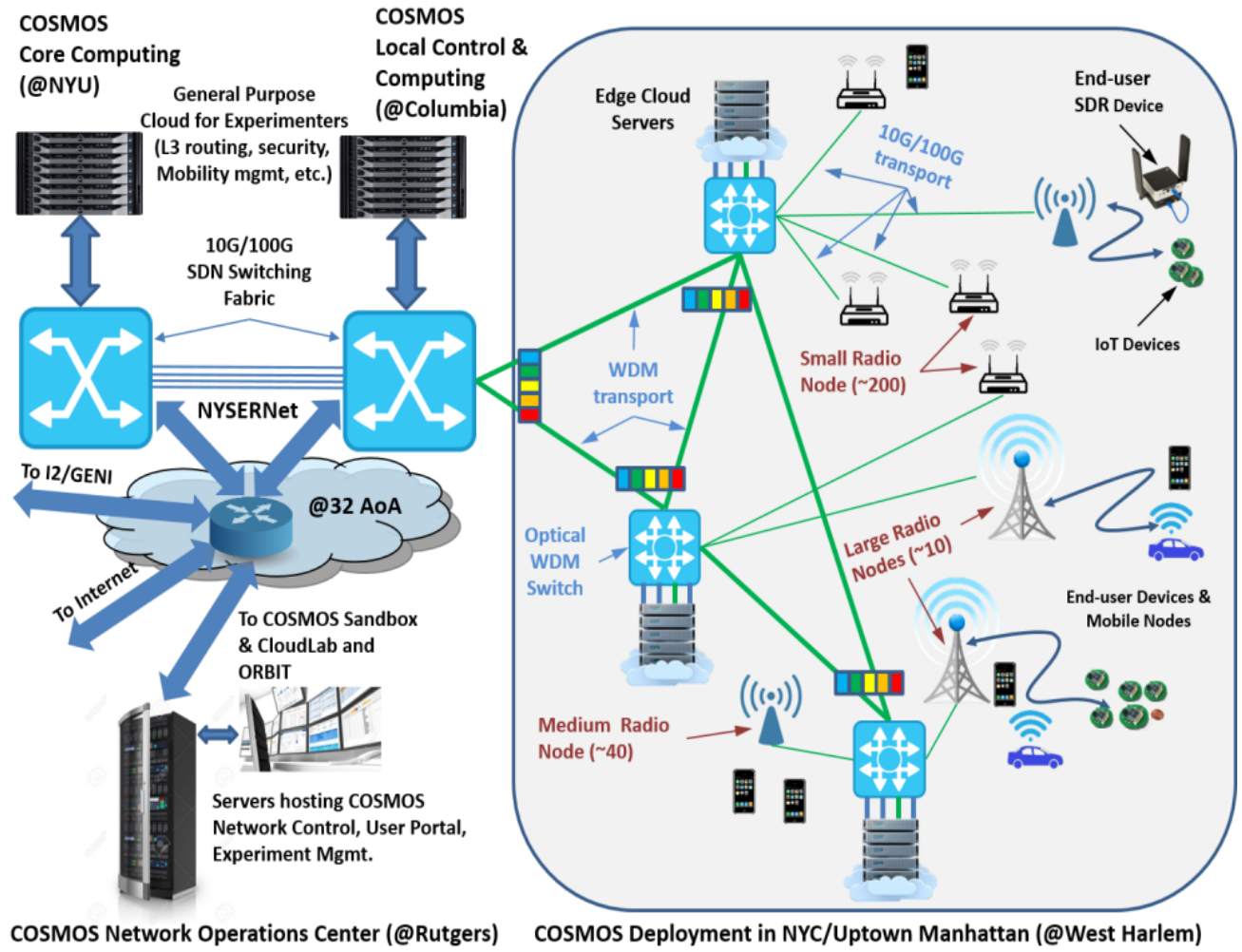
COSMOS: System Architecture

- System design based on three levels of SDR radio node (S,M,L) with M,L connected via fiber to optical WDM transport
- SDN-based backhaul and compute services, with access to ORBIT, GENI…
- COSMOS control center and general purpose cloud at Rutgers via 32 AoA PoP




COSMOS Deployment Map
Morningside Heights
Site Ownership:
DOE
CCNY
CU
NYCHA
DOT
Existing Fiber Plant:
Nysernet
ZenFi
CUIT Network
Deployment:
Large node: rooftop deployments with number of antennas and edge cloud
Medium node: street-level devices dual use with wireless/wired backhaul
Control Center: CRAN, control, management and operations center

West Harlem Innovation Zone

FCC NEWS from the Federal Communications Commission

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For Immediate Release

FCC ESTABLISHES FIRST TWO INNOVATION ZONES

New York City & Salt Lake City Projects Empower Advanced Wireless Technology and 5G-Ready Network Experimentation

Frequency Band	Type of operation	Allocation	Maximum EIRP (dBm)
2500-2690 MHz	Fixed	Non-federal	20
3700-4200 MHz	Mobile	Non-federal	20
5850-5925 MHz	Mobile	Shared	20
5925-7125 MHz	Fixed & Mobile	Non-federal	20
27.5-28.35 GHz	Fixed	Non-federal	20
38.6-40.0 GHz	Fixed	Non-federal	20

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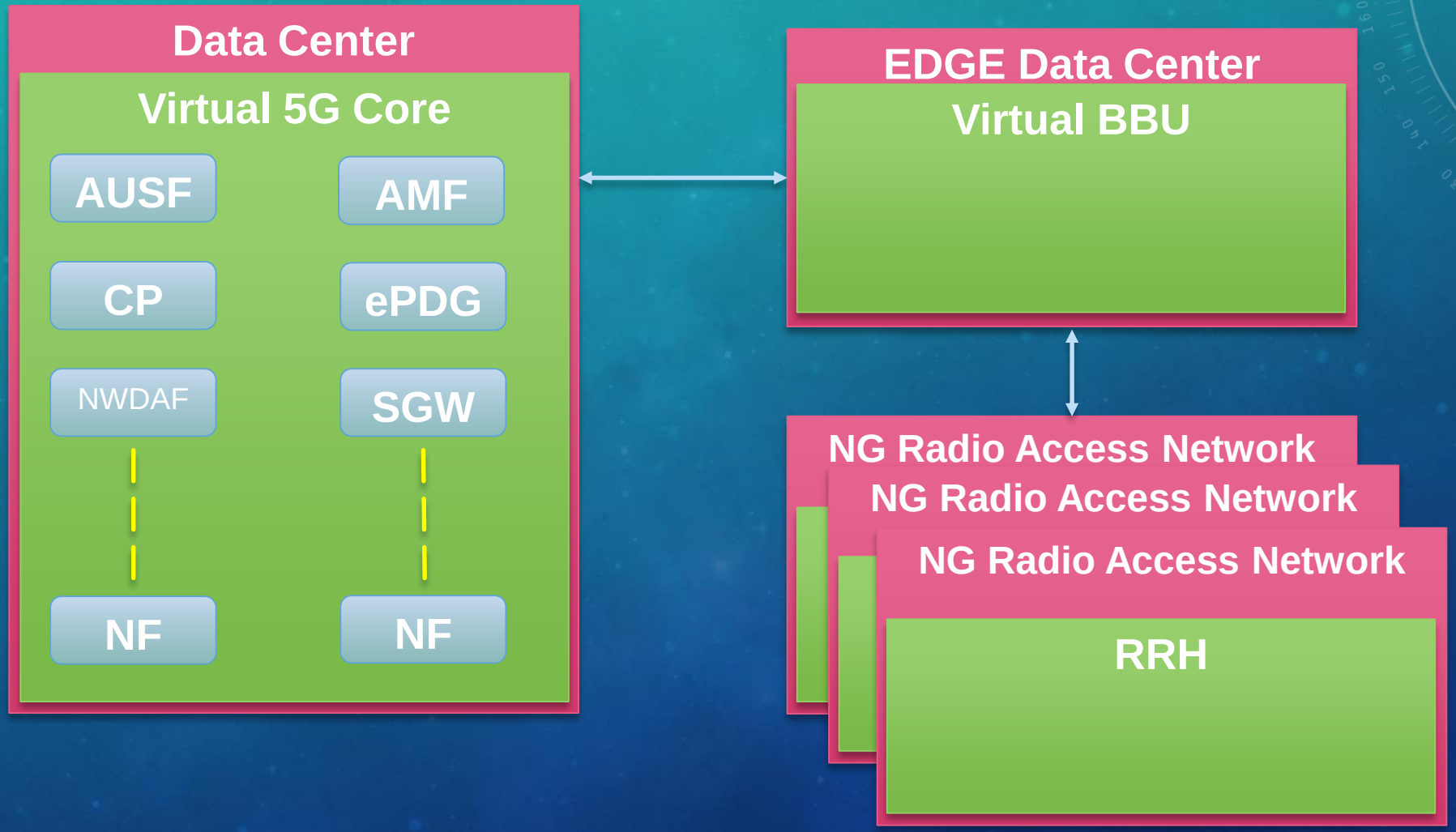
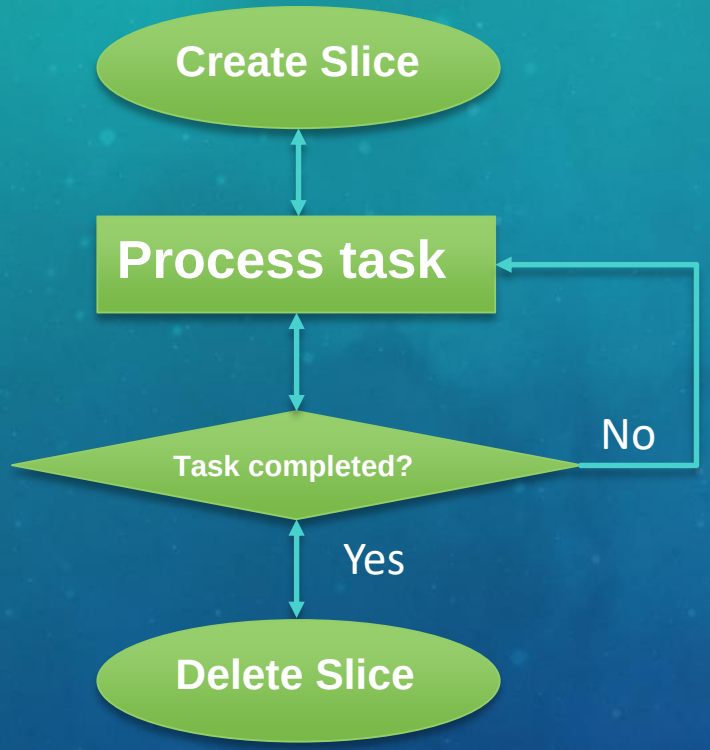
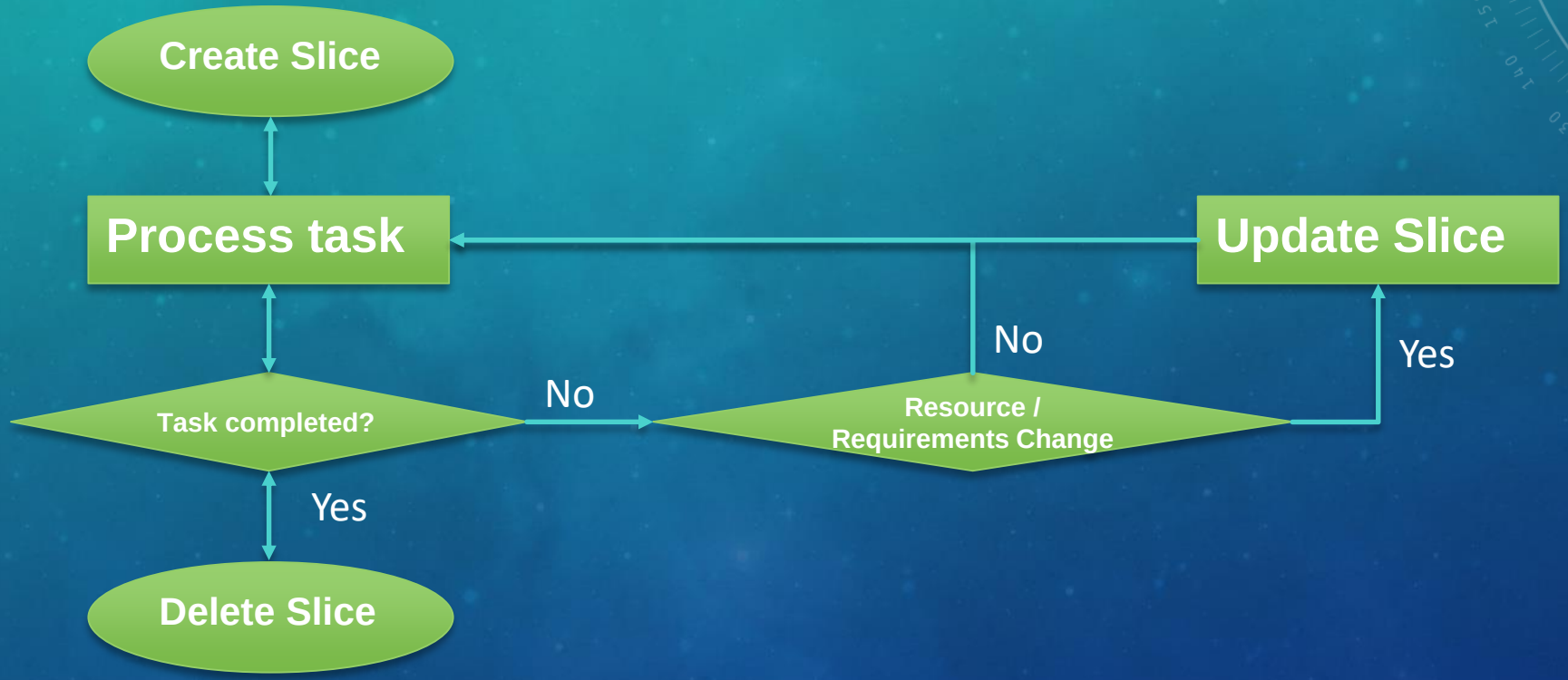
3GPP NETWORK SLICING: SLICE COMPONENTS



“STATIC” (TRADITIONAL) SLICING



DYNAMIC SLICING



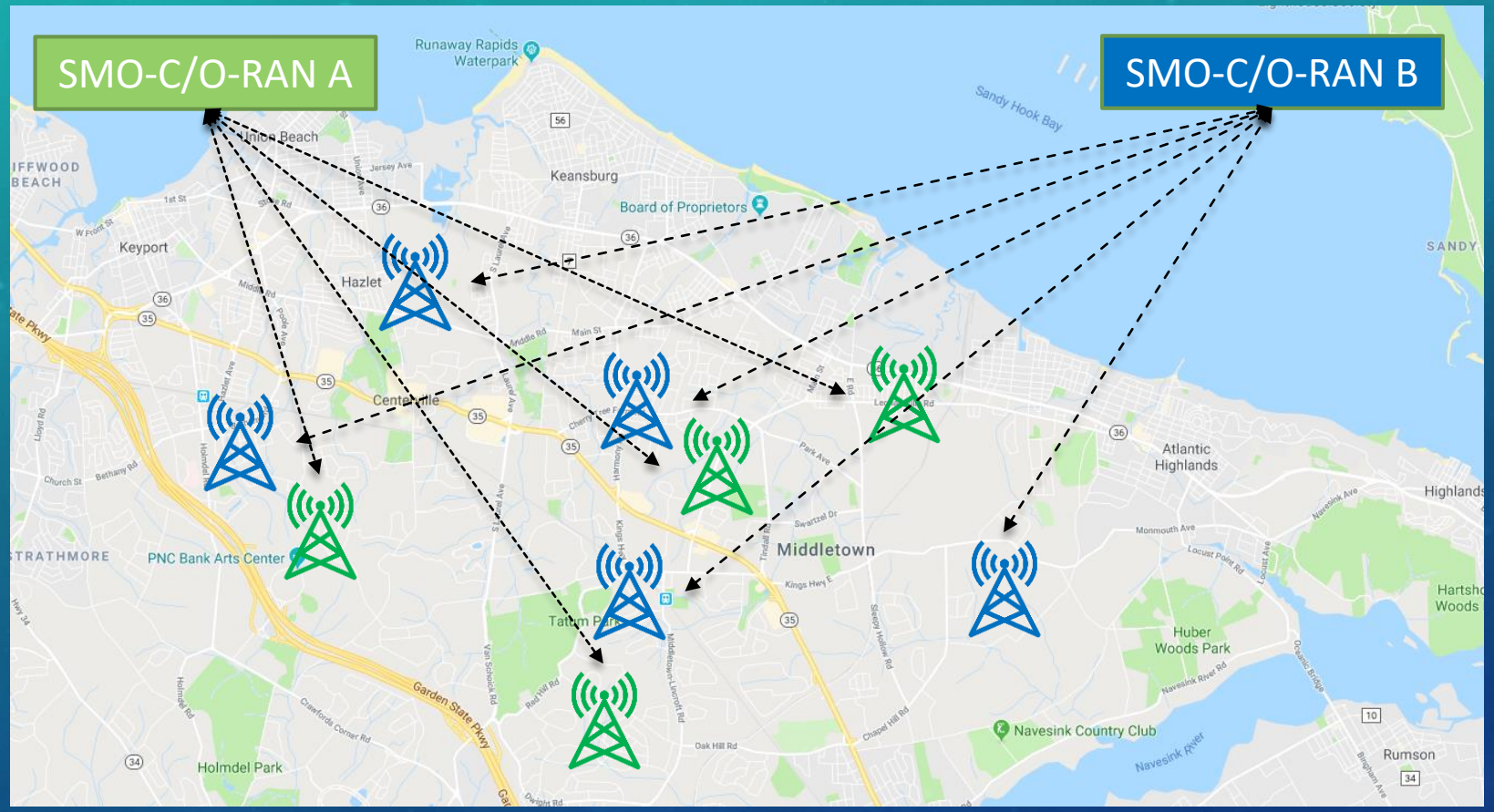
HOW TO REALIZE DYNAMIC SLICING?

- Common Open Service Management and Orchestrator Controller (SMO-C): e.g., ONAP
- Open Standard 5G Core and nGR APIs.
  - nGR management and control APIs: e.g., O-RAN
  - 5G Core management and control APIs: ?

USE CASE SCENARIO: DISASTER

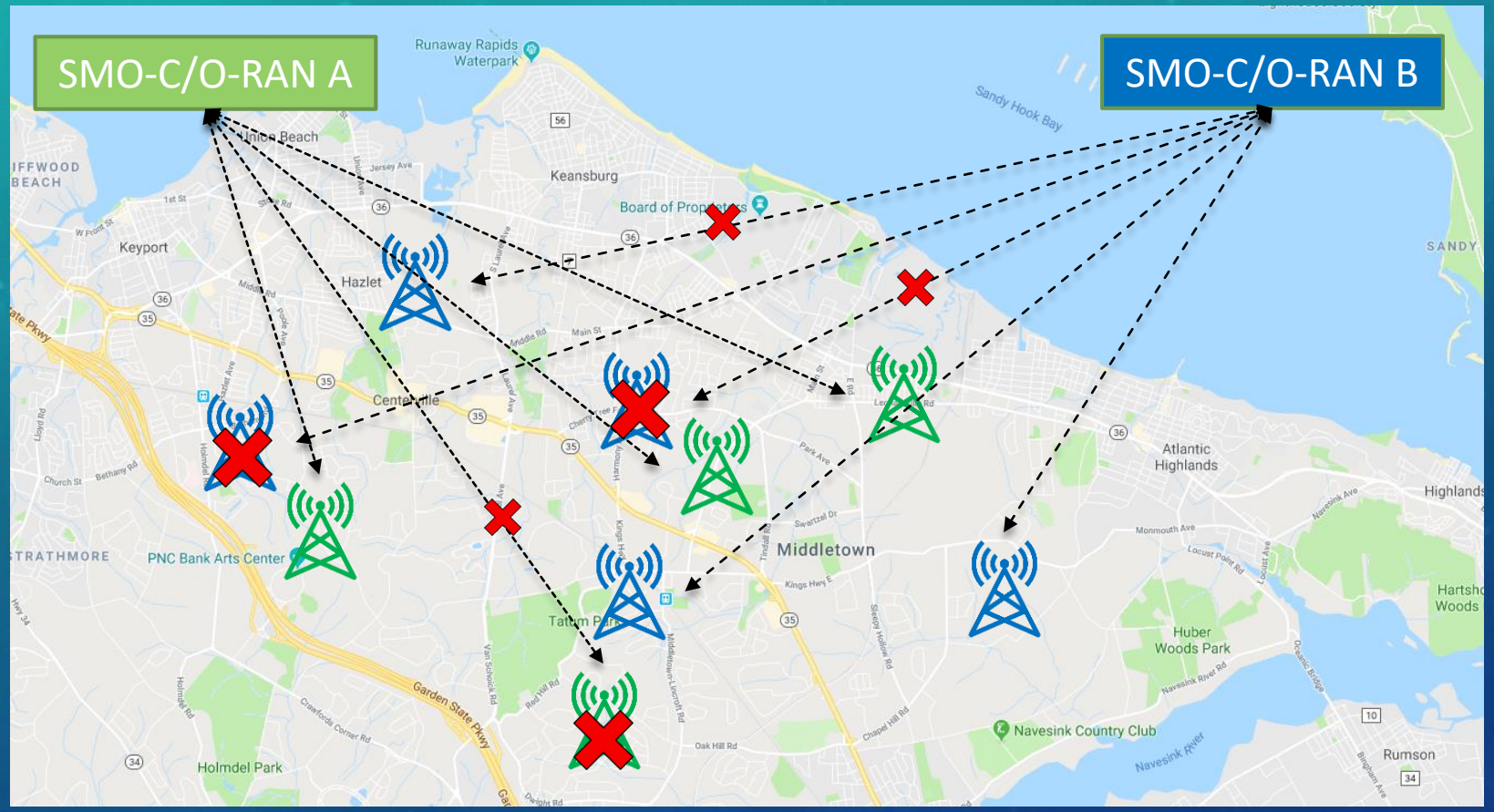
Physical event	Network event
Earthquake / Tsunami / Wild Fire	**Massive network outage**
	Verify the active/available mobile RANs/NEs
	Create the disaster recovery slice across all operators based on available network resources
Set out for Emergency/Paramedics/Police team for help, aid and assist	**Adjust the slice dynamically based on situation and for the desired period of disaster recovery**
Full service restoration	**Delete the slice**

DYNAMIC NETWORK SLICING REALIZATION (1)



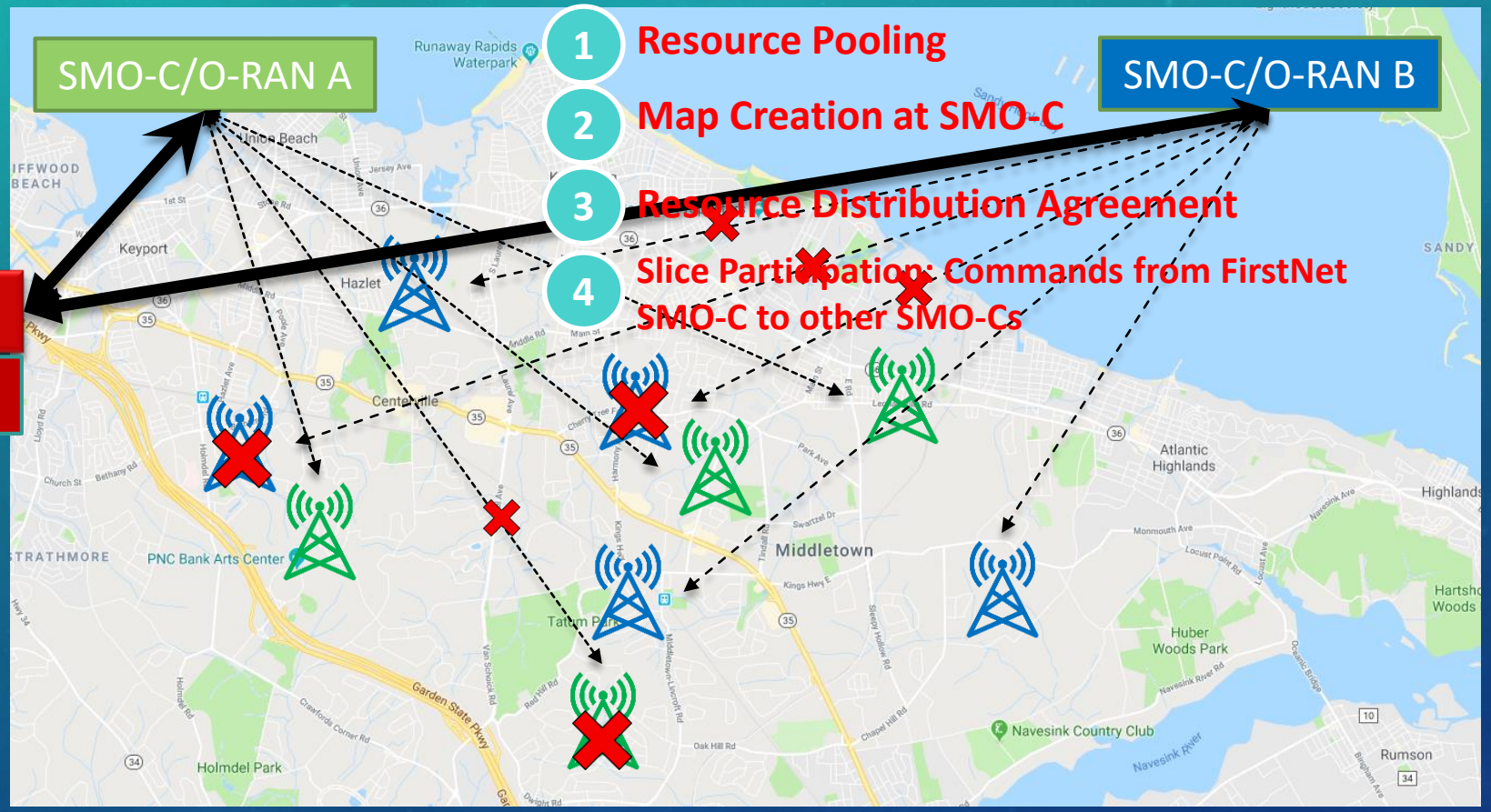
Normal Operation

DYNAMIC NETWORK SLICING REALIZATION (2)



Disaster

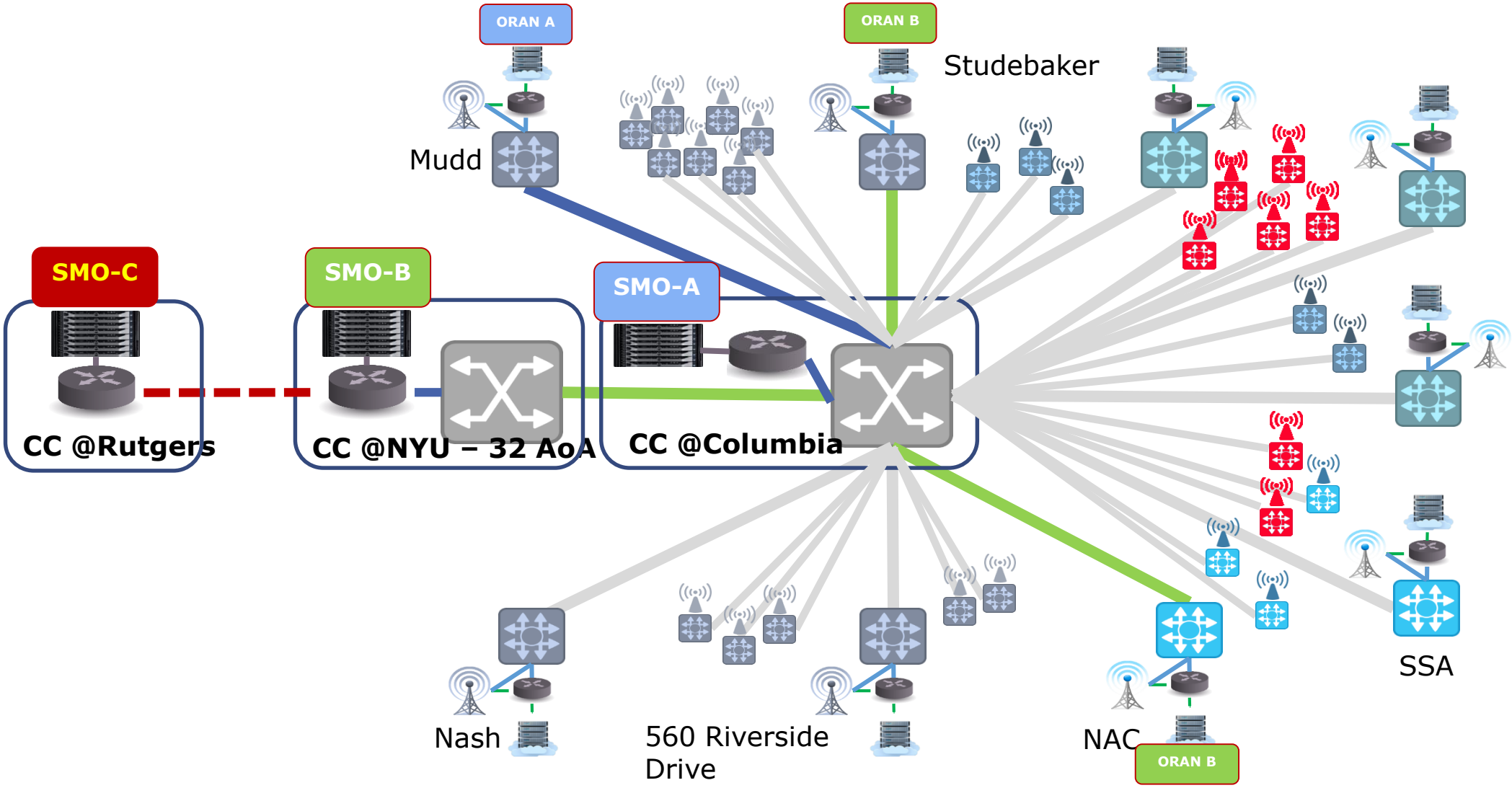
DYNAMIC NETWORK SLICING REALIZATION (3)



Additionally, SMO-C/O-RAN-C can interface the existing Centralized Approach (if they are partly damaged) controllers

Recovery:

Dynamic Slices on COSMOS



References

- ONAP: https://wiki.onap.org
- ORAN: https://www.o-ran.org/
- ORBIT: https://www.orbit-lab.org/
- COSMOS: https://www.cosmos-lab.org/