



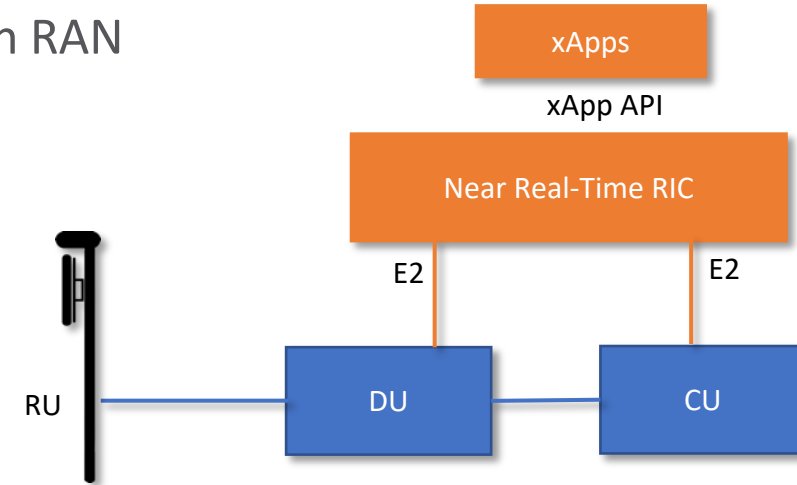
O-RAN ARCHITECTURE CONSISTENT  
μONOS-BASED CLOUD-NATIVE nRT-RIC AND xAPPS PLATFORM

# RAN Market is Poised for Disaggregation

- O-RAN Alliance is defining architecture and APIs for Open RAN
  - Formed by operators to help advance Open RAN agenda



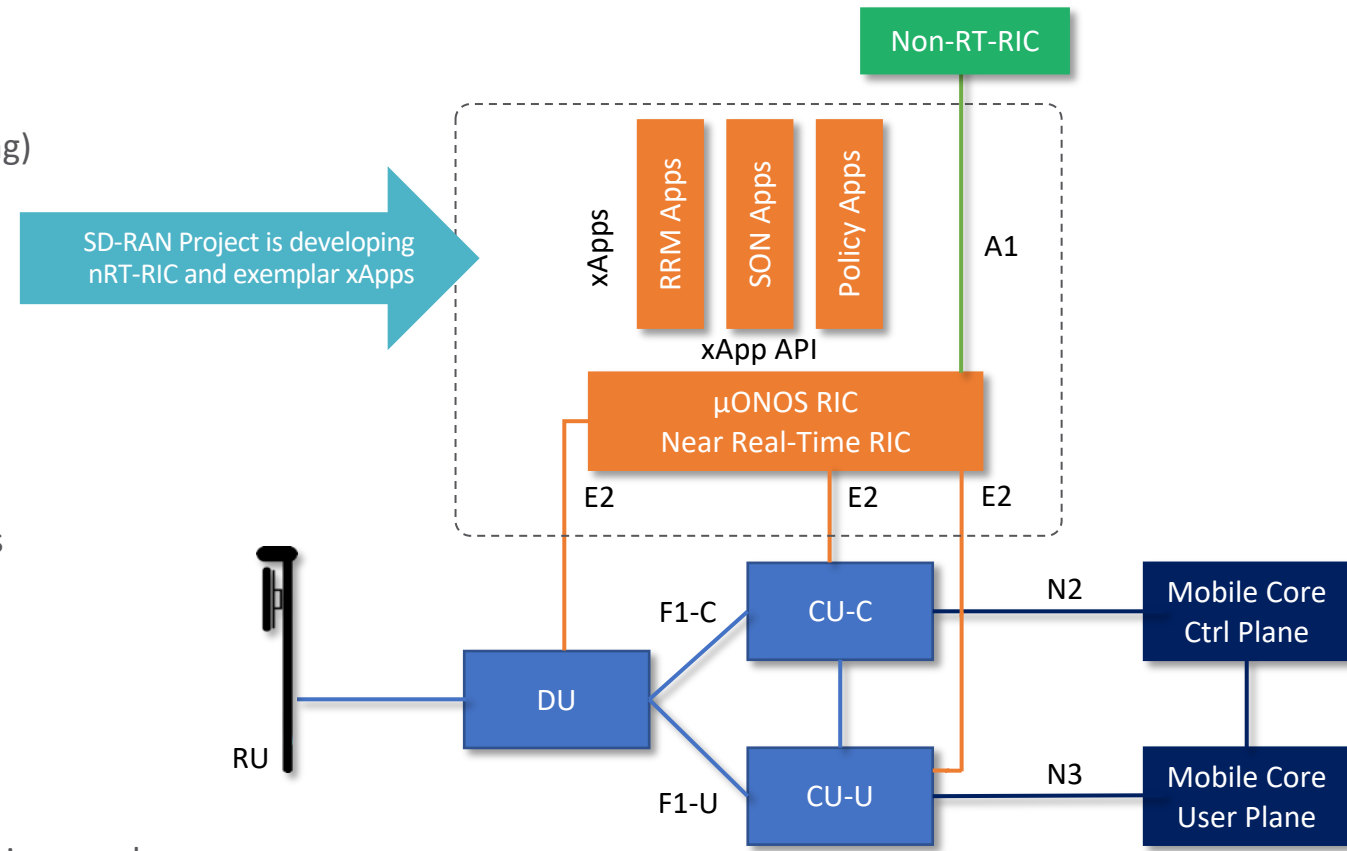
O-RAN Alliance is disaggregating the RAN architecture



- But - Vendors have been slow to embrace opening control to RIC and xApps
- Operators are advocating for RIC-based solutions via partnership with ONF
  - Operators want powerful RIC, xApps and multi-vendor interoperability
  - History has shown that an implementation is necessary in order to help the market transform
  - SD-RAN project is filling this void with a cloud-native open source implementation

# SD-RAN Overview and Goals

- The SD-RAN project is building:
  - nRT-RIC based on ONOS ( $\mu$ ONOS-RIC)
  - Exemplar xApps (starting with handover and load balancing)
- SD-RAN Goals:
  - Prove what is possible with nRT-RIC xApps
  - Accelerate the adoption of the O-RAN architecture
  - Accelerate availability of interoperable O-RAN components
  - Catalyze creation of an xApp ecosystem and industry
- Will follow O-RAN and 3GPP standards
  - Only where necessary, will extend beyond standards to achieve goals
  - Any extensions will be contributed back to O-RAN in partnership with operators

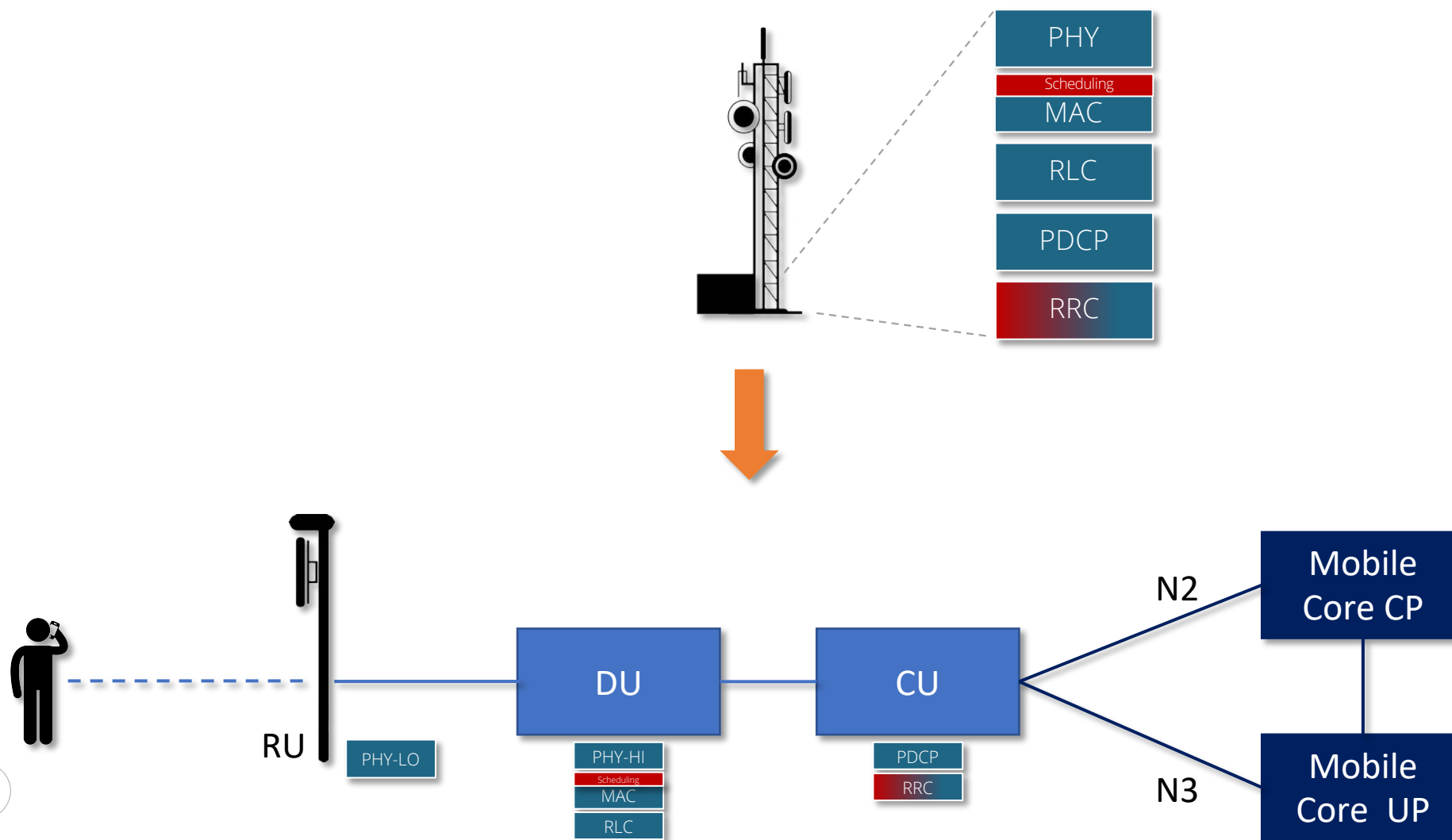


nRT-RIC and xApps are integral to the O-RAN architecture and vision

xApps will be responsible for advanced functions (like handover) that historically have been opaque vendor proprietary functions embedded in the base stations.

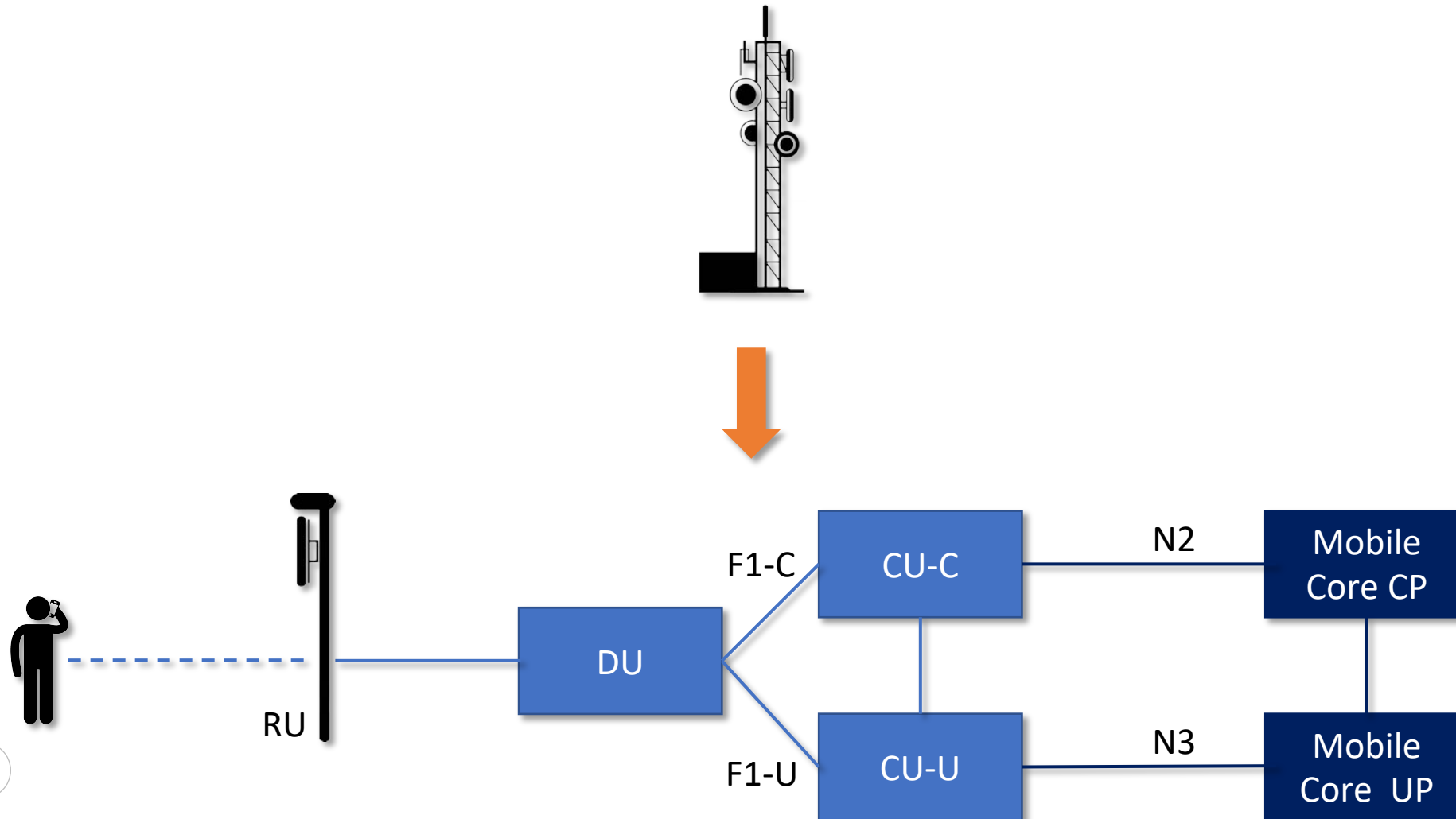
# RAN Disaggregation

## Step I: Horizontal Disaggregation



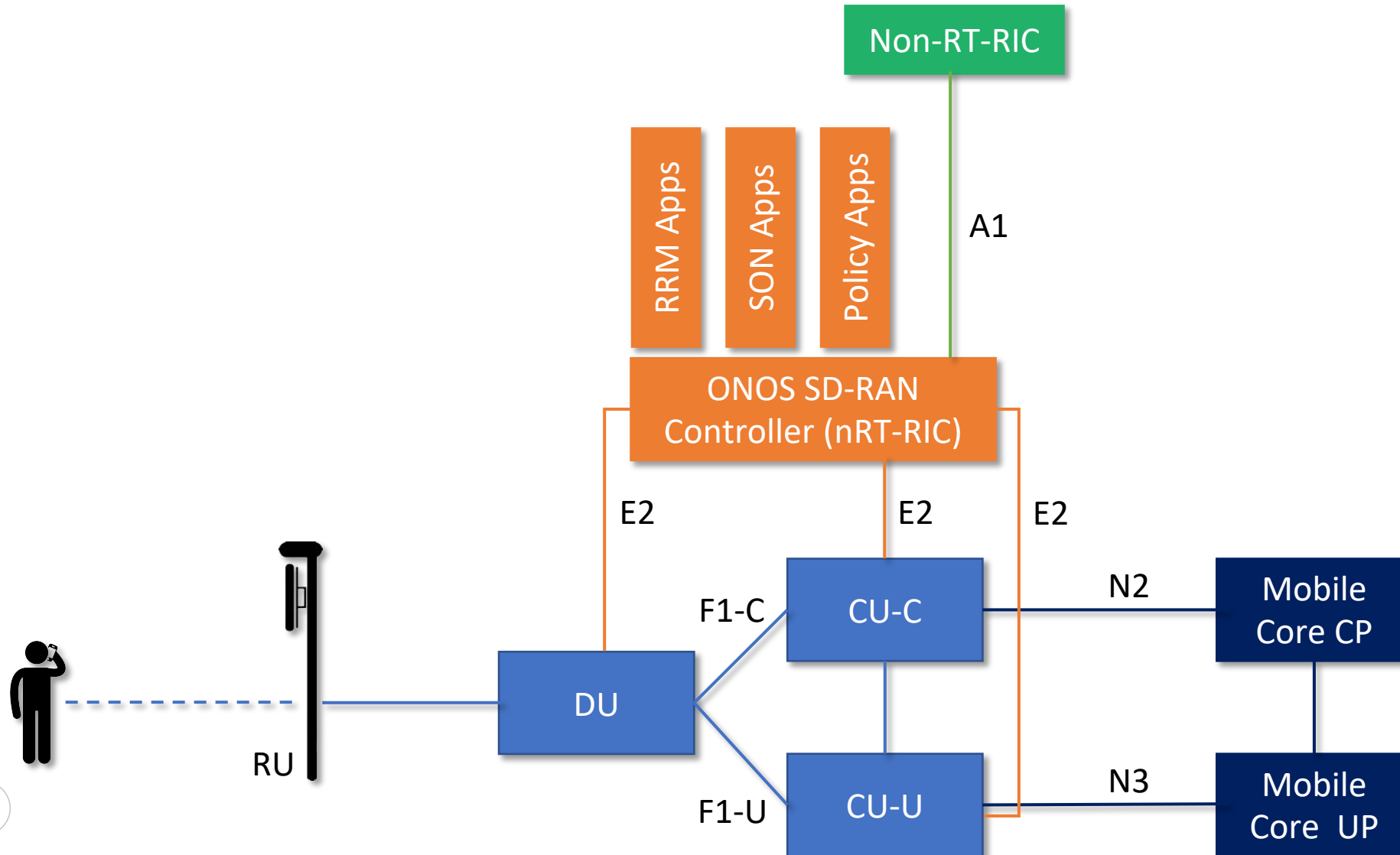
# RAN Disaggregation

## Step II: Vertical Disaggregation: CUPS

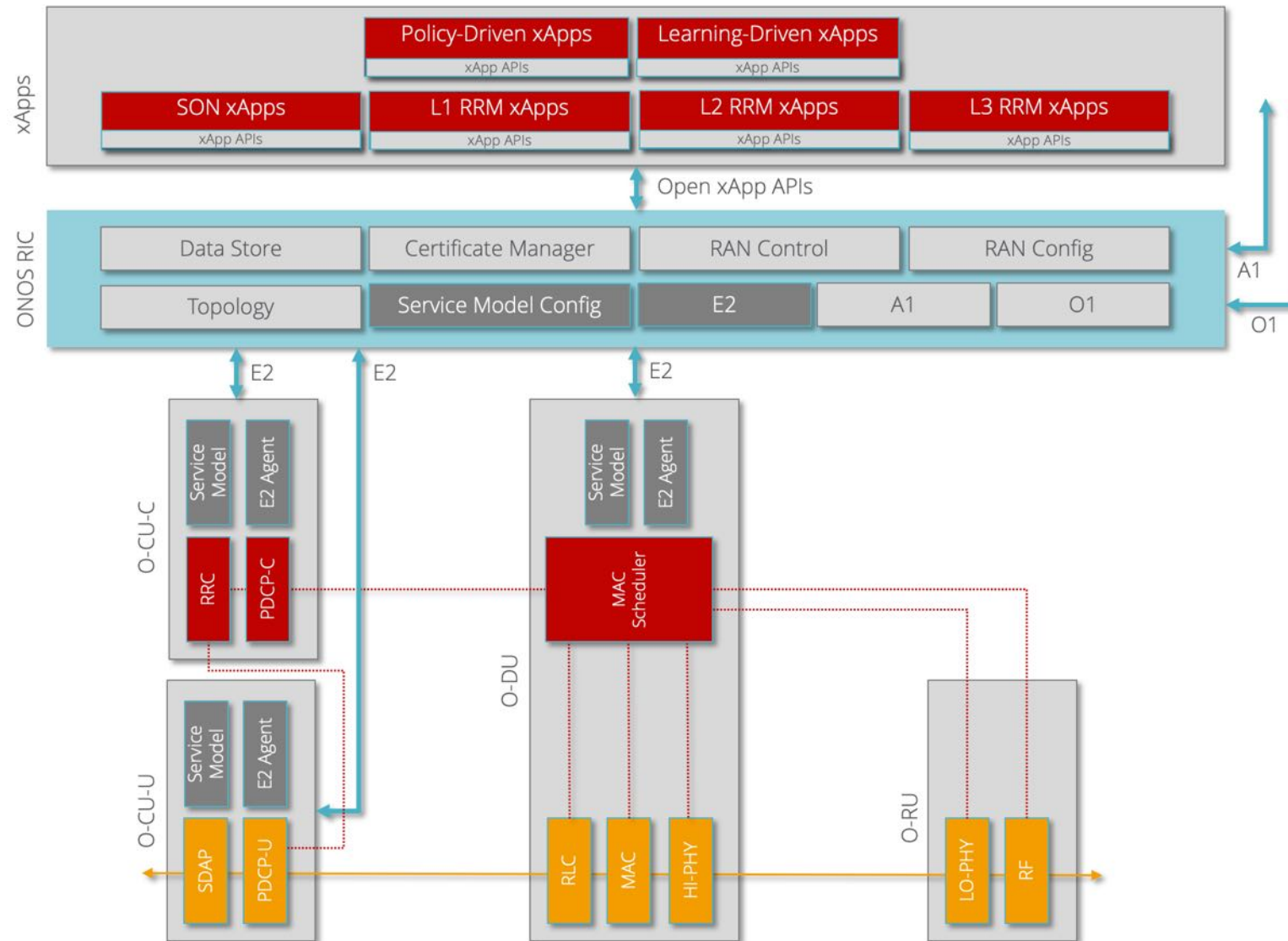


# RAN Disaggregation

## Step III: Vertical Disaggregation with SDN

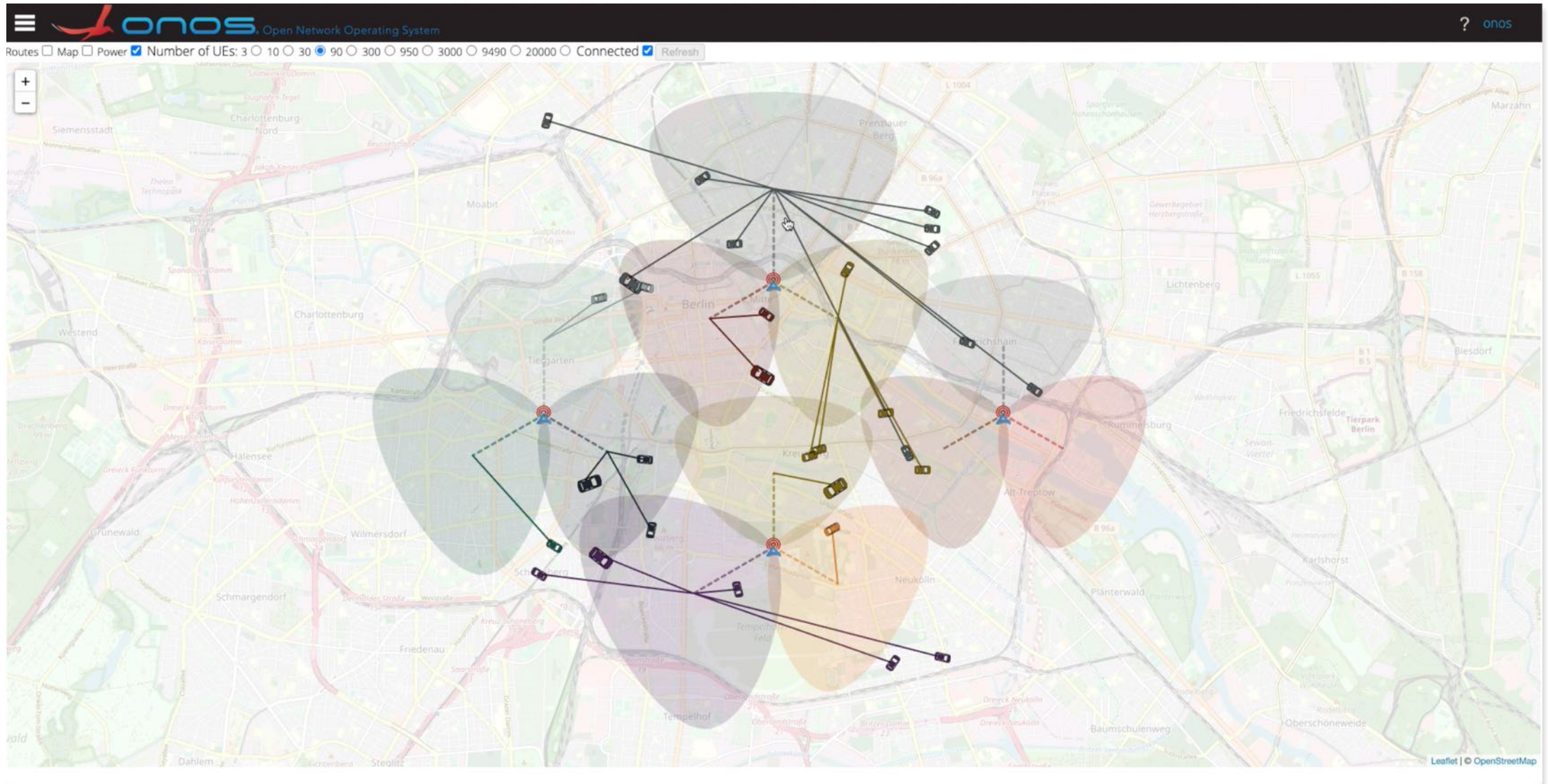


# μONOS-based SD-RAN Controller Platform





# $\mu$ ONOS RIC GUI





# $\mu$ ONOS RIC xApp Performance Monitoring / Alerts



# Initial Performance Results with the Highly Available $\mu$ ONOS nRT RIC

Handover xApp running on 2  $\mu$ ONOS nRT RIC instances with distributed stores providing scaling and HA

Cloud Native, Instances running on Aether Connected Edge (ACE)  
K8 with Flannel CNI on 2 servers  
CPU: X5650 @ 2.67GHz (Westmere), Physical cores: 24 cores (\* 2 thread), Memory: 48G

## Single Cluster Performance

Latency	Number of UEs		
	10,000	25,000	100,000
Average	0.8 ms	1.3 ms	1.5 ms
90%	1.3 ms	1.5 ms	1.5 ms
95%	1.9 ms	2.5 ms	1.9 ms
99%	4.6 ms	8.3 ms	4.4 ms



Compute Resources:

1x

3x

## Multi Cluster Performance

Latency	Number of UEs	
	10,000	100,000
Average	1.2 ms	2.3 ms
90%	1.6 ms	3.1 ms
95%	2.0 ms	3.4 ms
99%	6.1 ms	9.8 ms
100%	38 ms	57.7 ms

Network experiencing 200-300 handovers/sec

# SD-RAN Ecosystem

## Operators

Pushing for open transparent  
RAN solutions



TELECOM INFRA  
PROJECT

## Ecosystem of Organizations

Pushing for open RAN



## Technology Providers



## RAN Vendors



SD-RAN Project is open  
to working with additional  
RAN Vendors

