

# INDIGO

## Intelligent 5G “All-G” Networks Designed and Integrated for Globalized Operations

*Ensuring Secure & Resilient Connectivity for First Responders in a Crisis*

Tracy van Brakle, AT&T



# INDIGO Topics

Intelligent xG Networks Designed and Integrated for Globalized Operations

- Value Proposition / Vision
- Team
- use case; current and future roadmap
- Gaps in standards and way forward
- Demo
- Wrap Up

*Disclaimer: The INDIGO Operate-Through use case is intended to inspire the need for standards community action and may not represent the official position of contributing firms.*

# INDIGO Value Proposition / Vision

*Q1: What problem does INDIGO solve?*

*Q2: Who benefits?*

A1: INDIGO recovers/restores 5G communications in peacekeeping missions or civilian disasters by introducing intelligence, cooperation, and automation, beyond existing 5GS roaming agreements and beyond the capabilities of RAN sharing approaches

A2: Peacekeepers and first responder teams benefit from 5G-Operate-Through that includes Security, Resilience, and Quality of Experience (QoE) that can be intelligently controlled end-to-end

## VISION:

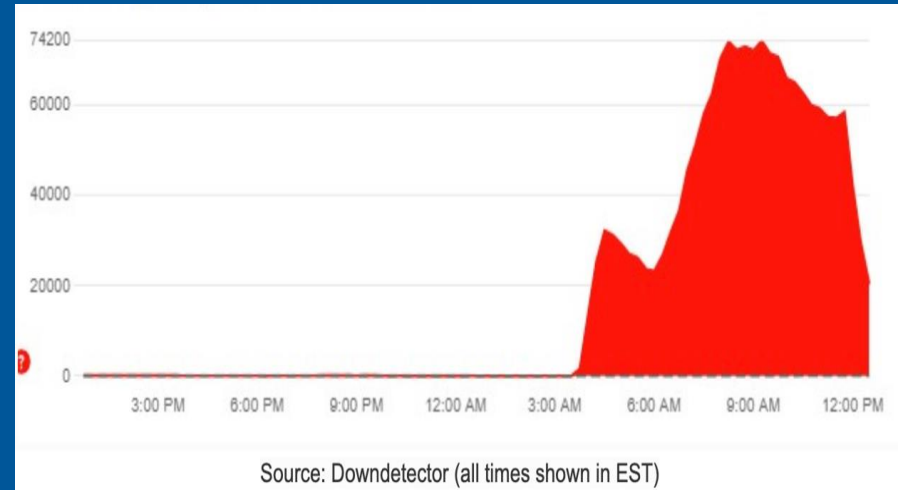
- INDIGO aims to overcome existing limitations of 3GPP-based 5G roaming agreements as well as limitations of emerging RAN sharing approaches, e.g., MORAN, MOCN (refer to slide #)

# TEAM: Public/Private Partnership with Academia, Industry, Standards Development Organizations, Open Source PTLs

Organization	Domain	Team member	Expertise / Role
AT&T	Industry - Mobile Service Provider	Tracy van Brakle, PI, Al Bolden, Roger Wong	Global Tier 1 Operator and Wireless Service provider; O-RAN co-founder, OSFG co-chair, ATIS chair
University of California Riverside (UCR)	Academia – Computer Science	K.K. Ramakrishnan, Co-PI	SDN/NFV applications; RAN Intelligent Controller open source and proprietary applications and integration; evolved multi-path protocols
Columbia University (CU)	Academia – Electrical Engineering, Computer Science	Gil Zussman, Co-PI	COSMOS Platform for Advanced Wireless Research; WiMNet Lab Director; Project-based learning within large-scale interdisciplinary research efforts
Rutgers University	Academia - School of Computing	Ivan Seskar, Co-PI Kostas Oikonomou, SP	COSMOS Platform for Advanced Wireless Research; Primary contributor experimental systems and prototyping, INDIGO education toolkit Human Centered Artificial Intelligence (HCAI), AI Planner
Ericsson	Industry – 5G/NextG Information and Communications Technology provider	Brenda Connor, SP	3GPP Cellular Networks, 5G security, interoperable open ecosystems for data driven outcomes, Innovation and orchestration enablement including MANO/ONAP and rApps/O-RAN. RMF/ATO expert
Fujitsu	Industry – 5G/NextG Information and Communications Technology provider	David Allabaugh, SP	O-RAN IM/DM, Multi-operator RAN SMO; TMF APIs
highstreet technologies USA Corp	Industry – Technology Research Company	Martin Skorupski, SP Alexandru Stancu, SP	O-RAN Software Community PTLs, SDN/NFV applications; RAN Intelligent Controller open source and proprietary applications and integration;

# Why INDIGO is needed during disasters?

- ❑ **Limitations** of the single operator approach:
  - **vulnerable** to infrastructure damage
  - network **congestion** may still occur
  - **fixed** parameters, e.g., spectrum cannot be dynamically adjusted
- ❑ **INDIGO** allows for:
  - resource pooling and **cooperation** between available network resources
  - adaptable **prioritization** of specific user equipment
  - **rapid modification** to mission parameters as situation unfolds



Public Safety Network Outage Reports 2/22/24

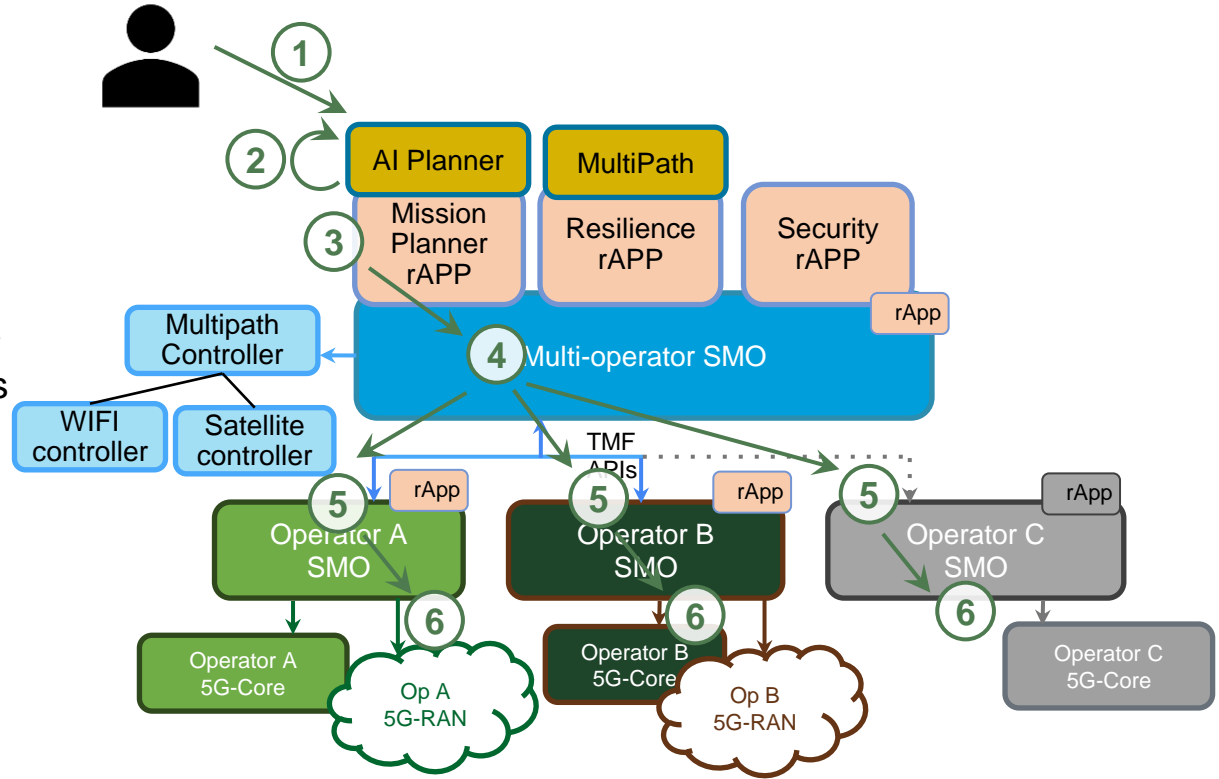
# Contributors

- Technical team
  - MUI: John Drogo
  - AI Planner - Kostas Oikonomou, Sreeram Mandava, Sanskar Shah
  - MO-SMO - Dave Allabaugh, Min Yoon, Joseph Nguyen
  - SO-SMO
    - O-RAN-SC OAM team - PTL Martin Skorupski
    - O-RAN-SC OAM team - PTL Alexandru Stancu
- Architecture, Program Management, Environment Leadership
  - Tracy van Brakle, Blanka Dalezman, Brenda Connor, Roger Wong, K. K. Ramakrishnan, Gil Zussman, Al Bolden
  - Ivan Seskar, Jennifer Shane

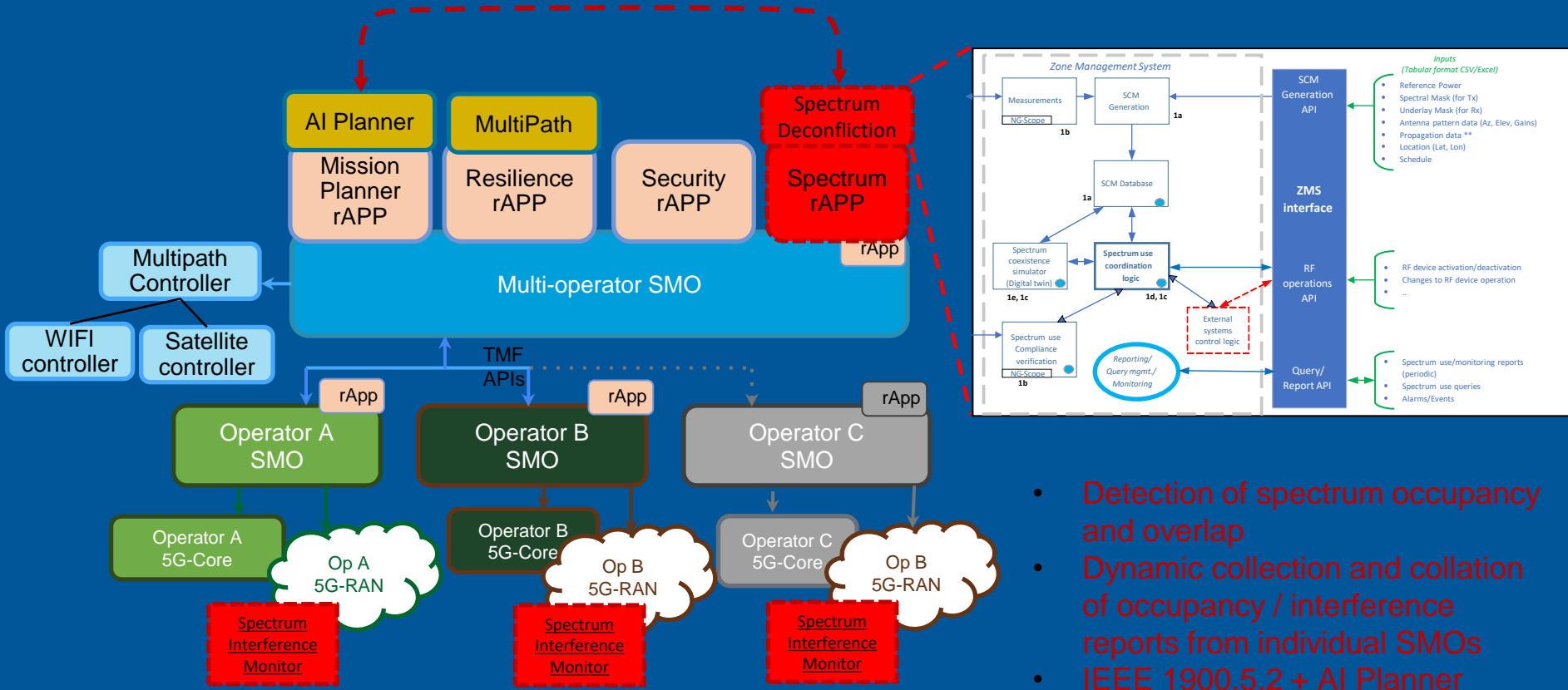
# Service/Slice Provisioning

**Flow** (After Disaster)

1. Define Mission
2. Create Plan
3. Forward Plan to MO-SMO Services (TMF641)
4. Process and TMF ServiceOrder and forward TMF ServiceOrders to SO-SMOs
5. Process TMF ServiceOrder and convert into 3GPP based O1 and OFHM.
6. Configure the O-RAN Network



# Proof of Concept: Dynamic Spectrum Access Orchestrated Deployment



- Detection of spectrum occupancy and overlap
- Dynamic collection and collation of occupancy / interference reports from individual SMOs
- IEEE 1900.5.2 + AI Planner spectrum planning





thank you



**ACCoRD**



*Accelerating Compatibility and Commercialization  
of open RAN for Deployments*

# Agenda

- 1 Overview Vision & Mission
- 2 NOFO #1 and ACCoRD Goals
- 3 Tasks & Milestones
- 4 ACCoRD and ATIS MVP Initiative
- 5 Technical overview
- 6 Notional tasks & timeline



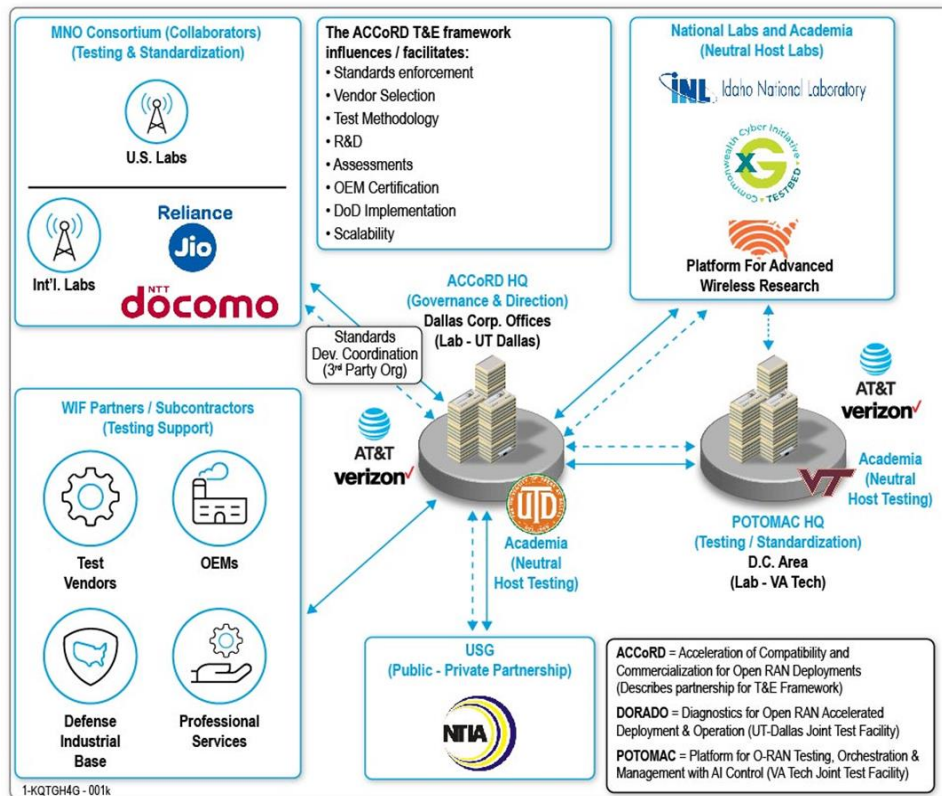
*for additional info contact Tracy van Brakle <[vanbrakle@att.com](mailto:vanbrakle@att.com)>*

*(why is ACCoRD doing what we are doing?)*

1. Increase availability, affordability, and accessibility of T&E in the US to support development, deployment, and adoption of open and interoperable, standards-based radio access networks
2. Conduct open and interoperable, standards-based 5G T&E with a comprehensive and feasible technical approach, work plans, and milestone plans
3. Lead to sustained and accessible testing resources and data that advance industry adoption of open RAN
4. Analysis and safeguarding of data collected from the testing; sharing information with participants and other interested parties
5. Provide ongoing neutral T&E outside of T&E events; expand access to companies to develop open and interoperable 5G radio access network solutions, including small and medium-sized companies, start-ups, and SEDI owned businesses, which otherwise may not be able to afford high-cost test equipment for product development.
6. Provide technical assistance and support to new and emerging industry entities in the 5G T&E ecosystems
7. Additional activities proposed to facilitate the programs goals
8. Long-Term Sustainability

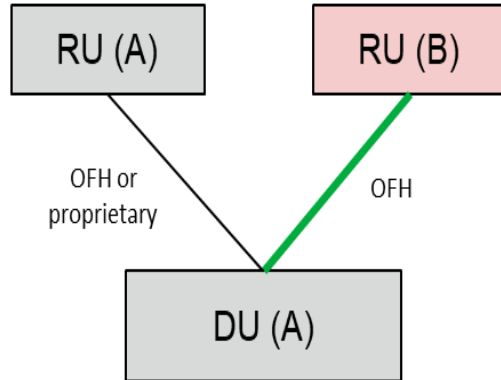
# “Increase the availability, affordability, and accessibility of testing and evaluation in the United States in support of the development, deployment, and adoption of open and interoperable, standards-based radio access networks” [from PWSCIF NOFO #1]

- NTIA vision supports Nat’l 5G Strategy, CHIPS and Science Act, and NDAA:
  - Assess OEM IOT, performance, and security
  - Expand U.S. supply chain and knowledge base
  - Chart path towards commercial scalability
- AT&T is delivering a federated lab with multiple testbeds to support NTIA acceleration goals
- Leveraging combined strength of MNO collaborators, O-RAN early adopters, research labs, & test providers
  - Proposed an MNO consortium and program with other operators and curated component vendors
  - Partnership of 21 OEMs, 4 Testing Services providers, and 6 Neutral Test Facilities (Academia & Gov’t)
    - Includes addition of no-cost contributors



- Role of Mobile Network Operator (MNO)
- ACCoRD Cloudified Federated Lab-as-a-Service
  - DORADO: Diagnostics for Open RAN Deployment and Operations (DALLAS)
  - POTOMAC: Platform for ORAN Testing, Orchestration, and Management with AI Control (WASH DC)
- Injection process
- Data management
- NTIA compliance, public testing events and workshops

## RU Introduction in Brownfield Deployment



1. Establish and evolve ACCoRD “Big Tent” (Public-Private Partnership) with an eye on inclusivity and sustainability
2. Prioritize RU/DU vendor pairings as well as use cases
3. Co-lead T&E from Conformance/ IOT through E2E testing to assess parity with respect to features, performance, resilience, and security
4. Collaborate and coordinate with other NTIA PWSCIF T&E and R&D project teams
5. Institutionalize the learning – submit contributions and change requests to O-RAN, 3GPP, and other SDOs (Standards Development Organizations) to align specifications and standards documentation with key learnings
6. Support data management (secure & share) in compliance with NTIA requirements

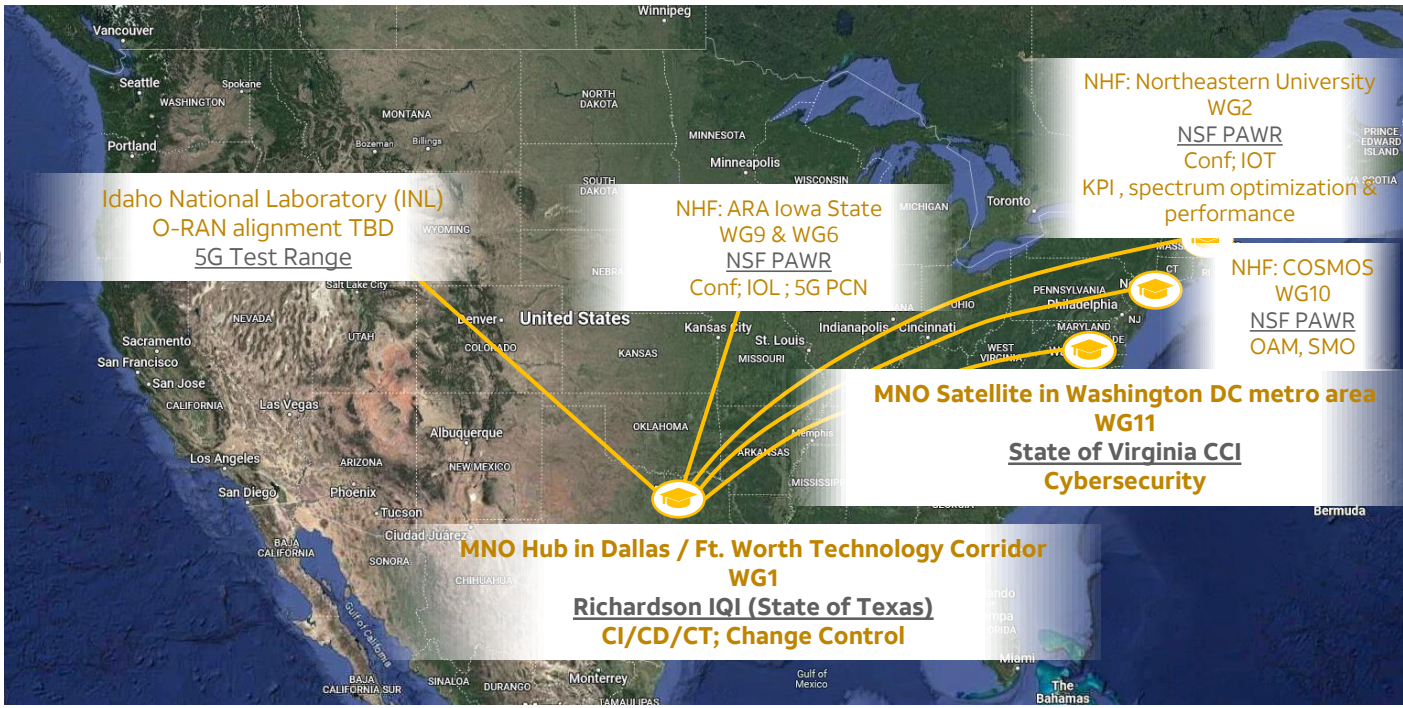
One ACCoRD lab with multiple testbeds and test networks directed by US-based MNOs with collaboration and technical support internationally.

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*

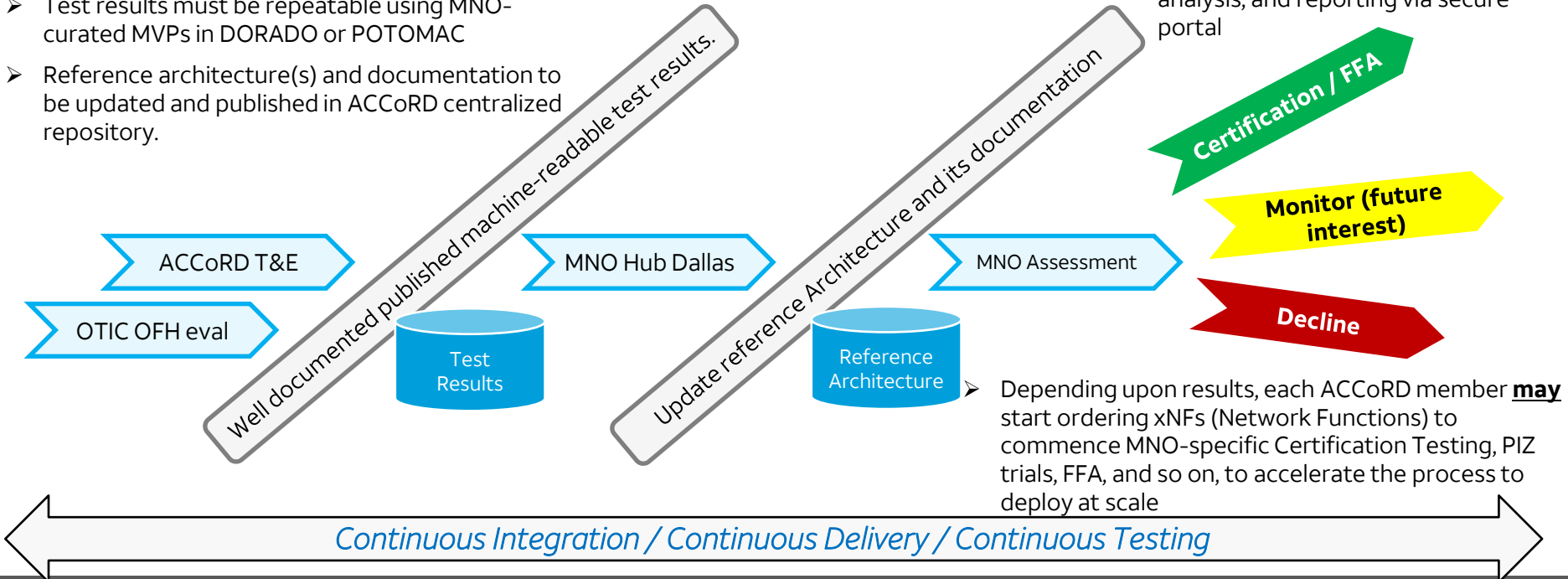
*Does NOT replace MNO-specific pre-deployment Certification and FFA*





- The ACCoRD Injection Process starts with O-RAN WG4 OFH component-based testing followed by successful Operator/Vendor demonstrations in one or more ACCoRD testbeds.
- Test results must be repeatable using MNO-curated MVPs in DORADO or POTOMAC
- Reference architecture(s) and documentation to be updated and published in ACCoRD centralized repository.

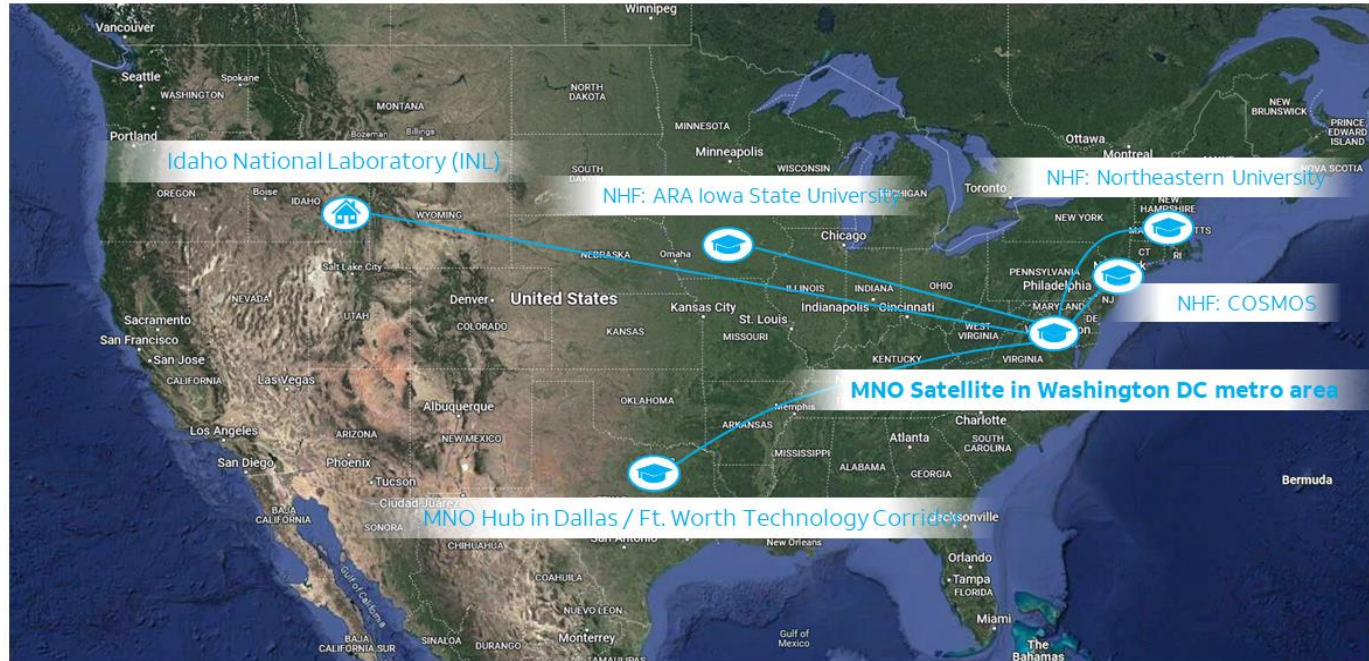
- The test results are shared among the ACCoRD members, i.e., MNOs
- Test results are then anonymized and aggregated for NTIA viewing, analysis, and reporting via secure portal





### Data Management Network; NTIA-mandated compliance & public expos

- Provide a testbed to support T&E activities required by NTIA with heightened security requirements
- Demonstrate progress toward NTIA T&E goals as well as relevant solutions specifically to NTIA and clients in the Washington DC metro area
- Serve as the hub for Data Management Network; centralized location for secure portal
- Coordination and technical support for US-based Neutral Host Facilities
- Coordination and technical support for OCONUS partners





# Task 1-4 (wiki in progress)

## ACCoRD Testing Support by Task Area

### TASK 1 – Establish NTIA ACCoRD Lab with MNO hub in Dallas/Ft Worth Telecom Corridor, satellite hub in Washington DC metro area, and NHFs nationwide

- Bring together ecosystem partners, vendors, suppliers, and a consortium of US-based operators to expand T&E activities that accelerate development, deployment, and adoption of Open RAN networks by addressing the challenges faced by MNOs in the United States in collaboration with Global MNOs and technology partners
- Focus on interoperability, performance, and security against industry-accepted test cases and best practices for 5G systems (e.g., 3GPP specifications, O-RAN ALLIANCE™ specifications, and/or other relevant industry-accepted test cases).
- Facilitate research into new testing methods to enhance existing methods of testing, evaluating, and validating the evolving Open RAN ecosystem to support the accelerated adoption of Open RAN networks.

**PRIMARY BENEFIT: The creation of the ACCoRD consortium by US MNOs and the creation of the Dallas and Washington DC metro area INDUSTRY HUB facilities is a long-term investment that will expand and sustain accessible testing resources and data, to advance industry adoption of open and interoperable wireless networks during and beyond the period of performance.**

### TASK 2 - Migration options for MNOs in the evolution from traditional to Open RAN

MNOs have an established base of large-scale RAN networks and service management systems; therefore, evaluating incumbent vendor product functionality and performance when supporting open ran architectures is a first step for an established MNO's "brownfield" migration to Open RAN.

- In parallel, expand testing and accelerate deployments of Open RAN systems at smaller scale (lower risk), e.g., enterprise locations, venues, and government facilities/military bases.
- Incumbent vendors' testing and integration of open fronthaul (OFH) with new entrants' open radio unit (O-RU) accelerates migration at low risk and includes a common service management and orchestration (SMO) framework to manage the lifecycle of the network functions.

**PRIMARY BENEFIT: Increase Open RAN velocity at lowest risk (unlike rip-&-replace approaches that are wasteful, unaffordable, and destabilizing)**

### TASK 3 – Insertion of Open RAN technologies from new entrants in incumbent vendor 5G/LTE macro RAN while leveraging new entrant knowledge

- Initial focus on incumbent RAN vendors (e.g., Ericsson, Nokia, Samsung) with expanded T&E to insert technologies from new entrants (e.g., Mavenir, JMA, Radisys, Fujitsu), i.e., an aggressive campaign to migrate to open architecture and to ensure that migration does not impact performance or QoS/QoE
- Benchmark performance relative to incumbent single-vendor stack

**PRIMARY BENEFIT: Rapid insertion of Open RAN technologies without performance degradation**

### TASK 4 – Institutionalize learnings from entire T&E initiative to evolve current and future O-RAN ALLIANCE™ specifications and 3GPP releases

- Submit contributions and change requests to O-RAN, 3GPP, and other SDOs (Standards Development Organizations) to align specifications and standards documentation with key learnings from the results of NTIA T&E activities; includes Network Capacity Performance, Network Throughput Performance, Computing Efficiency, and Energy Efficiency
- Reduce the dependence on, and the costs of, vendors' technical support services over the period of performance via formalized Knowledge Transfer to empower operations teams to maintain and sustain Open RAN technologies in 5G and Next G networks; includes courseware, hands-on training, and formal assessments to recognize skill levels of Open RAN testing technicians, Open RAN Security Analysts, and so on.

**PRIMARY BENEFIT: Experience-based maturation of specifications with the most relevance for brownfield deployments; formalized KT (Knowledge Transfer) to develop the workforce**

ACCoRD Testing Support by Task Area**TASK 5 - Federated Labs as a Service (FLaaS) model to accommodate promising Open RAN innovations regardless of vendor or inventor**

Decoupling of the Open Radio Unit (O-RU) from the Open Distributed Unit (O-DU) baseband functions is key for all Open RAN deployments

- Ensure radio performance is on par with traditional RAN; achieve interoperability among diversified O-RU and O-DU vendors
- Evaluation of densification & fiber deployment challenges, optical fiber headend capacity, fiber vs. “Fiber speed” wireless systems, and fiber ring topologies
- Provide Neutral Host Facilities with technical support for small and medium-sized companies, start-ups, and SEDI owned business

**PRIMARY BENEFIT: Public-Private Partnership (P3) to expand T&E and maximize effectiveness of Industry (Hub) testbeds paired with Regional Open Testing and Integration Centers co-hosted by US MNOs and co-located with NSF PAWR sites that are also FCC Innovation Zones**

**TASK 6 - Test Service Management & Orchestration frameworks:**

The O-RAN ALLIANCE™ Service Management and Orchestration (SMO) platform is an intelligent automation platform which applies automation at scale to simplify the complexity of networks, as well as improve network performance, enhance customer experience and minimize RAN operational costs. There are both vendor independent open-source solutions (e.g., OSM, ONAP) as well as proprietary solutions which provide the ability to manage the lifecycle of physical network functions (PNFs) and cloud native network functions (CNFs). The SMO architecture accelerates and automates deployments in multivendor environments. SMO can work with intra-network components that enable multivendor disaggregated architectures that includes 3GPP interfaces, as well as interoperability (e.g., ability for SMO solutions to control network elements from more than one supplier/manufacturer).

**PRIMARY BENEFIT: Achieve cost-effective management and AI-enabled automation of physical/virtual/cloud/network functions from multiple vendors**

**TASK 7 – T&E deployment scenarios; evaluate performance of Open RAN distributed, hybrid, and fully centralized architectures:**

- Distributed RAN: the BBU functions are co-located with the O-RUs at the cell site
- O-CU/O-DU split: centralized O-CU deployment where the O-DU is deployed at the cell site
- Fully centralized O-CU/O-DU: only the O-RUs are deployed at the cell site.
- Enterprise solutions/Large venues, Rural deployments, Urban deployments/City Center
- Digital Divide - evaluation of Open RAN performance for closing the digital divide
- Incremental feature/performance/security parity with conventional RAN for prioritized deployment scenarios

**PRIMARY BENEFIT: Tactical and practical emphasis on deployment scenarios that scale with minimized risk**

**ACCoRD Testing Support by Task Area****TASK 8 – T&E to verify security controls for Open RAN**

- Open specifications allow operators to test and verify associated security controls, rather than mainly trusting their RAN vendor to adequately protect non-standard interfaces. Security issues can be addressed much more efficiently in virtualized, cloud-enabled environments than with traditional deployments.
- The use of Open RAN does not fundamentally alter the security risk landscape, compared to more traditional RAN; nevertheless, concerns about increased “attack surface” compared to traditional RAN persist
- The Security T&E effort proposed will evaluate overall security of Open RAN systems, test performance impacts of security mechanisms, and identify mitigation measures to make it feasible to ensure equivalent levels of security exist between traditional and Open RAN deployments without performance impacts.

This effort includes:

- Trust zone identification
- Determine if the presence of more vendors within telecommunications supply chains makes vendor coordination more complex than with traditional RAN
- Identify risks stemming from utilization of cloud-based infrastructure that can affect both traditional and Open RAN deployments similarly, along with any technological solutions that leverage cloud services.
- Address concerns related to use of artificial intelligence, machine learning, and open-source software (OSS) which are neither unique to Open RAN nor immitigable.
- Encryption dependencies on deployment scenarios
- End-to-end security

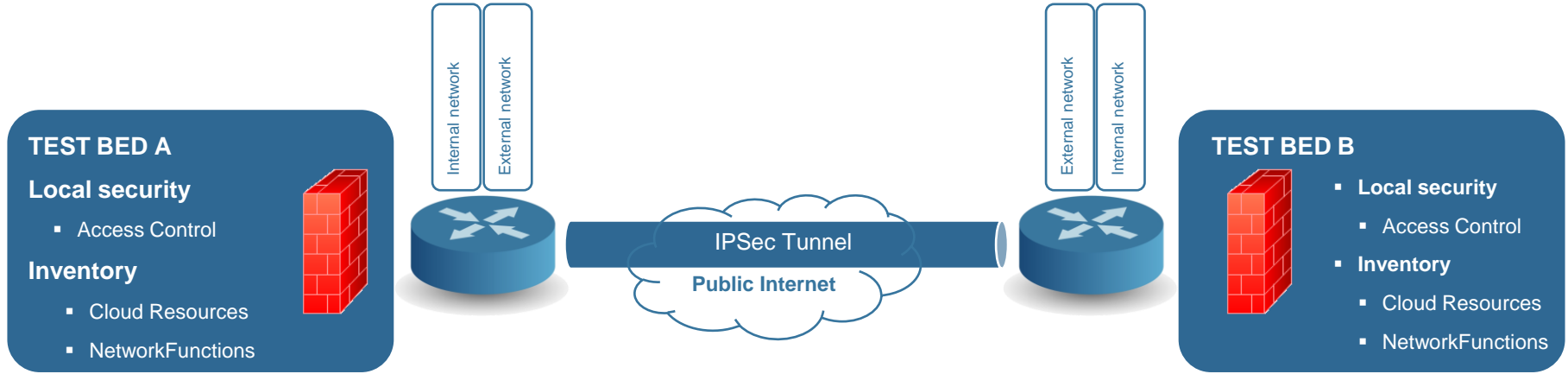
**PRIMARY BENEFIT: Accelerate Zero Trust Architectures to achieve milestones of Zero Trust Roadmaps**

**TASK 9 – T&E to verify Security End-to-End (E2E)**

Security will be tested on both end-to-end systems and individual RAN elements with industry-accepted specifications (e.g., 3GPP SA3 specifications, O-RAN Alliance specifications, NIST guidance on 5G cybersecurity, ESF security guidance, CISA’s Open RAN security paper, etc.). Testing methods may include “Red Teaming of open and interoperable 5G solutions to identify vulnerabilities in deployment and/or operation of RAN systems Vulnerability Scans.

**PRIMARY BENEFIT: Measure and manage effectiveness of capabilities to securely operate through open 5G / NextG infrastructure**

Point-to-point via IPSec



## Advantages

- Known technology
- Secure
- Easy to setup and control
- Local Access Control
- IP Conflict resolution between labs (lab independent IP management)

## Open Points

- IPSec Cert management
- Global vs local DNS
- others

# Typical Testbed Design

Repositories

**Test Specification**

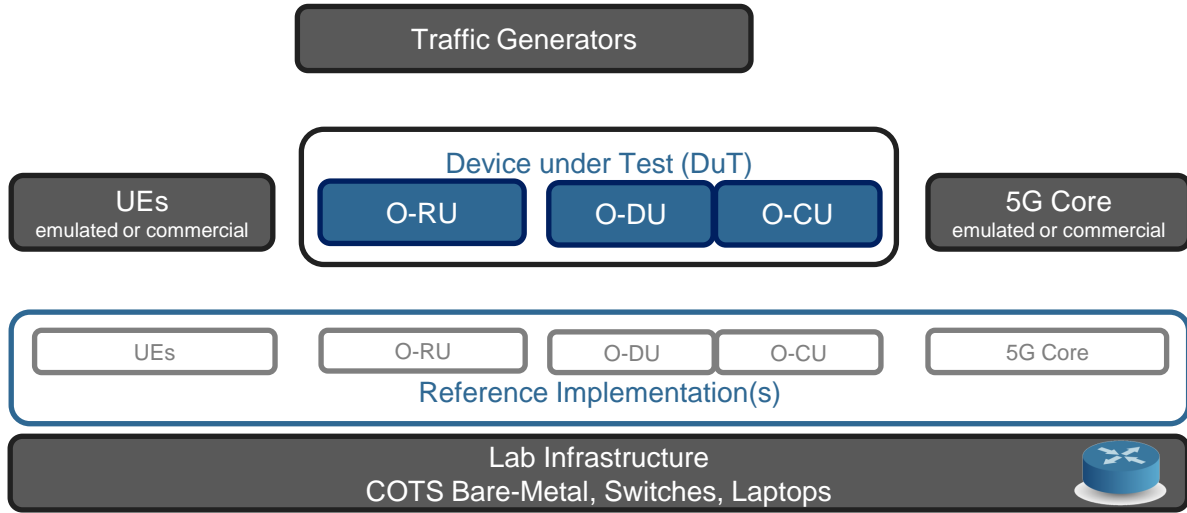
- O-RAN
- 3GPP
- SCF
- others

**Test cases**

- Security
- User plane
- Control plane
- Sync plane
- Management plane
- Energy efficiency
- others

**Test automation**

- Deployment
- Topology changes
- Execution
- Profiles



**Test results**

# Access to Information



WELCOME  
ACCELERATING COMPATIBILITY AND COMMERCIALIZATION  
OPEN RAN FOR DEPLOYMENT

[EXPLORE NOW](#)

Let me know if you have any questions!  
I have a question

ACCoRD, NTIA PWSCIF T&E project - 19 Mar 4:42 pm

I have a question  
10:03 am - Viewed

Thanks! Your message has been submitted.  
We'll get back to you here or via email.  
We'll respond as soon as we can.

The NTIA ACCoRD lab consists of 6 indoor/outdoor city-scale testbeds or test networks - refer to wiki (in progress)

ACCoRD, NTIA PWSCIF T&E project - 10:43 am

Enter your question or message here

ABOUT ACCORD, NTIA PWSCIF T&E PROJECT



Starting point: [accord-wif.org](https://accord-wif.org)

After a two-factor authentication for ACCoRD members, this page should act as an entry point to access:

- wiki
- tracking tools
- repositories
- etc. etc. etc.



## Q&A

Need additional info? Email [helpdesk@accord-wif.org](mailto:helpdesk@accord-wif.org)