Large-Scale Experimentation Facilities Panel

Berlin 6G Conference 2025

July 2nd, 2025

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RUTGERS

WINLAB

Platforms for Advanced Wireless Research (PAWR)

- NSF public/private program ($50M + $50M)
- Managed by PAWR Project Office (NEU/US-Ignite)
- Build four “city scale” platforms in US
- Enable core wireless and mobile research
- Enable research related to services/applications that rely on wireless and mobile

POWDER
Salt Lake City

COSMOS
New York City

AIRPAW
Research Triangle

ARA
Central Iowa

First round completed in early 2018:

- POWDER-RENEW (University of Utah, Rice University)
- COSMOS (Rutgers University, Columbia University, New York University)

Second round winner early 2020:

- AERPAW (North Carolina State University, Mississippi State University, RENCI)

Third round winner July 2021:

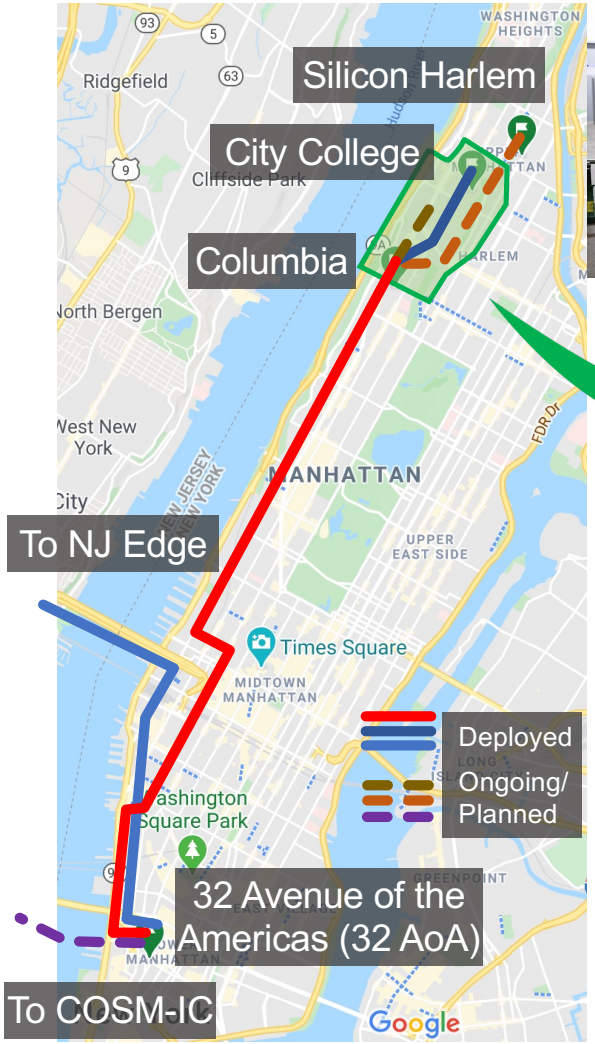
- ARA (Iowa State University)

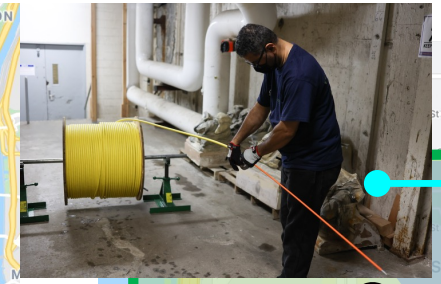
Additional facilities and resources:

- Colosseum - The world's most powerful wireless network emulator
- OpenAirX-Labs (OAX) - An end-to-end open source 5G software lab

Platforms for Advanced Wireless Research

COSMOS: Deployment





- Large Node
- Medium Node
- Columbia
- CCNY
- Light Poles
- Public Schools
- Public Housing
- Pilot
- Phase 1

Large (rooftop)

Medium (street-level)

Small (portable)

COSMOS Experimental Licenses

FCC Innovation Zone: “The New York City Innovation Zone encompasses area bounded by W 120th Street on the south, Amsterdam Avenue to the east, W 136th Street to the north and Hudson River on the west”

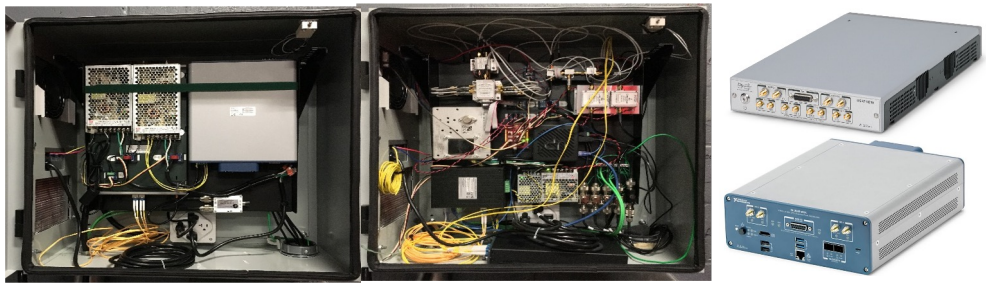
Frequency Band	Type of operation	Allocation	Maximum EIRP (dBm)
2500-2690 MHz	Fixed	Non-federal	20*
3700-4200 MHz	Mobile	Non-federal	20*
5850-5925 MHz	Mobile	Shared	20*
5925-7125 MHz	Fixed & Mobile	Non-federal	20*
27.5-28.35 GHz	Fixed	Non-federal	40*
38.6-40.0 GHz	Fixed	Non-federal	40*

(Additional) Program Experimental License: at Rutgers, Columbia and CCNY campuses

COSMOS Key Technologies

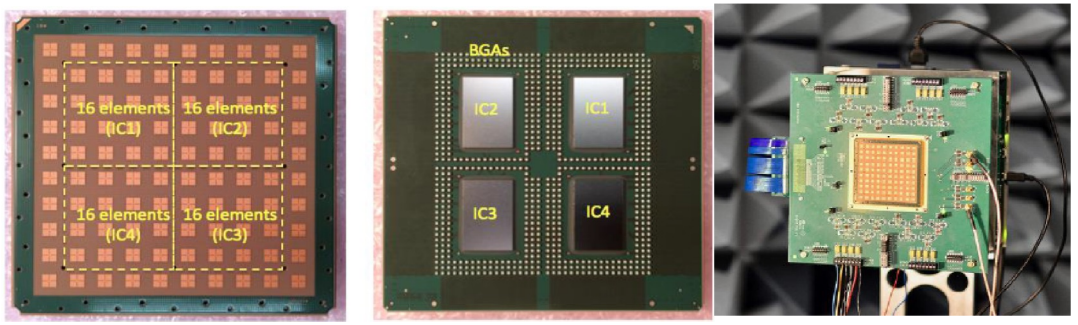
SDR

Design goal: 70 Mhz – 6 Ghz + 28 Ghz and 60 Ghz bands, ~500 Mhz BW, Gbps



mmWave

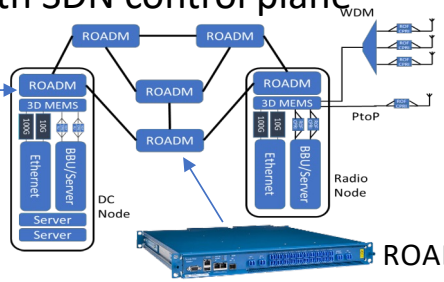
IBM 28 GHz mmWave phased arrays (64 antennas with 1 or 8 beams)



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



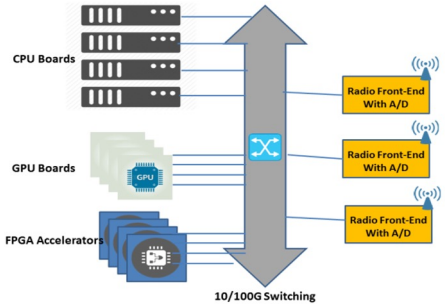
fast front-haul/mid-haul/back-haul connectivity between radio nodes and edge cloud

ROADM (whitebox)

SDN and (distributed) Cloud

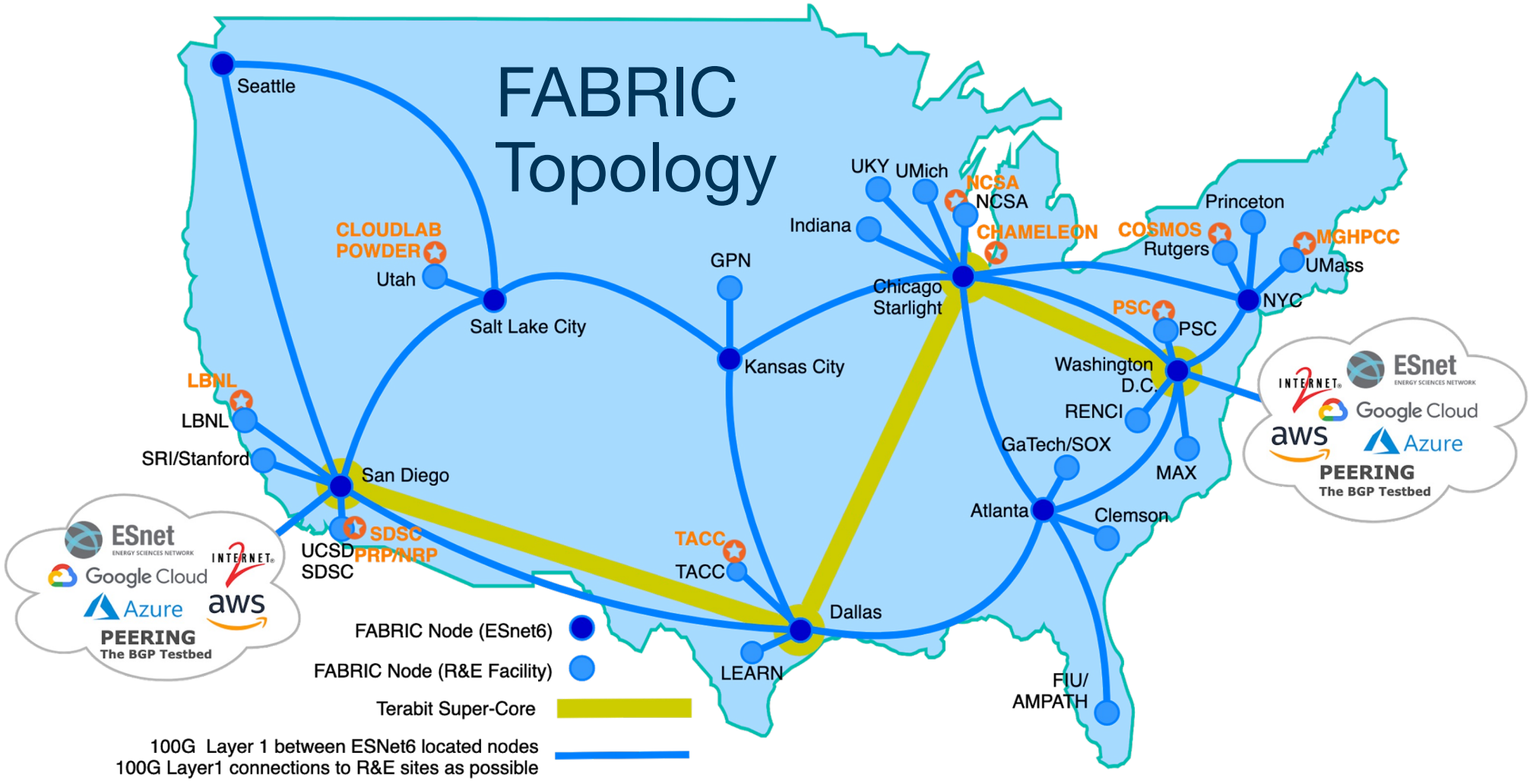
Compute clusters with choice of CPU, GPU and FPGA proc.

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

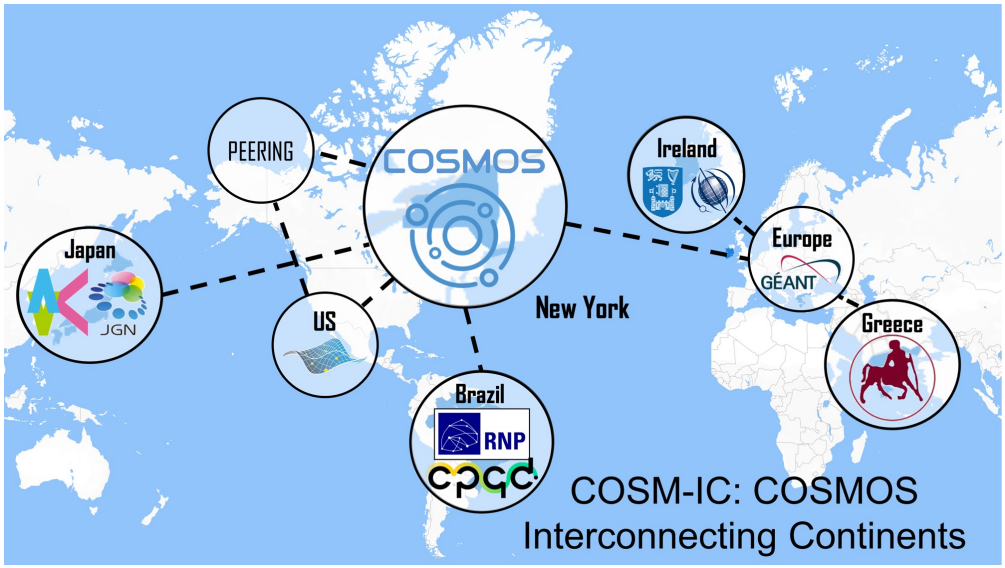


Access to regular (far) cloud racks over L3

COSMOS RUTGERS COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK NYU NYC <sh> The City College of New York THE UNIVERSITY OF ARIZONA IBM



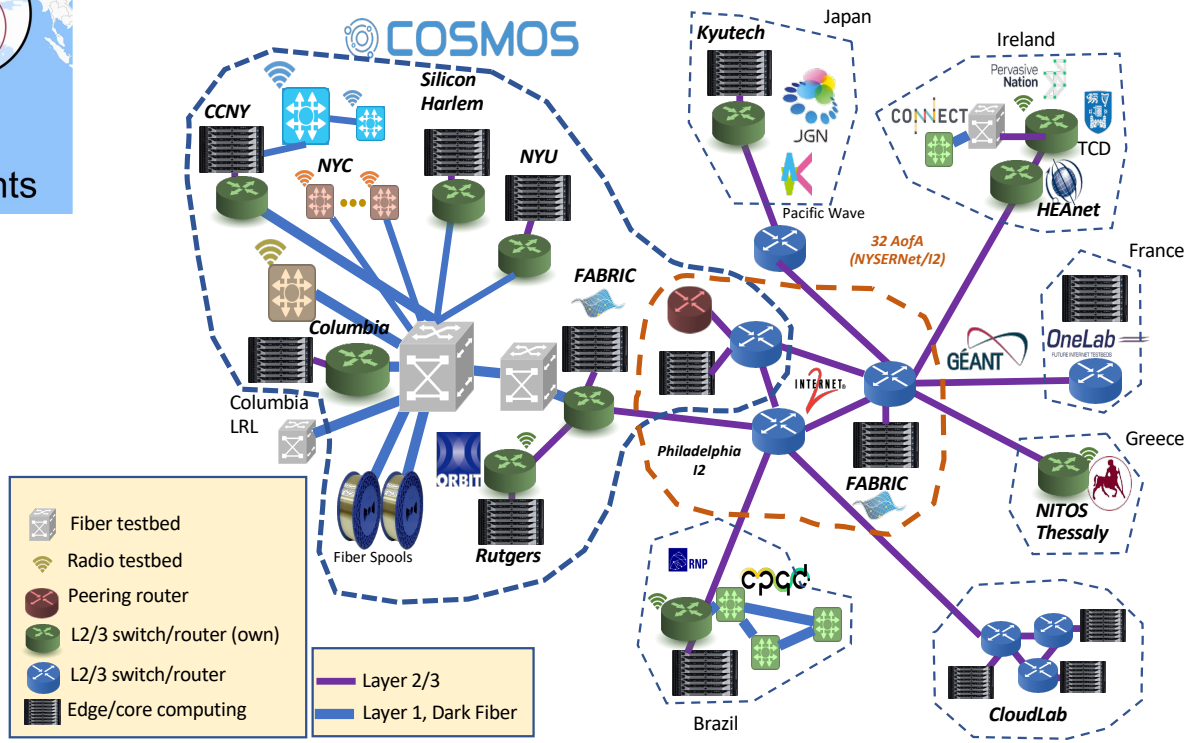
FABRIC Testbed



Implementation of connectivity between several wireless/optical/IoT testbeds to support global experimentation

Research Plan:

- Cross Layer SDX Experimentation
- Mininet Optical with Data-Driven Platform Models
- Federating with and via PEERING
- EIR (Edge Aware Interdomain Routing) Experimentation
- Education and Outreach



COSMOS · Columbia University in the City of New York · Rutgers · The City College of New York · Duke University · Princeton University · Syracuse University · NOAA-CESSRST

CHIPS and Science Act

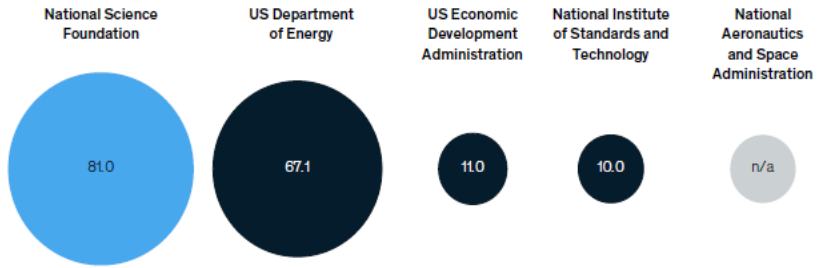
The Innovation Fund aims to facilitate the adoption of open and interoperable wireless networks by:

- Accelerating commercial deployment of open, interoperable equipment;
- Promoting and deploying compatibility of new 5G equipment;
- Managing integration of multi-vendor network environments;
- Identifying criteria to define equipment as compliant with open standards; and
- Promoting and deploying security features and network function virtualization for multivendor, interoperable networks.

Other recipients of FY 2021 NDAA / CHIPS Act funding

The CHIPS and Science Act authorizes $174 billion for investment in science, technology, engineering, and math programs, workforce development, and R&D.

CHIPS and Science Act funding 2022–27,[1] $ billion



[1]Final funding levels subject to future budget appropriations by US Congress.
Source: Congress.gov; Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022, H.R. 4346, 117th Cong. (2022)

McKinsey & Company

National Telecommunications & Information Administration

NOFO 1 (T&E Labs): Two specific research focus areas (SRFAs):

SRFA 1: Testing and Evaluation (T&E) Activities: Funded projects to expand testing and evaluation of open and interoperable 5G network equipment.

SRFA 2: Research and Development of Test and Evaluation Methods

NOFO 2 (Open RU Commercialization and Innovation):

SRFA 1: Open RU Commercialization: Accelerating the development of open RU products to meet carrier needs and prepare them for commercial trials.

SRFA 2: Open RU Innovation: Improving the performance and capabilities of open RUs through targeted research and development.

PWSCIF

U.S. DEPARTMENT OF COMMERCE NTIA NATIONAL TELECOMMUNICATIONS & INFORMATION ADMINISTRATION

What problems does ACCoRD aim to solve?

ACCoRD
Acceleration of Compatibility and Commercialization for Open RAN Deployments

FROM:	TO:
Geopolitics and time-consuming (lengthy) negotations within multinational standards development organizations (SDOs) and open source communities	Focus on **US-based MNOs** and requirements of US-based Public/Private customers with international reach that excludes untrusted entities
Fixation on rigid conformance with O-RAN specifications	Flexible "enlightened" approach to end-to-end (E2E) testing with **pass/fail based on performability ranges** instead of conformance with specifications
Making a "splash" and sending out press releases whenever novel capabilities "work" even if there is no indication of eventual deployment-readiness	Focus on **deployment-readiness**, e.g., supplier-agnostic computing solutions, security capabilities (ZT), and resilience, instead of novelty
All-inclusive approach that makes no distinction between products that are on the cusp of deployment-readiness versus "wannabes"	Hybrid approach: **NTIA ACCoRD labs for Open RAN products that are imminently deployable**; neutral host facility (NHF) for promising newcomers
Greenfield approaches to Open RAN acceleration even though rip-&-replace is **NOT** an option for commercial 5G/LTE networks upon which customers rely	Brownfield approaches to insert Open RAN technologies in single-vendor RAN incrementally **without sacrificing security or performability**
Three main, mostly disconnected, stakeholder groups: industrial, academic and standards/alliance compliance bodies	**"Big Tent" approach for closer collaboration and coordination** among MNOs, 5G technology suppliers, universities, SDOs, and open source
Testbed inconsistencies, lack of testbed interoperability events, lack of cooperation (federation) between testbeds	Cloudified Federated Lab as a Service (**CFLaaS**) with Bring Your Own Software / Bring Your Own Device (**BYOS/BYOD**) and **reproducible results**

AT&T verizon

ACCoRD CFLaaS from the perspective of MNO Hub | **Dallas**

DORADO: Diagnostics for Open RAN Deployment and Operations

ACCoRD
Acceleration of Compatibility and Commercialization for Open RAN Deployments

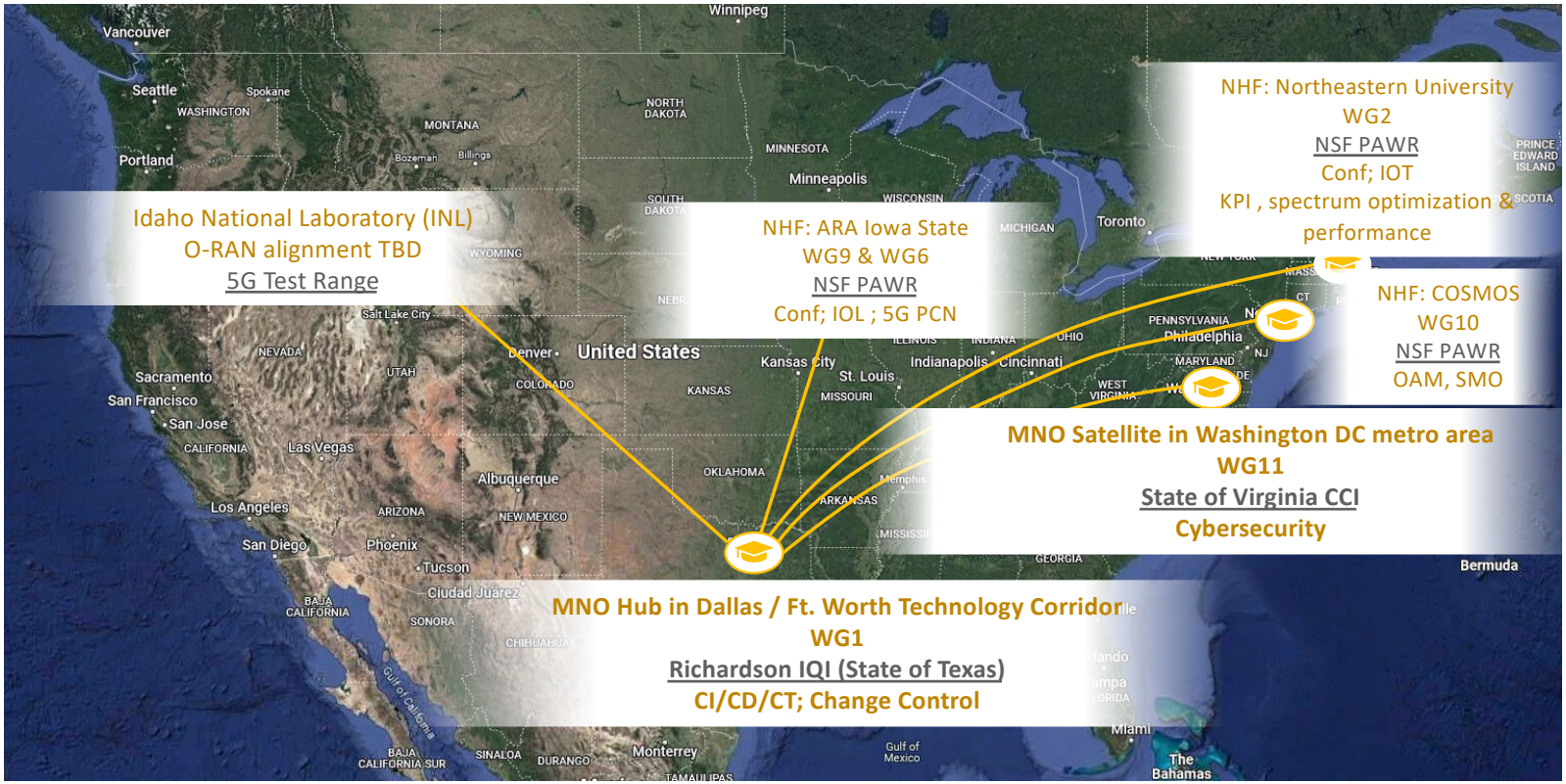
One ACCoRD lab with multiple testbeds and test networks directed by US-based MNOs with collaboration and technical support internationally.

Lab-as-a-Service (LaaS) model; Bring Your Own Software / Bring Your Own Device (BYOS/BYOD)
P3 (Public/Private Partnership)

GOAL: Rapid satisfaction of US MNO entrance criteria at reduced cost to accelerate deployment at scale

Entrance criteria include feature, performance, reliability, security parity with (or better than) conventional RAN

Does NOT replace MNO-specific pre-deployment Certification and FFA



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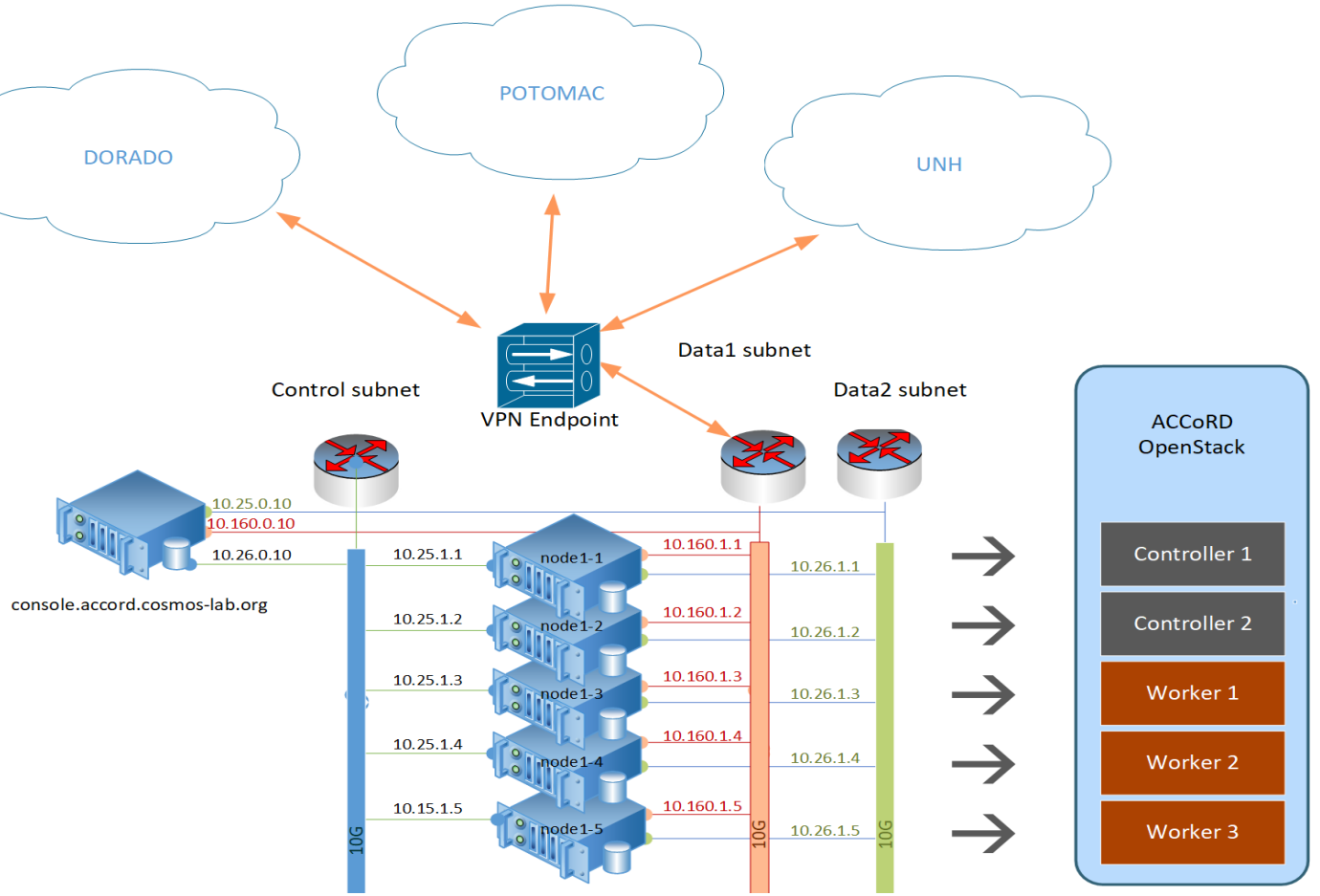
COSMOS Lab Inter-connectivity

ACCoRD
Acceleration of Compatibility and Commercialization for Open RAN Deployments



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POET: End-to-end & Emulated testing

Public Wireless Supply Chain INNOVATION FUND

Grafana Dashboards

Prometheus DB

MongoDB (Offline data)

Automated Data Collection

PDU power KPI (all physical equipment)

IPMI/ Redfish power KPI (all servers)

Kepler/ Scaphandre power KPI (VNF/CNF)

SMO/OAM (OFH-MP controller)

OAI, srsRAN, Amarisoft

Core ↔ CU ↔ DU

End-to-end testing

PTP GM Switch

RU-1

RU-2

RU-N

antennas

switches

cables

UE-Emulator

UE (Phone)

UE (Modem)

DU Emulator

Vector Signal Analyzer

Emulated testing

DC Power Supply

PDUs

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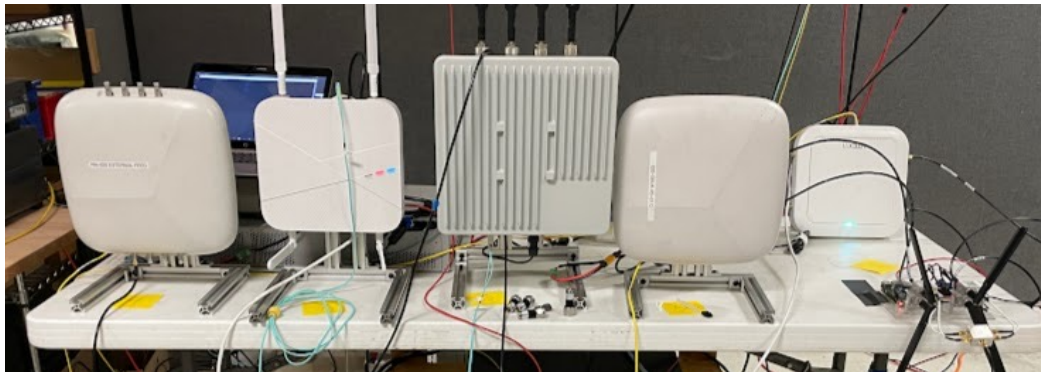
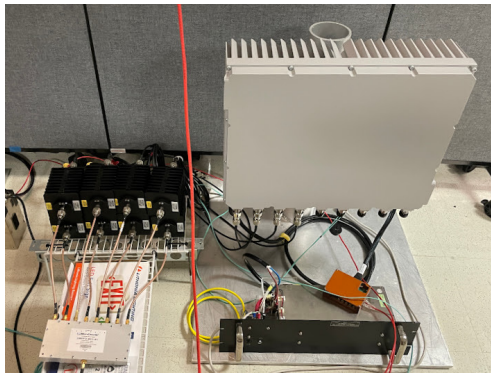
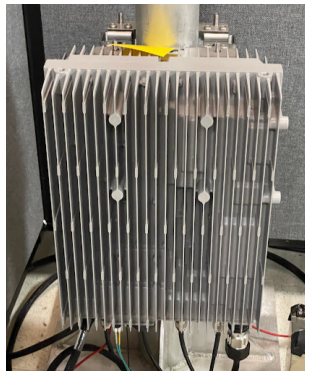
POET: End-to-end & Emulated testing

Public Wireless Supply Chain INNOVATION FUND

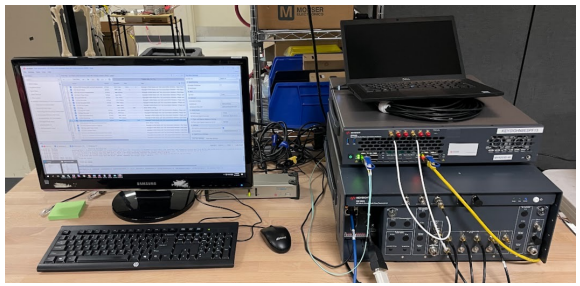






O-RUs (low/medium-power)

O-RUs (high-power)



DU Emulator

PTP GM Switch

Servers hosting O-RAN end-to-end and automated data collection

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Automated O-RU Energy Testing

Public Wireless Supply Chain INNOVATION FUND

- Objective: Develop best approach to add energy efficiency testing to O-RAN conformance tests
- Research into energy tests to improve modeling and methodology
- Automated scripting of ETSI Energy Efficiency Test Case (step through Full/Busy/Medium/Low load scenarios)
- Co-existence of End-to-end & Emulated Testing for multiple O-RUs
- Remote-enabled testing - RU-switching without cable changes

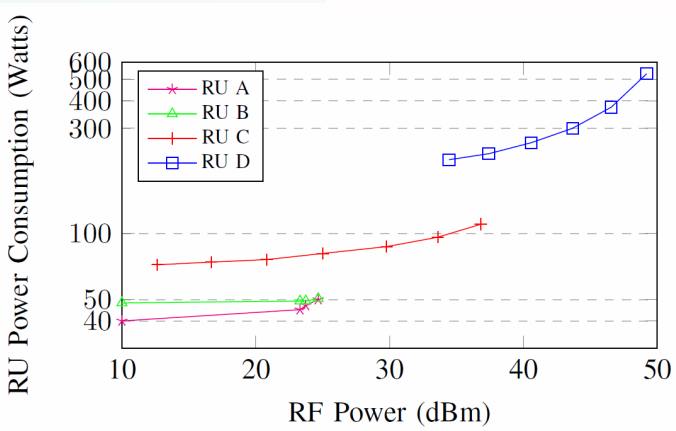
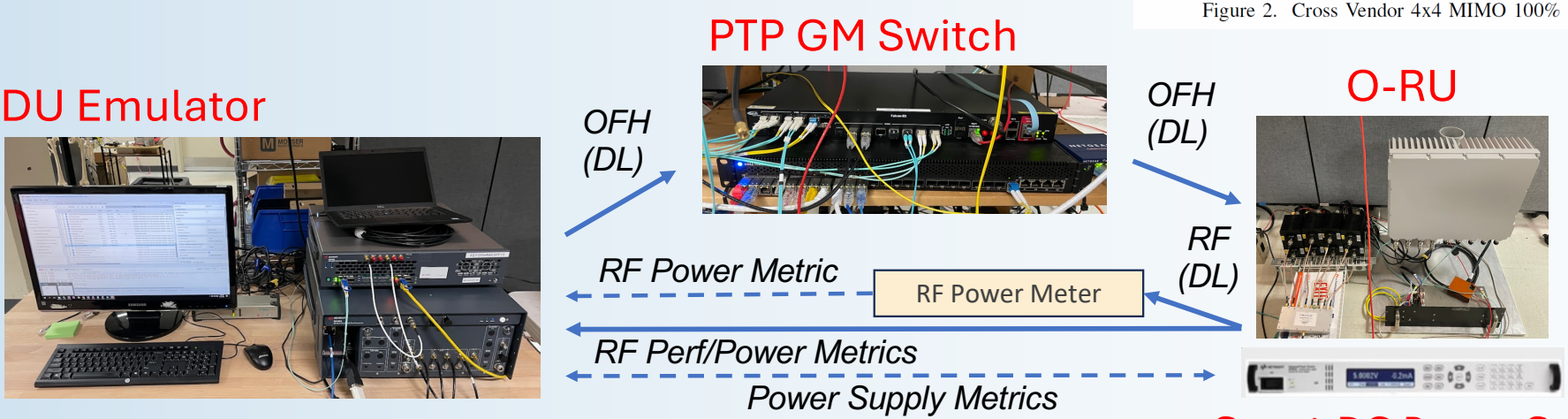


Figure 2. Cross Vendor 4x4 MIMO 100% PRBs (log-scaled)



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