RECHARGE: Resilient Commercial Real Estate enabling Holistic Advancement of Smart Grid, Power & Manufacturing

a) Executive Summary

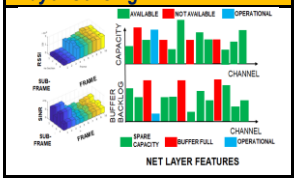
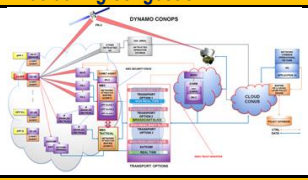
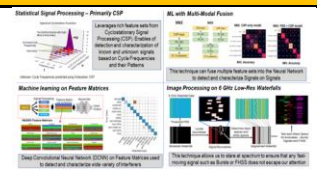
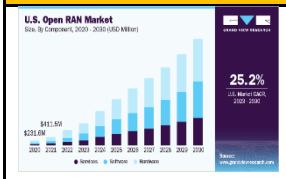
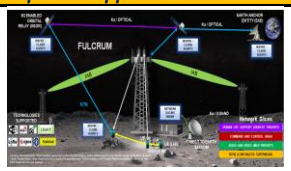
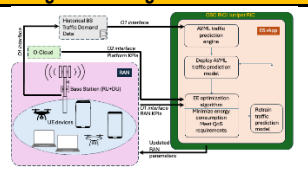
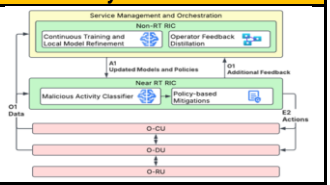
U.S. leadership in the global Radio Access Networks (RAN) market is tied to the introduction of vendors and vendor solutions that uncover the advantages of U.S. companies. Operators and Enterprise adoption of O-RAN will be essential to attain the stated goals for PWSCIF. Both operators and enterprise service providers need to have customers who recognize the client-facing advantages with Open RAN (O-RAN) and translate that into a return on investment that is sufficient to rationalize their investment in new network services. To address this challenge, AiRANACULUS Team proposes ***Resilient Commercial Real Estate enabling Holistic Advancement of Smart Grid, Power & Manufacturing (RECHARGE)*** to address the challenges of the Specific Research Focus Area 1 (***SRFA-1***)

RECHARGE is poised to ignite demand for O-RAN by mobilizing committed partners from ***Commercial Real Estate, Manufacturing, and Electrical Utilities***—each ready to integrate O-RAN into their operations. Together, these partners will co-develop and deploy both new and existing RAN-hosted applications to unlock business value across their organizations. Six field pilots will serve as the proving ground, with a shared emphasis on industrial resiliency. These efforts will directly benefit communities in Appalachia and Puerto Rico—regions where power and communications outages often discourage corporate investment. By prototyping robust, real-world solutions, RECHARGE will demonstrate how O-RAN can strengthen infrastructure in similarly underserved and rugged environments. Building on the momentum of the NOFO2 Wireless Heart of America (WHOA) Consortium, RECHARGE strategically aligns with NOFO3, allowing available funds to drive deeper O-RAN adoption across industry verticals. Every RECHARGE partner brings a footprint that extends beyond the pilot sites, with a shared commitment to scaling O-RAN solutions that deliver measurable ROI. We believe broad industry uptake of advanced O-RAN capabilities—across both our operational areas and competitive sectors—will reduce costs, accelerate innovation, and create a vibrant ecosystem of open applications and microservices tightly integrated with our IT and OT systems.

The AiRANACULUS led RECHARGE Team has strong, experienced partners who have agreed to work together sharing implementation and sustainment best practices, process improvement and cybersecurity information exchange. Resilient Commercial Real Estate enabling Holistic Advancement of Smart Grid, Power & Manufacturing stands to ***transform the $1.2 Trillion commercial real estate market***, by enabling resilient communications through 5G O-RAN to become an expected capability for future smart buildings and industrial centers. At the same time, supporting electrical power generation, distribution and distributed energy resources will realize improved Industrial Control Systems (ICS) and Supervisory Control and Data Acquisition (SCADA) through O-RAN, with an opportunity to work much more closely with RAN operators to integrate resiliency preparedness activity and response to emergencies and natural disasters. This aspect of the RECHARGE will bring O-RAN enabled advantages to our communities and other critical infrastructure.

This project is a collaborative effort by a consortium of partners including: AiRANACULUS, a Smal and Medium Entity (SME) (App Developer for O-RAN and AI-RAN, Systems Integration), Puerto Rico Industrial Development Company (PRIDCO), enabler of Commercial Real Estate for many industry verticals, OcyonBio (Biotech & Pharmaceuticals), Gig Aerospace (New Space), Collins Aerospace (Aerospace & Defense), SPECE (Commercial Real Estate Vertical), Anterix (Smart infrastructure, Smart Cities, Smart Communities and Nationwide Spectrum Holder in 900 MHz – n106), Virginia Tech Electric Service (Utility), Pelorus, the consulting practice standing up the Wireless Heart of America Consortium (WHOA), Juniper Networks (RIC Vendor), Abside Networks (O-RU Provider and NOFO2 Awardee) and also a SME, Radisys (DU/CU/Core Provider), Fujitsu (DU/CU/Core Provider), Virginia Tech / University of Southern California (USC) / North Carolina State University (NCSU) (Nation's Premier Research Institutions), PR5G (Non-profit to promote 5G enabled connectivity in Puerto Rico), Laser Light Communications (Multi Domain Global Network Platform) and Althea Networks (Decentralized Payments Provider).

b) Technical Objectives

Table b.1 RECHARGE benefits to Exponentially Grow Commercial 5G O-RAN Deployments			
Transforms Commercial Real Estate ($1.2T Market) using 5G O-RAN.	*Leverages and Builds on Successes of NOFO1 and NOFO2.*	*Enhances Many Industry Verticals – Power / Energy, Smart Manufacturing, Biotech, Aerospace*	*Opens a Brand-New Frequency Band n106 to provide 5G O-RAN enabled MMTC / IoT in 900 MHz for Smart Grid*
			
Leverages E2, O1, A1 Interfaces to Provide Autonomous Intelligent Reconfiguration through Cross Layer Sensing	*Provides a Gamut of Applications (xApps / rApps) to drive various Industry Verticals and ensures security-by-design.*	*Provides Resiliency – Primary, Alternate, Contingency, Emergency (PACE). Critical Application Traffic from n48 Band may be switched to n106 during congestion.*	*Leverages Open Fronthaul to Perform Integrated RF Sensing for Interference as well as Intrusion Detection and Mitigation.*
			
Enhances US Competitiveness in 5G/ 6G	*ORAN based Network Slicing and NFV Provide QoS for Important Applications.*	*Provides Detection of Anomalies and End to End Cybersecurity by Design Resulting in ZTA*	*Provides an APP Store for wide variety of Applications that may be commercially sold.*
			

Currently, operators face growing network demands and intense capital expenditure. As a result, many operators are hesitant to invest in new technology, such as 5G Open Radio Access Network (5G O-RAN), without a clear path to revenue generation and cost savings. O-RAN, on the other hand, has unique features (e.g., RAN Intelligent Controller (RIC), O1 interface, E2 interface, Service Management and Orchestration - SMO) that provide higher visibility into and control of the network and its associated network data. Access to this data can allow network operators and third parties to build software solutions for industry verticals more efficiently with Open RAN than with full-stack, closed architectures.

AiRANACULUS Team proposes ***Resilient Commercial Real Estate enabling Holistic Advancement of Smart Grid, Power & Manufacturing (RECHARGE)***, a transformative solution targeting the ***$1.2 Trillion Commercial Real estate Market*** by enabling resilient communications through 5G O-RAN. ***Table b.1*** provides the value proposition for RECHARGE towards meeting the objectives of the ***Specific Research Focus Area 1 (SRFA 1)***. ***Figure b.1*** illustrates the Concept of Operations (CONOPS) for RECHARGE. RECHARGE focuses on solving industry problems by identifying barriers to adoption of new technologies such as high costs, integration challenges, legacy dependencies and customizing solutions. Our aim is to reduce operating costs through energy efficiency, downtime minimization, enhanced performance, improved security, and ensured full interoperability with existing systems.

Commercial real estate is foundational across all industry verticals, from office environments to smart manufacturing and labs. RECHARGE provides a cross-cutting framework that supports Power & Energy (Anterix, Virginia Tech Electric Service), Biotech and Pharmaceuticals (OcyonBio), Aerospace and Defense (Collins Aerospace, Gig Aerospace), Commercial Real Estate (SPECE), Distributed Payment Systems (Althea), Telecommunications (Laser Light Communications). By demonstrating productivity gains through interoperable, resilient, and secure wireless networks, RECHARGE fosters collaboration between wireless and industry stakeholders, drives economic and workforce growth in underserved U.S. regions, and advances U.S. leadership in next-generation wireless technologies. It directly benefits real businesses by increasing the operational value of commercial real estate through

Figure b.1. Concept of Operation for RECHARGE

greater network reliability and readiness. RECHARGE supports real live businesses that will benefit through increased value to commercial real estate from higher availability.

RECHARGE includes the ***design and integration of a software solution across a network***, leveraging Open RAN components to access new or previously untapped sources of data or unique Open RAN innovations, such as the RIC. *AiRANACULUS (App Developer for O-RAN and AI-RAN, Software Integration)*, will work with Juniper Networks (RIC Vendor), Abside Networks (O-RU Provider and NOFO2 Awardee), Radisys (DU/CU/Core Provider) and Fujitsu (DU/CU/Core Provider) to develop inter-operable 5G O-RAN solutions in two frequency bands – n48 - Citizens Broadband Radio Service (CBRS) and n106 - 900 MHz spectrum where our team member, *Anterix (**Vertical Specific Expertise**) has a nationwide license to operate and provide services on their 3 MHz by 3 MHz Frequency Division Duplex (FDD) spectrum*. Virginia Tech, University of Southern California (USC) and North Carolina State University (NCSU) will provide wide variety of Applications to enable verticals.

Our team has been structured to fully utilize and build upon the NTIA' s prior NOFO1 and NOFO2 investments. Through the Wireless Heart of America (WHOA) consortium (NOFO2 Performer), *which includes several* Mobile Network Operators (MNOs) and in association with Puerto Rico Industrial Development Company (PRIDCO) *(**Vertical Specific Expertise**)*, we will showcase how 5G O-RAN enables resilient commercial real estate and resilient power at four sites in Puerto Rico (Collins Aerospace, OcyonBio, Gig Aerospace and SPECE) as part of our ***first deployment***. Puerto Rico 5G Zone (PR5G) will coordinate this project in association with Pelorus. ***Our second 5G O-RAN deployment*** will be at Virginia Tech Electric Service (VTES), in Blacksburg, VA, which will showcase how 5G O-RAN can transform a complex and highly regulated industry (Power & Energy). Virginia Tech and Virginia Tech Electric Service (VTES), a full-service utility *(**Vertical Specific Expertise**)* servicing VT campus and an additional 6,000 customers in the Town of Blacksburg, have identified candidate buildings for sensor installation. These buildings include the Corporate Research Center (CRC) and Goodwin Hall. These sensors will provide visibility for VTES regarding electric power consumption, temperature, humidity, hot steam, and voltage/currents. These measurements will be used by VTES to optimize and monitor the health of campus energy consumption using xApps and rApps developed on RECHARGE. This work is expected to significantly reduce the current service times specially in emergencies, when VTES engineers who on average have a one-hour commute time to campus, need to manually check the status of switches and active feeders and execute a manual procedure to restore power.

• **The technical requirements of the proposed solution necessary to support relevant business applications and services, and elements, features, and interfaces of the Open RAN architecture employed by the solution.**

The RECHARGE O-RAN network solution includes two (2) Pilot Deployments in Puerto Rico and Blacksburg, VA.

Puerto Rico Deployment: Figure b.2 illustrates the CONOPS, locations and industry verticals for 5G O-RAN Pilot

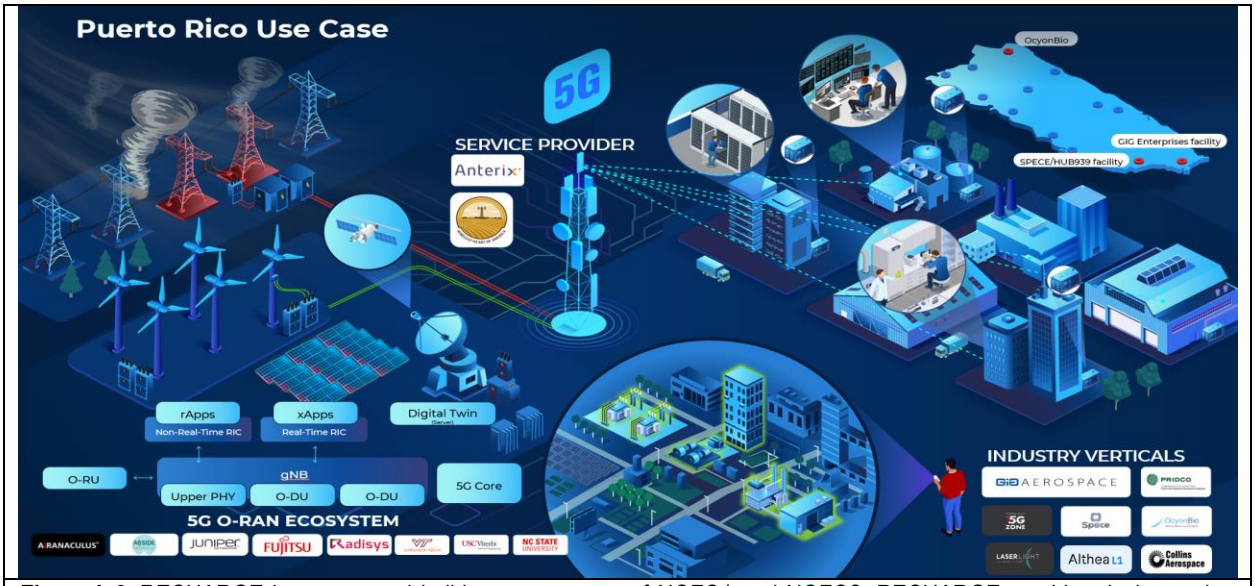


Figure b.2. RECHARGE leverages and builds on successes of NOFO1 and NOFO2. RECHARGE provides design and integration of a software solution across a network, leveraging Open RAN components (Abside, Fujitsu, Radisys) to access new or previously untapped sources of data using RIC (Juniper). This Figure provides insights into the RECHARGE deployments in Puerto Rico serving industry verticals of Commercial Real Estate, Biotech and Aerospace & Defense.

Deployments in Puerto Rico. Puerto Rico offers a unique economic landscape that blends U.S. regulatory advantages with emerging-market agility. Historically, ***manufacturing*** has been the bedrock of Puerto Rico's economy – employing roughly a quarter-million residents out of 3.2 million and long serving as the island's most important economic sector. In the late 20th century, federal incentives (notably Section 936) spurred a ***booming pharmaceutical and electronics industry*** hub on the island. Today, Puerto Rico stands at the cusp of an economic revival driven by "reshoring" and "nearshoring" trends. U.S. firms, pressured by pandemic-era supply chain disruptions and geopolitical risks, are actively seeking to bring manufacturing back to American shores. Crucially, Puerto Rico already has an extensive inventory of ***commercial real estate*** for reuse. PRIDCO, under the Department of Economic Development and Commerce (DEDC), owns dozens of industrial parks and shell buildings across the island. Many of these sites have undergone feasibility studies for new uses – including a current analysis of semiconductor (microchip) manufacturing viability on the island. In Puerto Rico, RECHARGE will provide 5G O-RAN enabled communications infrastructure to hundreds of thousands of square feet of available factory space and underutilized infrastructure which will offer incoming projects "plug-and-play" sites, drastically shortening setup time.

Table b.2 Smart Grid Communications Requirements

Application	Distances / Coverage	Desired Data Rates	Desired Latencies
Protective Relay	10 – 100 km	<1Mbps	16 ms (One 60 Hz Cycle)
Distribution Automation	16 Km	<1.2 Mbps	100 ms (Relay commands to control center) 1 second (fast restoration)
Synchrophasors and Phasor Measurements Units (PMUs)	5 – 10 km	<1Mbps	17– 100 ms
Video Surveillance	5 – 10 km	10 – 20 Mbps	<1 Second
Microcontroller Monitoring and Configuration	5 – 10 km	<1 Mbps	< 1Second
AMI / SCADA	5 – 10 km	<1 Mbps	< 1 Second

Virginia Tech Electric Service Pilot Deployment: ***Figure b.3*** illustrates the CONOPS, locations and industry verticals for 5G O-RAN Pilot Deployments at Virginia Tech in Blacksburg, VA. Modern day electric grid relies on communications to enable wide variety of functions including protective relays, distribution automation, substation monitoring, monitoring and configuration of switches and microcontrollers, load shedding, smart metering, Autonomous Metering Infrastructure (AMI), Supervisory Control and Data Acquisition (SCADA) etc. All these applications have their own requirements in terms of data rates, distances and latencies that need to be supported. ***Table b.2*** illustrates the smart grid communications needs. As shown in the Table, ***5G is capable of meeting and exceeding the requirements of majority of the smart grid communications*** applications.

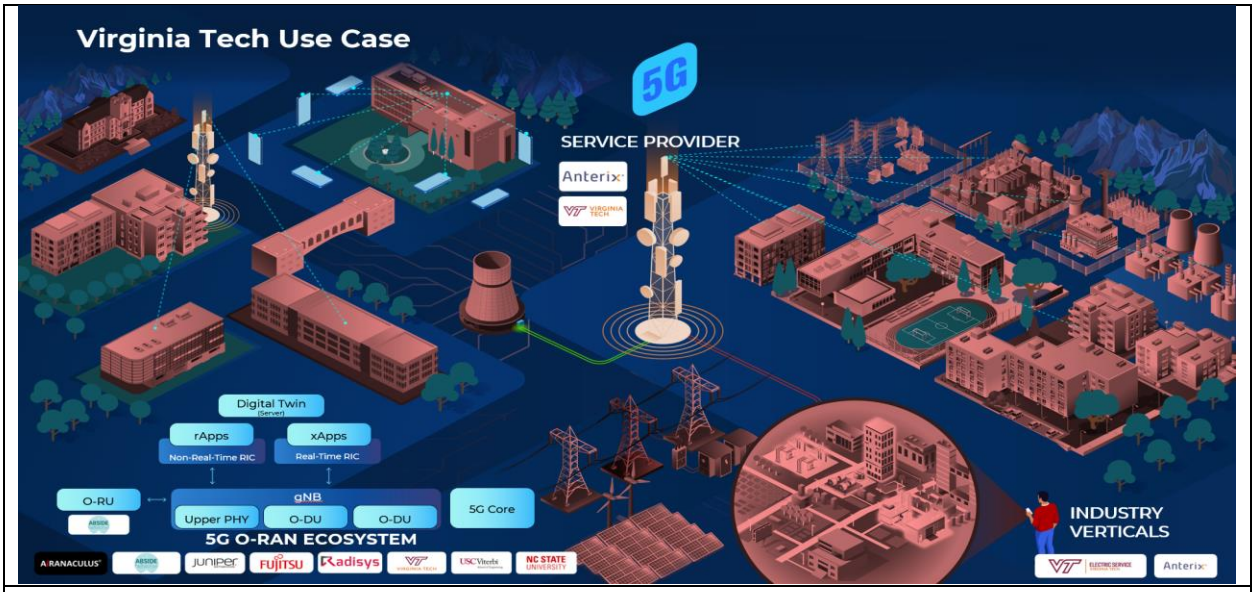


Figure b.3. RECHARGE Pilot Deployment at Virginia Tech

Virginia Tech researchers in the Power and Energy Center (PEC), in collaboration with Virginia Tech Electric Service (VTES) will develop detailed plans to upgrade manual electrical switches at the VT Corporate Research Center (CRC) to automated communication-enabled switches. This upgrade, in addition to operational electrical advantages, provides significant advantages in terms of quality of service by decreasing the service time, increasing situational awareness, and enabling consistency of service. With such switches, VTES utility engineers can be aware of the status of feeders providing power to buildings with VTES. VTES is unique since it is self-contained and controls ***energy generation, energy distribution and energy consumption***. This will allow the RECHARGE Team to test scenarios such as Primary Alternate Contingency and Emergency (PACE) and 5G O-RAN enabled switching or sharing between various energy sources – e.g., hydro-electric to Distributed Energy Resources (DER).

Figure b.4 illustrates the systems architecture of the Pilot Deployments in Puerto Rico and at Virginia Tech. The RECHARGE 5G ORAN network builds on the successes of NOFO1 and NOFO2 and includes a rich and diverse set of proven 5G O-RAN technologies. The robust layered design supports multiple frequencies to enable continuous connectivity and seamless failover should resources become unavailable while providing sufficient capacity, throughput, coverage, and minimal latency. The RECHARGE 5G O-RAN network combines RU from NOFO2 winner Abside Networks with CU/DU from NOFO winning teammates Fujitsu and Radisys, RIC from industry leader Juniper, and exceptionally well documented and compliant 5G core from Amarisoft. Our team also plan to experiment with a few other O-Rus (e.g., Benetel). This O-RAN technology stack provides a strong and solid foundation for the RECHARGE xApps and rApps. Each RECHARGE O-RAN network testbed is a 5G stand-alone (SA) deployment with each of the networks supporting multiple physical locations, multiple base stations and spectrum support. This

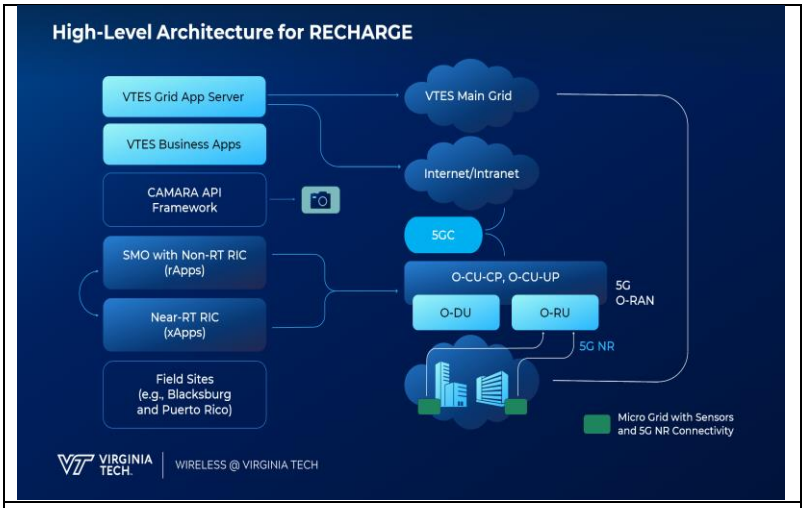


Figure b.4. Figure illustrates the systems architecture of the pilot deployment in Puerto Rico and at VT.

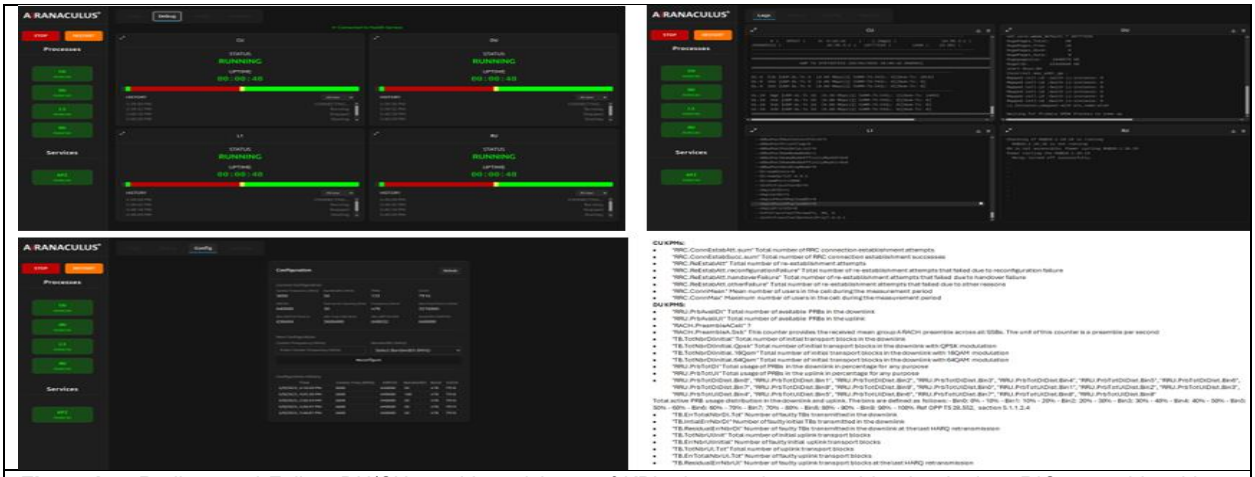


Figure b.5. Radisys and Fujitsu DU/CU provide a rich set of KPIs that are harnessed by the Juniper RIC to enable wide variety of Applications. Figure illustrates the AiRANACULUS GUI that is used for Configuration Management (CM), Fault Management (FM) and Performance Management (PM).

controlled expansive Pilot Deployment will support dozens of buildings and hundreds of User Equipment (UEs) with high bandwidth low-latency connectivity. Both deployments at multiple locations each, will also offer 5G O-RAN connectivity in two frequency bands – n48 - Citizens Broadband Radio Service (CBRS) and n106 - 900 MHz spectrum where our team member, *Anterix* (***Vertical Specific Expertise***) *has a nationwide license to operate and provide services on their 3 MHz by 3 MHz Frequency Division Duplex (FDD) spectrum*.

- **How the performance and interoperability requirements will be addressed.**

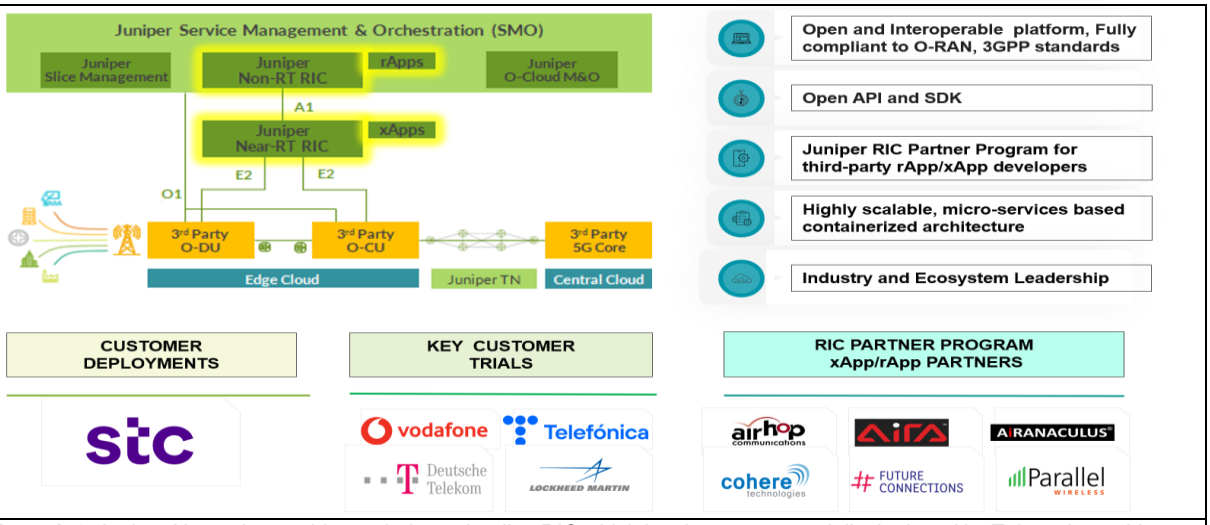


Figure b.6. Juniper Networks provides an industry leading RIC which has been commercially deployed by Telcos. It provides a solid framework to build various xApps and rApps that will drive industry verticals. RECHARGE leverages existing Juniper Networks capabilities and develops its own vertical specific Apps to enable resilience.

The RECHARGE 5G O-RAN network configuration will be compliant with 3GPP 5G NR Release 16 specifications and the latest releases of the O-RAN Alliance specifications. Key Performance Metrics (KPMs) are the quantifiable measurements used to determine whether Key Performance Indicators (KPIs) that may be achieved. ***Figure b.4*** provides some insights into some of the KPMs that will be used to measure the effectiveness of the project. These ***KPMs*** are related to connection establishment, configuration, availability of Physical Resource Blocks (PRBs) and the Modulation and Coding Scheme (MCS), Error Rates on Transport Blocks (TBs) etc. These KPMs originate from CU/DU and RU (e.g., Radisys CU/DU and Abside RU). RECHARGE utilizes xApps and rApps to optimize 5G O-RAN for commercial real estate use cases. The performance of xApps and rApps will be quantified using ***traditional KPIs*** and ***vertical-specific KPIs***. The traditional RAN KPIs to be monitored and controlled in the project include (i)

NR frequency bands for FR1 38.104 (Rel 18 Dec 2024)

Band	Name	Mode	ΔF_{Raster} (kHz)	N_{ref} step size	Downlink (MHz) Low nr-arfcn	Middle nr-arfcn	High nr-arfcn	Bandwidth DL/UL (MHz)	Uplink (MHz) Low nr-arfcn	Middle nr-arfcn	High nr-arfcn	Duplex spacing (MHz)	Geographical area	3GPP release	SCS (kHz)	Channel bandwidth (MHz)	Note
n48	TD 3600	TDD	15	1	3550 636667	3625 641667	3700 646666	150					Global	16.0	15	5 10 15 20 30 40 50	
			30	2	636668	641668	646666								30	10 15 20 30 40 50 60 70 80 90 100	2
															60	10 15 20 30 40 50 60 70 80 90 100	
n106	900	FDD	100	20	935 187000	937.5 187500	940 188000	5	896 179200	898.5 179700	901 180200	39		18.4	15	3	
															30		
															60		

Figure b.7. Frequency Bands chosen for Virginia Tech and Puerto Rico Pilots.

average throughput, reliability (e.g., block error rate), radio interface latency, and resource utilization per network slice and (ii) network slice utilization. Vertical-specific KPIs are application-level KPIs for the commercial real estate and power grid use cases and include application-level end-to-end latency and application layer throughput. A comprehensive framework for monitoring and control of KPIs will be developed during the project based on the insights gained during the design and field demonstrations to facilitate widespread commercial deployments of these verticals. Numerical targets for KPIs will be determined during the design phase of the project based on the service requirements of the use cases. ***Figure b.5*** illustrates the AiRANACULUS GUI that is used for ***Configuration Management (CM), Fault Management (FM) and Performance Management (PM).*** We propose to leverage Juniper Networks' industry leading RIC which has been commercially deployed by Telcos as shown in ***Figure b.6***. It provides a solid framework to build various xApps and rApps that will drive industry verticals. ***RECHARGE leverages existing Juniper Networks capabilities and develops its own vertical specific Apps to enable resilience***.

Figure b.8. Juniper App Store - xApps that perform Tenant / Slice Aware Admission Control, Traffic Steering, Energy Savings and RAN Slice SLA Assurance are readily available through Juniper.

- **The architecture of the solution, including the network configuration and the required network performance parameters to support the solution (e.g., capacity, throughput, coverage, latency).**

Given that RECHARGE plans to have two Pilot Deployment sites and operate in two frequency bands as shown in ***Figure b.7***, we have established two O-RAN implementation tracks. For n48 Band, we will pair Abside O-RU with *Fujitsu* DU/CU and Amarisoft Core. For n106, Abside O-RU will be paired with *Radisys* DU/CU and Amarisoft Core. Juniper, Radisys and Fujitsu will work with O-RAN use case application partners (Anterix, VTES, AiRANACULUS etc.) and the industry vertical end-user partners (OcyonBio, Collins Aerospace, Gig Aerospace, SPECE) to help identify the performance and operational requirements of the proposed scenarios. Juniper and Radisys will then map the required performance metrics and KPIs to 3GPP and O-RAN specifications, measure and collect these metrics to generate the required KPIs and provide them to the use case partners. Juniper RIC is already compliant with O-RAN Release 3+

and 3GPP Rel 16 specifications and where needed, O-RAN Release 4 related specification upgrades will be implemented during the early phases of this project. Radisys 5G CU(L3)/DU(L2) software stack is compliant with 3GPP Release 18 specification supports O-RAN E2 and O1 interfaces and features such as Network Slicing that are essential for AiRANACULUS to build their 5G products for RECHARGE network. During the early phases of this project, Radisys will upgrade the 5G CU(L3)/DU(L2) stack software to O-RAN Release 4 specification. Radisys 5G CU(L3)/DU(L2) stack software is highly interoperable and is available on all 5G capable platforms, is optimized for various use cases and supports different O-RAN, 3GPP architectural options for different performance needs. To operate in the n106 Band for 3 MHz X 3 MHz FDD channels, Radisys will make minor modifications the DU/CU. ***Figure b.8*** shows the notion of an ***App Store*** where xApps that perform Tenant / Slice Aware Admission Control, Traffic Steering, Energy Savings and RAN Slice Service Level Agreement (SLA) Assurance are readily available through Juniper.

- **Definition of the vertical-specific End Points to be controlled/deployed by the solution, including their source, form factor, availability, and integration into the network.**

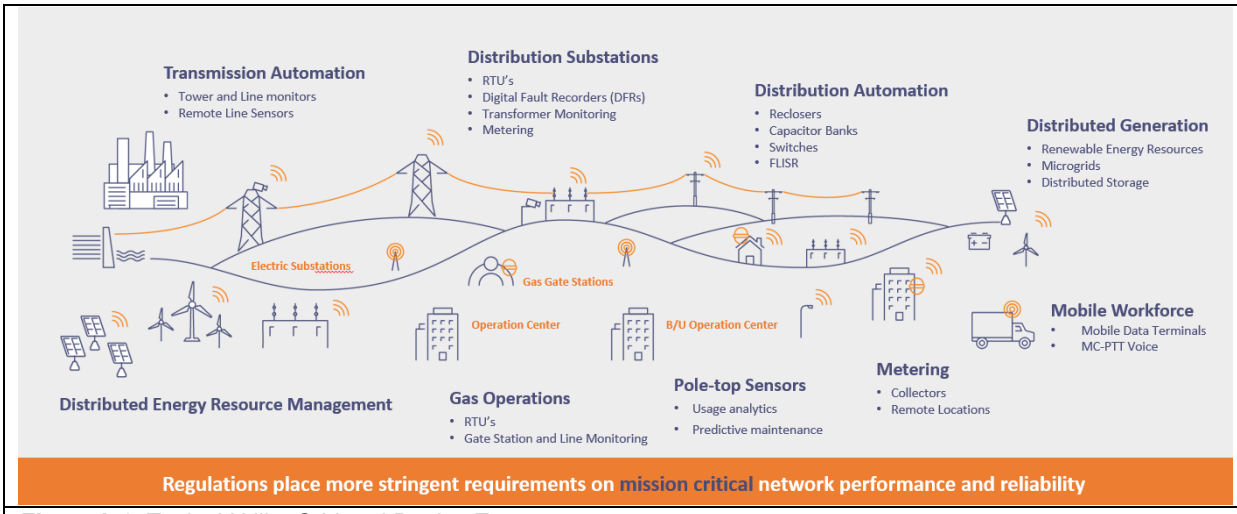


Figure b.9. Typical Utility Grid and Device Ecosystem.

Anterix' s mission is to deliver transformative broadband with 900 MHz licensed spectrum, to enable modernization of critical infrastructure for energy, transportation and other industries. Anterix is the largest 900 MHz spectrum holder across the US , including Hawaii and Puerto Rico, enabling US Utilities to build foundational private broadband networks – utility owned and operated, secure and resilient. Anterix has created the AAE (***Anterix Active ecosystem***), bringing leading 125+ technology companies together supporting 900 MHz private networks in 4G Long Term Evolution (LTE) today and future 5G. With an initial focus on utility companies and use-cases, there stands a robust end-device ecosystem that's today deployed in 4G across various utility use-cases. The goal is to replicate the same in a 5G deployment scenario, giving utilities the option to migrate to 5G in the future, either from 4G to 5G or deploying 5G in the future as a greenfield private network. ***Figure b.9*** illustrates the grid from traditional power generation to newer Distributed Energy Resources (DER's), including transmission and distribution. There are a variety of device end-points which are 4G-enabled today which provide secure, reliable and resilient communication over the private network. The end-devices can be cellular enabled by integrating 4G/5G modules as they serve as communication end-points. End-devices include Meters, Line sensors, Pole-top sensors, Routers, Access Points and Gateways in the distribution networks. There is also a strong use-case for cellular-enabled mobility devices such as rugged smartphones/radios, tablets and Toughbook's for voice and mission critical PTT applications. Today, a robust 900 MHz end-device ecosystem exists for 4G/LTE and the same must be evolved to a 5G use-case for the future. Amongst the end-devices supported , there are ***10 models of Routers/Gateways, 15 cellular-embedded Modules, 6 Meters and 8 sensor-based 3rd party solutions to support distribution automation***. As a part of this project, we envisage initial 5G end-point devices could be prototypes used in initial phases, and maturing into commercial chipsets and modules which can be leveraged into end-devices such as routers and sensors in the 5G private network. As 5G matures for the utility industry with cost-effective platforms and solutions, meters/metering devices could also be a part of the 5G utility deployments, ***enabled by RECHARGE in quantity of Millions providing Scale***.

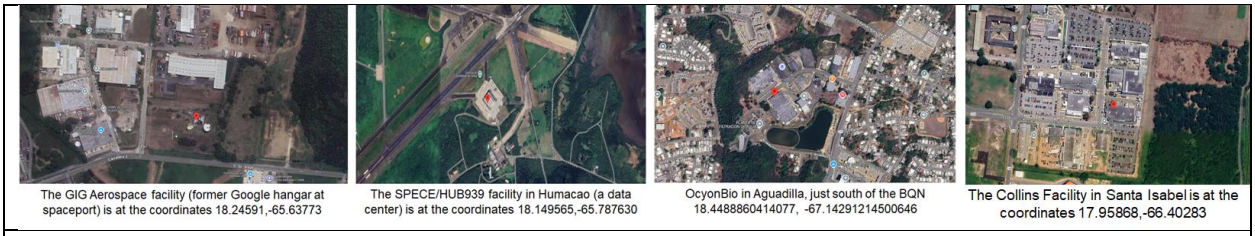


Figure b.10. RECHARGE will deploy 5G O-RAN to provide connectivity at four sites in Puerto Rico. Gig Aerospace at Spaceport, which is an emerging new space company, SPECE in Humaçao (commercial high security office space provider for Aerospace and Defense), OcyonBio in Aguadilla (Biotech company) and Collins Aerospace in Santa Isabel.

The RECHARGE O-RAN network RU will be providing 5G connectivity in both the n78/n48 (CBRS) band as well as the n106 band. 5G NR n106 is a new and emerging band focused specifically on the utility vertical and the RECHARGE O-RAN network plans to make use of existing commercially available off the shelf (COTS) User Equipment (UEs) including Customer Premises Equipment (CPE). ***Sequans and Anterix*** recently announced availability of chipset solutions supporting both n48 and n106 (Link). Additionally, RECHARGE team member Abside has a decade long relationship with cellular chipmaker Sequans and has ***produced UE with Sequans chips*** as part of a $600M Department of Justice (DoJ) IDIQ Contract. Additionally, the RECHARGE team will continue working with industry giant ***Semtech***, the manufacturer of the Airlink line of industrial CPE devices (Link), as an additional source of CPE devices for the RECHARGE project.

Figure b.11. RECHARGE will deploy 5G O-RAN to provide connectivity at two sites at Virginia Tech, in Blacksburg, VA. The first one will have 5G gNodeB at the VT Corporate Research Center (CRC) which will connect to various sensors and switches using UEs. Another deployment will be at the Goodwin Hall with UEs connected to various electric grid modules at the Whittmore Hall and Durham Hall.

- **Description of how the prototype demonstration meets the following requirements:**

Environment: ***Figure b.10*** shows that RECHARGE will deploy 5G O-RAN to provide connectivity at four sites in Puerto Rico. Gig Aerospace at Spaceport, which is an emerging new space company that was founded by Tom Markusic (Formerly with SpaceX, Co-Founder of Firefly Aerospace), SPECE in Humaçao (commercial high security office space provider for Aerospace and Defense), OcyonBio in Aguadilla (Biotech company) and Collins Aerospace in Santa Isabel. RECHARGE will deploy 5G O-RAN to provide connectivity at two sites at Virginia Tech, in Blacksburg, VA as shown in ***Figure b.11***. The first one will have 5G gNodeB at the VT CRC which will connect to various sensors and switches using UEs. Another deployment will be at the Goodwin Hall with UEs connected to various electric grid modules at the Whittmore Hall and Durham Hall.

5G Open RAN Network: In the previous section, we provided an insight into the way in which we plan to deploy the network in Puerto Rico and at VT over n48 and n106 spectrum bands. Radisys CU/DU (L2) software stack is compliant to true O-RAN architecture and interoperated with multiple ecosystem partners over different O-RAN interfaces such as O-RAN 7.2 Fronthaul, O-RAN E2 and O-RAN O1 interfaces. Radisys CU/DU software with Intel FlexRAN Hi-PHY is integrated with various O-RU vendors such as Foxconn, Benetel, VVDN, Pegatron, WNC, Microamp to name a few. Radisys CU/DU E2 interface has been integrated and interoperated with RIC vendors like Juniper, VMware, Accelleran, IS-Wireless and ONF RIC. Radisys CU/DU(L2) stack O1 interface has been

integrated with SMO vendors like Aarna, Fujitsu, ONAP SMO etc. to name a few`.

Juniper RIC supports O1 and E2 interoperability with any O-RAN compliant CU/DU vendor. Juniper have performed RIC integrations with multiple RAN vendors including Parallel Wireless, Casa Systems, Mavenir, Intel and a large defense contractor's own base station as well as integration and O-RAN spec compliancy tests with vendors like Keysight and Viavi who can emulate CU/DU nodes. Juniper RIC also supports onboarding and deployment of O-RAN compliant r/xApp vendors and have demonstrated use cases with many different partners, such as AirHop, Rimedo, Parallel Wireless, Future Connections, Intel, Microsoft to name a few.

Scale: We provide an example of the scale of RECHARGE using Puerto Rico as an example. Due to Puerto Rico's grid-related challenges, many industrial users have found that on-site power solutions not only represent more stable electrical and thermal power, but also energy savings. Currently, industrial rates are approximately 25 ¢/kWh, compared to 8 ¢/kWh in the US, 20¢/kWh in South America, and ¢20/kWh in Europe. In July 2024, rates in Puerto Rico went up by 4.6% and they are expected to be raised at least twice more in 2025 due to the heavy reliance on fuel, the electric utility's restructuring, and grid unreliability. By improving the management of their on-site resources, securing high-tech equipment, and enhancing the interoperability energy sources and network assets, industry in Puerto Rico can strengthen its competitiveness. By leveraging AI-driven optimization, virtualized architectures, and open interfaces, 5G O-RAN empowers industrial manufacturers to build energy-efficient networks that align with sustainability goals while supporting the high-performance demands of Industry 4.0 applications like IoT, automation, and real-time analytics. Efficient energy management supports manufactures in reducing their energy bills. However, it can also help the industry avoid significant cost burdens associated with poor power quality, such as equipment damage, operational downtime, and ruined products or raw materials. In Puerto Rico, where industrial power rates are among the highest in the United States, these benefits can mean significant savings and boosts in competitiveness. 5G Open Radio Access Network (O-RAN) offers industrial manufacturers innovative ways to optimize operations and reduce energy costs by leveraging its open, flexible, and intelligent architecture

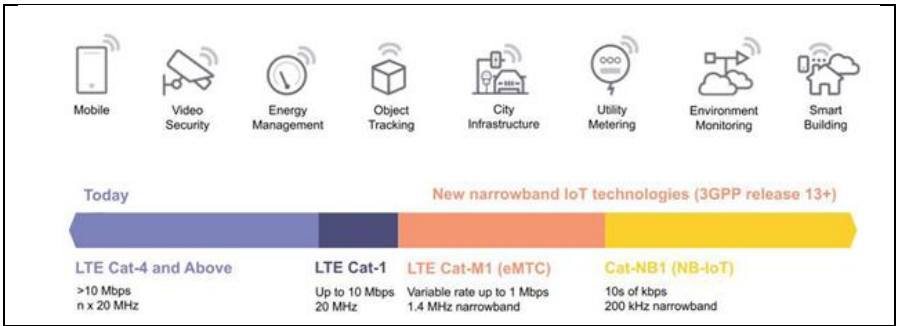


Figure b.12. End point devices TODAY for n106, 900 MHz spectrum band.

End Points: Majority of the 5G end points (e.g., UEs) support the n48 (CBRS) frequency band. As referenced previously, there exists a very robust IoT device ecosystem for 4G/LTE for 900 MHz in the form of variety of cellular modems/modules, routers and gateways, sensors and meters. ***Figure b.12*** illustrates a quick representation of 4G/LTE technologies and devices used in utility use-cases today. ***The n106 Band is a Multi-Billion $ Greenfield market for 5G O-RAN***. Initial phase will focus on prototyping devices for use-case integration and interoperability testing. The later phases we expect commercial availability of n106 supported chipset platforms/modules that will be integrated into end-devices such as routers and gateways, fulfilling distribution automation, substation use-cases. As 5G matures and devices ecosystem develops, helped through this project, future cost-effective 5G devices will also translate to the technology being adopted into typical low-cost IoT devices on the electric grid such as sensors and meters. Eventually, with the sunsetting of LTE networks, a robust 5G device and infrastructure ecosystem needs to be developed to support evolving utility needs and use-cases.

Data Collection: RECHARGE vertical applications will drive the 5G O-RAN Functional Requirements. The project maps the service requirements of target use cases into 5G QoS requirements for various standard and custom network slices. New commercial real estate oriented xApps are designed in the project to meet these QoS requirements. The actual O-RAN performance and the target O-RAN performance are evaluated to adjust O-RAN parameters.

Examples of the KPIMON xApp KPIs that may be exploited in the proposed project include number of utilized and available Physical Resource Blocks (PRBs), number of active UE connections, QoS Class Identifiers (QCIs) associated with active data transmissions, and downlink and uplink data transferred in bytes for each QCI session.

During the xApp design phase, relevant inputs and outputs consistent with the target use cases will be determined to meet the vertical-specific requirements in support of the use cases such as timely transport of sensor measurements, configuration and reconfiguration of switches and microcontrollers, load shedding, and switching or sharing between various energy sources. The performance of xApps will be evaluated in the VT lab first and used to optimize xApps. Optimized xApps will be demonstrated in the field using a new 5G O-RAN based system and upgraded VTES infrastructure.

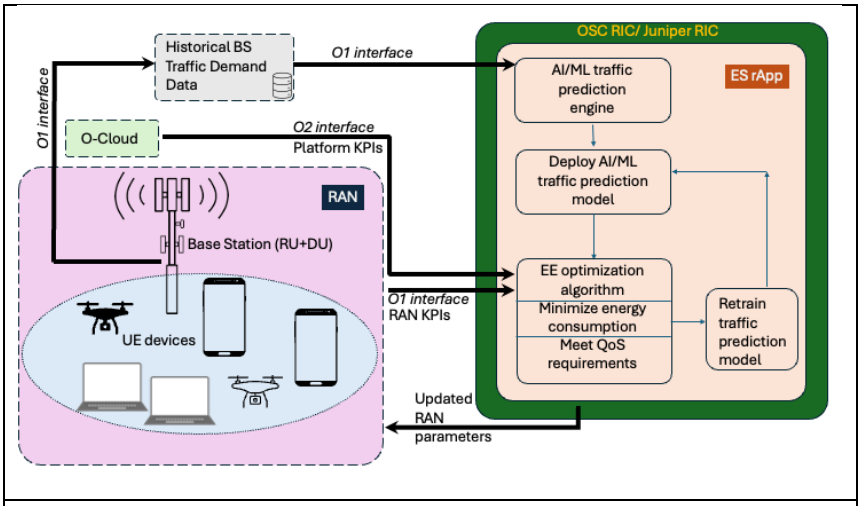


Figure b.13. Proposed Energy Saving (ES) rApp Architecture.

Radisys CU/DU (L2) Software Stack supports O-RAN E2 and O1 interfaces for supporting Near RT RIC, SMO/Non-RT RIC related use cases.

- For the E2 interface, Radisys software supports multiple E2 service models including E2 Service Model Key Performance Measurement (E2SMKPM), Cell and Configuration Control (E2SM-CCC) and Radio Control (E2SM-RC) to support a variety of ***xApp use cases like Energy Savings, Bearer Admission Control , Access Barring and KPI monitoring***.
- At the O1 interface, Radisys software supports Configuration Management, Fault Management and Performance Management related FCAPS operation. This enables integration with any ORAN complaint SMO / Non-RT RIC vendor for a variety of SMO/rApp Use cases.
- Radisys will work with AiRANACULUS to document the specifics of the E2 Service models and O1 data points required for each use case as part of the project.

Juniper RIC supports O1, A1 and E2 interface, including all the O-RAN defined E2 Service Models (E2-SMs).

- The collection of performance metrics will be achieved via O-RAN O1 interface for rApps and E2 interface for xApps. For O1 case, 3GPP 28.552 Performance Metric specifications and any O-RAN O1 extensions will be supported. For E2 case, O-RAN standards defined E2SM-KPM will be utilized.
- In addition to performance metrics, application partners may query and/or change the network configuration as part of their use cases. For this purpose, 3GPP 28.541 based Network Resource Model (NRM) and any O-RAN O1 extensions will be utilized For E2 case, E2SM-CCC will be used. If the use case partners require per UE optimization use cases, E2SM-RC is expected to be utilized.
- The specifics of the data points required for each use case will be documented as part of the project's system level design and use case level documents.

We provide an example of quantitative data collection using the Energy Savings rApp as illustrated in ***Figure b.13***. The rApp will leverage advanced AI/ML models to assess energy supply and demand conditions in smart grids (SG). By analyzing historical traffic patterns and real-time energy availability, our solution will dynamically adjust RAN parameters, such as carrier frequency scaling, cell on/off switching, transmit power control, and Advanced Sleep Modes (ASMs). These adaptive optimizations will ensure that energy efficiency is maximized while maintaining critical network functions. The ES rApp is designed to operate based on four key energy-demand scenarios: ***Low Energy High Demand (LEHD), Low Energy Low Demand (LELD), High Energy High Demand (HEHD), and High Energy Low Demand (HELD).*** By analyzing these conditions, the rApp will determine when to invoke energy-saving mechanisms. In LEHD situations, aggressive power-saving strategies will be applied to ensure network stability, while in HELD

scenarios, the system will remain fully operational without unnecessary energy reductions. For LELD and HEHD conditions, the rApp will fine-tune network parameters to maintain optimal efficiency.

Our solution will integrate both RAN and platform-level optimizations to achieve significant energy savings. In addition to tuning RF parameters, the ES rApp will evaluate compute resource utilization, dynamically adjusting CPU clock frequencies, memory allocation, and network bandwidth to further optimize energy use. This holistic approach will ensure that energy efficiency gains are realized across all layers of the network. The ES rApp intelligently prioritizes different types of traffic based on real-time energy constraints. When energy availability in the SG is low, it prioritizes Ultra-reliable Low-latency Communications (URLLC) over enhanced Mobile Broadband (eMBB) traffic, ensuring mission-critical applications continue to function without interruption. This dynamic traffic management enhances network resilience and service continuity under variable energy conditions. With a modular architecture, our ES rApp will be designed for continuous evolution. The AI/ML models within the rApp will be retrained and updated to adapt to changing network conditions, ensuring long-term effectiveness. Additionally, a structured deployment and support framework, including comprehensive documentation, will guarantee ease of adoption and scalability.

Detailed plans for the prototype demonstration, including, but not limited to, location (with maps and other depictions necessary to fully describe the environment), architecture (physical and logical), equipment and vendor(s), interfaces, projected coverage, methods of testing, and success criteria.

In the previous Sections we have provided locations and maps where our Pilot Deployments will take place. ***Figure b.14*** illustrates the connectivity of Abside O-RU having 384 antenna elements. Two buildings in Blacksburg have been chosen for placing smart grid equipment. An Abside Networks-led 5G O-RAN system will be deployed to provide radio coverage to the selected buildings. RF planning and design will be carried out to ensure adequate radio coverage at the target QoS for the available 5G devices connected to the DERs. Suitable O-RAN node locations will be determined based on the RF planning and design and accessibility to the high-performance servers to implement 5GC and application servers including VTES application servers. Target use cases will be supported by suitable xApps and rApps hosted on high-performance servers. Target KPIs will be quantified during the execution of test scenarios. Numerical values of RAN KPIs and commercial real estate specific vertical KPIs will be quantified during the field demonstration. Examples of RAN KPIs to be quantified include radio resource utilization (i.e., time-frequency resource utilization), block error rate (BLER), radio bearer drop rate, latency, and cell and user throughput. Vertical-specific KPIs include the utilization efficiency of macro and micro grids, service interruption period, and energy cost, and energy source fallback success rate. AM@VT to enhance the vertical-specific KPIs

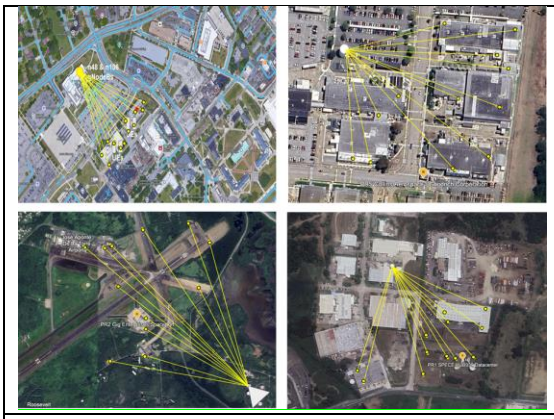


Figure b.14. Abside O-RU connectivity to various locations [TOP LEFT] Virginia Tech, [OTHERS] Puerto Rico.

Frequency ranges, power levels, channel bandwidth(s), carrier aggregation supported, multiplexing method, and multiple input, multiple output (MIMO) configuration of the prototype demonstration, as applicable.

RECHARGE will make use of two (2) different frequency ranges: n78/n48 (CBRS) and n106 (IOT) with spectrum licensing brought by VT, Liberty, and Anterix. Aside's expertise is rooted in advanced networking products, with a specific focus on 4G LTE and 5G technologies. The company's portfolio includes 5G coherent massive MIMO AAUs and full end-to-end 5G O-RAN compliant systems, showcasing their ability to handle complex network architectures. Notably, their work with secure, scalable, fully private 5G standalone networks highlights their capability to deliver customized solutions for challenging applications. The Abside n78/n48 64T64R RU is full band (3300 MHz to 3800 MHz) TDD array comprised of 384 elements @ 0.5W = 192W ERP supporting all channel bandwidths (10 MHz to 100 MHz) and configured in a CBRS 10 MHz channel using a 2x2 MIMO beam. The Abside n106 4T4R RU is a 4x5W FDD with external antenna unit and configured in a 3 MHz channel using a 2x2 MIMO beam. Link budget and performance testing will be conducted with two (2) different multiple input multiple output (MIMO) configurations (2x2 and 4x4) to validate performance regarding reflections, urban clutter, and building penetration.

- **Description of the relevance, scale, and representation of the prototype demonstration relative to the industry vertical and its applicability to the Commercial Transition Plan.**

The companies identified for deployment in this project were carefully selected to maximize the benefits of 5G O-RAN based smart factory enhancements to industry verticals for multiple sectors (smart manufacturing, power & energy, commercial real estate, biotech, aerospace & defense etc.). This allows us to frame specific advantages based on industry sector and analyses with competitive landscapes. Additionally, we incorporated emerging network capabilities such as AI managed multi-domain, space cable, and decentralized payment mesh networks. The ***companies collectively represent small and midsize enterprise (SME), multi-national perspectives, emerging technologies, robust industry economic ecosystems***.

Figure b.15. OcyonBio provides dedicated autonomous manufacturing capacity with interconnected infrastructure and systems to support phased appropriate development for early development, pre-clinical, clinical and commercial start.

O-RAN can provide the ability to manage private 5G utility networks efficiently, resiliently, reliably and securely in n106 spectrum band with our Partner ***Anterix***. The cost-effective scalability through O-RAN's modular design means utility networks can deploy small, low-cost networks and scale when demand grows, rather than traditional bulky and costly infrastructure. The technology could offer superior management, control, traffic priority through innovative network slicing, security and application support via xApps/RIC or other platforms, thereby leading the way for advanced grid capabilities and functionalities, improving operational efficiency. This could be a game-changer not only for the utility segment but also enable modernization and expand the private broadband deployments into other critical infrastructure such as energy, transportation and other industries.

As an example, ***OcyonBio*** is a drug discovery and contract manufacturing organization (CMO) with a recognition of the value of extensive secure data management, accelerating drug discovery and clinical trial phases of drug manufacturing(***Figure b.15)***. As a SME, OcyonBio can rapidly adopt the new system designs to advance innovation more effectively.

Gig Aerospace is an emerging new space design and manufacturing company and has developed a vertical launchpad to land hypersonic vehicle, as well as a last mile satellite repositioning vehicle (***Figure b.16***). As a Partner on RECHARGE, they will provide input on space industry related communications needs, and paradigm shifts in AI workforce changes expected over the next 10 years.

Collins Aerospace is a recognized Aerospace and Defense company with multiple facilities in Puerto Rico and plans to potentially expand. This project aligns to an existing corporate strategy to deploy ***smart factory enhancements*** to lower operational costs and improve competitiveness and strategy expansion implementation of those enhancements in tandem with ***5G O-RAN*** as aligned to the purpose of this solicitation. Collins Aerospace, a significant US producer of communication-related technology and a non-Federally funded partner, will gain an opportunity pipeline for new product partnerships.

SPECE is a regional private real estate company specializing in professional co-working offices, currently. fulfilling basic commercial real estate needs., As a future market opportunity, they have planned a ***highly secure co-working space*** near

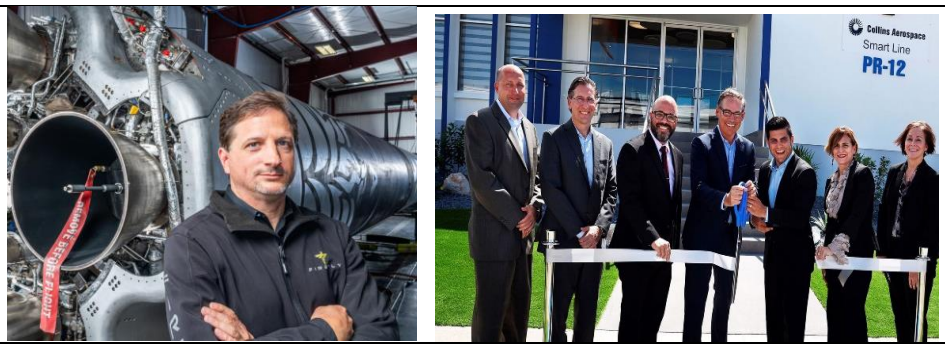


Figure b.16. [LEFT] Gig Aerospace is a new space design and manufacturing company. [RIGHT] Collins Aerospace advances digital manufacturing operations with new smart line capabilities in Puerto Rico.

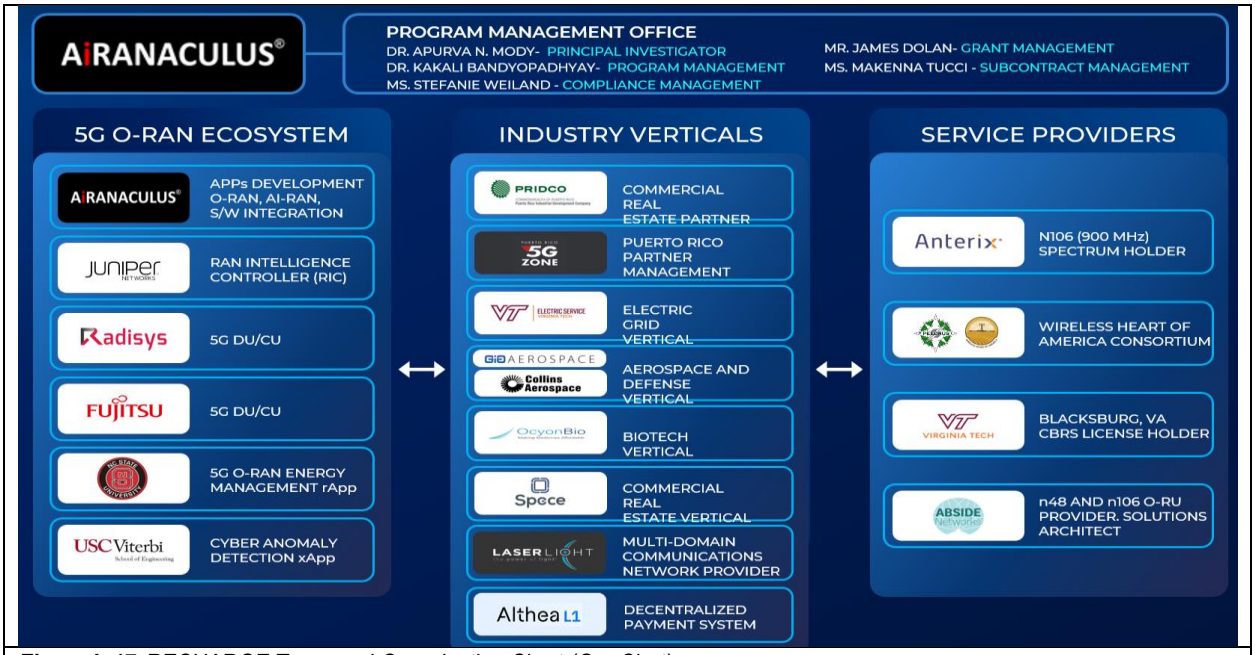


Figure b.17. RECHARGE Team and Organization Chart (Org Chat)

the proposed Spaceport for use by companies using the launch and retrieval services. These companies require a ***higher level of communication security, flexibility of interoperability, and efficiency of operations*** to make them cost effective for research and development activities. Thus, deployment at SPECE will offer the team an opportunity to evaluate the value of upgrading privately owned buildings.

Laser Light Communications is a multi-domain communication network based on MEO satellite to optic ground station laser connectivity, interfaced via AI with existing fiber optic and subsea cable infrastructure. The company will provide optimized low latency data transfer due to its advantaged position to the equator and connect to a global network of regional mesh networks with multiple nodes. This non-Federally funded partner will manage optimization of the network connectivity using ***5G O-RAN to gather real-time weather data and make AI-enabled decision making to switch between nodes receiving optimal signal and fiber or sea cable as a back-up***.

Althea Network is an intelligent energy and connectivity infrastructure provider with products and services based on decentralized payment solutions. They are establishing operations in Puerto Rico and eager to be a non-Federally funded partner in this initiative to test and validate their applications from an interoperability perspective. Their contribution also allows the exploration of various resilient regional network structures.

Our relationship with ***PRIDCO***, Puerto Rico Manufacturers Association, INDUNIV BioScience Partnership, the Puerto Rico Science, Technology and Research Trust, and Puerto Rico Aerospace and Technology Consortium will allow us to generate a pipeline of other post project deployment sites on the Island. Through our global emerging technology data platform and monthly meeting network we'll be able to produce ***'score cards' for product commercial value*** and identify a pipeline of emerging technologies and applications to test within our labs and deployment sites for interoperability validation. Finally, our knowledge and engagement with capital investment focused organization and individuals will assure that the project efficiency validations have the exposure needs to stimulate investment post deployment.

c) Work Plan Summary

Table b.3 **Milestones and Deliverables**

Item	Milestones Description	Deliverable	Milestones (MARO)
CDRL 101	Kick-off Meeting. Briefing in Power-point (PPT)	PPT	Month 1
CDRL 102	Monthly Status Reports, Monthly Financial Reports	PDF	All Months
CDRL 103	Functional Requirements Review (FRR) Meeting + Briefing	PPT	Month 3

CDRL 104	Systems Requirements Review (SRR) – SRR Document. High Level Architecture/Design Document & API Swagger definitions	PPT	Month 6
CDRL 105	Preliminary Design Review – FRR and Preliminary System Design.	PPT	Month 9
CDRL 106	Critical Design Review - Operational design/deployment document & Test reports	PPT	Month 12
CDRL 107	Technical Interchange Meeting and Initial Capability Demonstration of 5G O- RAN Inter-Operability Testing (AG)	PPT and Demo	Month 15
CDRL 108	Technical Interchange Meeting	PPT	Month 18
CDRL 109	Technical Interchange Meeting	PPT	Month 21
CDRL 110	Technical Interchange Meeting	PPT	Month 24
CDRL 111	Technical Interchange Meeting and In- Lab Capability Demonstrations (AH)	PPT and Demo	Month 27
CDRL 112	Technical Interchange Meeting	PPT	Month 30
CDRL 113	Technical Interchange Meeting and Capability Demonstration of Deployments and Pilots in Puerto Rico and Blacksburg (AI)	PPT and Demo	Month 33
CDRL 114	Plan for Sustainment (AJ)	DOC	Month 36
CDRL 115	Commercial Transition Plan (AK)	DOC	Month 36
CDRL 116	Final Capability Demonstration	Demo	Month 36
CDRL 117	Final Review	PPT	Month 36
CDRL 118	Final Report (AL)	DOC, PDF	Month 36
CDRL 119	Software and Hardware Bill of Materials	DOC	Month 36

Figure b.1 shows the RECHARGE CONOPS. ***Figure b.17*** provides the organization chart. ***Table b.3*** provides Milestones and Deliverables. ***Table b.4*** lists the Work Breakdown Structure (WBS), Schedule and Milestones (e. g. Kickoff, Systems Requirements Review (SRR), Preliminary Design Review (PDR) etc.). Detailed Work Plan for each of the Tasks and Sub-tasks has been provided in the Work Plan Document ***j***.

d) Qualification of the Applicant and Unique Aspect of the Proposal

AiRANACULUS is a Small and Medium Enterprise (SME) that is at the forefront in Intelligent RF and Networking Solutions for applications ranging from Space to Smart Cities. AiRANACULUS is a leading provider of autonomous, resilient wireless communications technologies, with a track record of delivering cutting-edge software and AI solutions for mission-critical environments. Founded in 2019, by ***Dr. Apurva N. Mody*** (Fellow of the IEEE, Former Vice Chair and Chair of the National Spectrum Consortium, 25+ Patents Granted), the company has demonstrated its ability to transform advanced research into deployable, commercially viable products that leverage O-RAN interfaces to provide secure, resilient connectivity. The mission of AiRANACULUS is to make all wireless networks intelligent through cross layer sensing and Autonomous Intelligent Reconfiguration™ (AIR).

AiRANACULUS stands out in the market with its ***patented network slicing technology for a heterogeneous wireless networks consisting of 4G/5G. future 5G and Wi-Fi™*** as shown in ***Figure b.17***, which offers unique features not found in existing solutions. Unlike current Wide Area Network (WAN) optimization products that perform optimization only at the network layer, AiRANACULUS' s solution performs cross-layer optimization and provides multi-vendor heterogeneous WAN optimization using network slicing. It is the first RF-aware WAN optimization product, capable of optimizing both terrestrial and space segments. The technology ensures that smart appliances are truly Plug & Play, scanning the environment for RF signals and automatically establishing connectivity.

In the context of smart transportation systems, where autonomous vehicles must maintain continuous connectivity via 4G/5G/satellite to traffic management systems, AiRANACULUS' s solutions significantly enhance connectivity by continuously scanning the RF environment and selecting the best available channel. ***AiRANACULUS has been granted three US patents, it has 12 US patents pending and 58 international patent applications that have been filed***. AiRANACULUS is currently at the ***Pre-Series-A*** and has investments from ***Harvard Business***

Table b.4. **Work Breakdown Structure, Milestones and Schedule**

Owner	Tasks	RECHARGE WORK PLAN SRFA 1 Task Description	SRFA1 Y1 Q1	Y1 Q2	Y1 Q3	Y1 Q4	Y2 Q1	Y2 Q2	Y2 Q3	Y2Q4	Y3 Q1	Y3 Q2	Y3 Q3	Y3 Q4
AiRANACULUS (AIR)	AA	**Program Management Office**												
AiR	AAA	Program Management												
AiR	AAB	Subcontracts Management												
AiR	AAC	Grants Compliance												
ALL	AB	**CONOPS and Functional Requirement Definition**	K, FRR											
ALL	AC	**Analysis of Alternates**												
	AD	**Systems Architecture and API definition**		SRR										
WHOA/ Abside / Fujitsu / Radisys / Juniper / App partners.	ADA	Systems Architecture for Resilient Commercial Real Estate Deployment												
VTES/ Abside / Fujitsu / Radisys / Juniper / App partners.	ADB	Systems Architecture for Resilient Power and Resilient Communications.												
Juniper	ADC	System Architecture for Non-RT RIC, Near-RT RIC and interfaces (O1, E2, R1, RICAPI).												
VT	ADD	Overall Integrated 5GS and Grid Architecture to support target use cases												
Abside / AiRANACULUS / Anterix / PR5G	ADE	Solutions Architecture for 5G O-RAN Deployment in Puerto Rico and Blacksburg, VA, and 900 MHz RU / CPE Design.												
AiRANACULUS (AIR) / VT	ADF	Development of APIs and ICDs for the 5G-ORAN System for Remote Configuration.												
AiRANACULUS (AIR)	ADG	Systems Architecture for xApps/ rApps for Resources and Needs Pairing and Configuration Control.												
VT/VTES	ADH	Systems Architecture for a Digital Twin (Resilient Power, Resilient Comms, Resilient Commercial Real Estate).												
WHOA / VTES / Anterix / Abside	ADI	Site Survey and Deployment Analysis. Spectrum Study and Deployment Plan.												
VT	ADJ	Systems Architecture for xApps/rApps for Network Slicing and QoS Control, Energy Reduction, and Fallback Connectivity												
USC / Pelorus	ADK	Systems Architecture for xApp/rApps for Cyber Security - Internal and External Comms Monitoring and Reconfiguration.												
NCSU	ADL	Systems Architecture for xApps/rApps for Traffic Classification and Energy Efficiency.												
ALL	AE	**Design, Development, Module Implementation**			PDR									
AiRANACULUS	AEA	Implement APIs necessary to enable Resilient Commercial Real Estate Deployment												
AiRANACULUS	AEB	Implement APIs necessary to enable for Resilient Power and Resilient Communications.												
Juniper / Fujitsu / Radisys	AEC	Design and Development of additional RIC features, interfaces and APIs required for RECHARGE use cases												
VT	AED	Determine network slicing requirements to meet use case requirements as a pre-requisite for the design of xApps and rApps												
Abside / AiRANACULUS / Anterix / PR5G	AEE	Finalize Deployment Plan for 5G O-RAN Deployment in Puerto Rico and Blacksburg, VA, and 900 MHz RU / CPE Design.												
AiRANACULUS (AIR)	AEF	Development of APIs and ICDs for the 5G-ORAN System for Remote Configuration.												
AiRANACULUS (AIR)	AEG	Design, Development, Module Implementaton for xApps/ rApps for Resources and Needs Pairing and Configuration Control.												
VT/VTES	AEH	Design, Development, Module Implementation for for a Digital Twin (Resilient Power, Resilient Comms, Resilient Commercial Real Estate).												
WHOA / VTES / Anterix / Abside	AEI	Finalize the Deployment Analysis. Spectrum Study and Deployment Plan. Obtain Special Temporary Authority (STA) License												
VT	AEJ	Design, Development, Module Implementation for xApps/rApps for Network Slicing and QoS Control, Energy Reduction, and Fallback Connectivity												
USC / Pelorus	AEK	Design, Development, Module Implementation for xApp/rApps for Cyber Security - Internal and External Comms Monitoring and Reconfiguration.												
NCSU	AEL	Design, Development, Module Implementation for xApps/rApps for Traffic Classification and Energy Efficiency.												
ALL	AF	**Software, Hardware and Systems Integration and Testing (SI&T)**				CDR								
AiRANACULUS	AFA	SI&T of APIs necessary to enable Resilient Commercial Real Estate Deployment												
AiRANACULUS	AFB	SI&T of APIs necessary to enable for Resilient Power and Resilient Communications.												
Juniper / Radisys / Fujitsu / USC / NCSU / VT / AiRANACULUS	AFC	Systems Integration of Juniper RIC, xApps/rApps with Fujitsu DU/CU and Radisys DU/CU.												
Abside / AiRANACULUS / Anterix / PR5G	AFD	Implement Backhaul and Infra for 5G O-RAN Deployment in Puerto Rico and Blacksburg, VA, and 900 MHz RU / CPE Design.												
AiRANACULUS (AIR)	AFE	SI&T of APIs and ICDs for the 5G-ORAN System for Remote Configuration.												
AiRANACULUS (AIR)	AFF	SI&T xApps/ rApps for Resources and Needs Pairing and Configuration Control.												
VT/VTES	AFG	SI&T of Digital Twin (Resilient Power, Resilient Comms, Resilient Commercial Real Estate).												
WHOA / VTES / Anterix / Abside	AFH	Finalize and Refine the Deployment Analysis. Spectrum Study and Deployment Plan, Special Temporary Authority (STA) License												
VT	AFI	SI&T of xApps/rApps for Network Slicing and QoS Control, Energy Reduction, and Fallback Connectivity												
USC / Pelorus	AFJ	SI&T of xApp/rApps for Cyber Security - Internal and External Comms Monitoring and Reconfiguration.												
NCSU	AFK	SI&T of xApps/rApps for Traffic Classification and Energy Efficiency.												
Abside / AiRANACULUS	AFL	SI&T for Abside RU / Fujitsu DU/CU, Amerisoft Core and Juniper RIC with various xApps and rApps												
Abside / AiRANACULUS	AFM	SI&T for Abside RU / Radisys DU/CU, Amerisoft Core and Juniper RIC with various xApps and rApps												
	AG	**5G O-RAN Inter-operability Testing**					D							
Abside [with Fujitsu / Radisys / Juniper] / VT/ AiR	AGA	Perform Interoperability Testing for Abside RU / Fujitsu DU/CU, Amerisoft Core and Juniper RIC with sample Apps												
Abside [with Fujitsu / Radisys / Juniper] / VT/ AiR	AGB	Perform Interoperability Testing for Abside RU / Radisys DU/CU, Amerisoft Core and Juniper RIC with sample Apps												
	AH	**In-Lab Demonstrations**									D			
Juniper / Fujitsu / Radisys	AHA	In-Lab demonstration of Non-RT RIC and Near-RT RIC.												
AiRANACULUS	AHB	In-Lab demonstration of xApps/ rApps for Resources and Needs Pairing and Configuration Control.												
VT	AHC	In-Lab demonstration of Digital Twin (Resilient Power, Resilient Comms, Resilient Commercial Real Estate).												
VT	AHD	In-Lab demonstration xApps/rApps for Network Slicing and QoS Control, Energy Reduction, and Fallback Connectivity												
USC / Pelorus	AHE	In-Lab demonstration of xApp/rApps for Cyber Security - Internal and External Comms Monitoring and Reconfiguration.												
NCSU	AHF	In-Lab demonstration of xApps/rApps for Traffic Classification and Energy Efficiency.												
Abside / AiRANACULUS / Anterix / PR5G	AHG	In-Lab demonstration of Abside RU / Fujitsu DU/CU, Amerisoft Core and Juniper RIC with various xApps and rApps												
Abside / AiRANACULUS / Anterix / PR5G	AHH	In-Lab demonstration of Abside RU / Radisys DU/CU, Amerisoft Core and Juniper RIC with various xApps and rApps												
	AI	**Deployments and Pilots**											D	D
WHOA / Abside / AiRANACULUS with Others	AIA	Deploy 5G O-RAN in Puerto Rico and Demonstrate how RECHARGE transforms the Commercial Real Estate.												
VT / Abside / AiRANACULUS with Others	AIB	Deploy 5G O-RAN in Blacksburg and Demonstrate how RECHARGE enables Resilient Power through Resilient Communications												
WHOA / VTES / Anterix / PR5G	AJ	**Sustainment**												
AiRANACULUS / PR5G / VT-Pamplin	AK	**Transition for Commercialization**												
	AL	**Final Report**												
	Reports	**Monthly Cost / Status Reports & Final Report (M = Monthly, I = Interim, F=Final)**	M	M	M	M	M	M	M	M	M	M	M	F
	TIMs	**Technical Interchange Meetings (K = Kickoff, TIM = Technical Interchange Meeting, D = Capability Demonstration, FRR = Functional Requirements Review, SRR = Systems Requirements Review, PDR = Preliminary Design Review, CDR = Critical Design Review.)**	K, FRR		SRR	PDR	CDR	TIM	TIM	TIM	TIM	TIM	TIM	TIM	D

School Alumni Angels of New York (HBSAA-NY) and companies such as EpiSci (NTIA NOFO 2 SRFA 2 Awardee) which is now an Applied Intuition Company. AiRANACULUS has also received a ***Letter of Intent from Treasure Coast Ventures, which plans to invest up to $5M in the company in exchange of its equity*** to mature and sell RECHARGE developed capabilities (See Commercial Transition Plan).

AiRANACULUS is working with federal agencies such as NASA, Department of Defense (Army, Navy, Air Force, Space Force, DARPA, OUSD), Intelligence Community (IARPA, DTRA) and consortia such as the National Spectrum Consortium. ***Figure b.18*** shows some of the relevant projects related to 5G and AI, where . In addition to these trusted customer relationships, AiRANACULUS has developed key industry partnerships to ensure interoperability, reliability, scalability and readiness of its commercial offerings. These partnerships include:

- ***O-RAN Alliance***, where AiRANACULUS is a member and a contributor. Juniper, Fujitsu and Radisys are leaders within the O-RAN Alliance chairing multiple Working Groups.
- **Nvidia,** where AiRANACULUS is a partner in their Inception Program for the startups. AiRANACULUS is also a member of the ***AI-RAN Alliance*** to develop next generation 5G/6G solutions for AI RAN operations and management.
- **Radisys,** where AiRANACULUS has entered a strategic partnership to integrate its Resilient Cell (ARC) software stack with the Radisys Trillium software; an industry hardened O-RAN gNodeB software stack with existing commercial deployments.

- **Juniper Networks,** where AiRANACULUS has entered a strategic partnership to provide the ARC xApp to enable resilient 5G.
- **Red Hat,** where AiRANACULUS has established a technical partnership to incorporate Red Hat's Ansible product for resilient 5G deployment Zero Trust Architecture (ZTA) and are working to provide AiRANACULUS software as part of the Red Hat Open Shift platform.
- **Dell,** where AiRANACULUS will be partnering to provide NASA with a space-hardened platform for resilient communications, and an industry hardened edge platform for resilient terrestrial 5G.

These existing customer relationships and partnerships reflect the trust that customers and partners have in the company and its ability to solve complex communications challenges in dynamic and contested environment. These are industry proof points in AiRANACULUS' ability to provide reliable & scalable solutions to ensure mission-critical network operations.

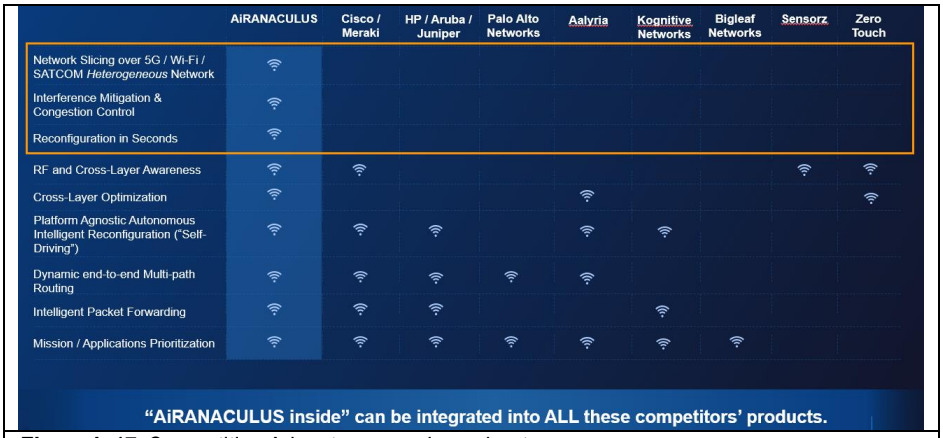


Figure b.17. Competitive Advantage over incumbents

The culmination of the team's efforts has been the development of the company's flagship solution, the **Autonomous Resilient Cell (ARC)**, (***Figure b.19***) which is the **world's first turnkey**, software-defined 5G platform purpose-built for secure, autonomous, and interference-aware operation using O-RAN interfaces. ARC Integrates the Radisys Trillium gNodeB, Juniper near real-time RIC and AiRANACULUS xApps to provide:

Program Title	Agency	Award Date	Value	Description
Cross-Layer Wide-Band Cognitive Communications Architecture Enabled by Intelligent Direct Digital Transceiver (CLAIRE)	NASA	July 2020	$1.25M	Develops a cognitive communications architecture for NASA' s moon mission in 2024. Uses advanced sensing and machine learning technologies for decision making.
Waveform Agnostic Decision Engine (WADER)	ARMY	June 2020	$1.22M	Makes DoD radios resilient by optimizing the degrees of freedom using machine learning techniques.
NSC 5G Dynamic Spectrum Sharing	AF	March 2021	$100K	Technique to enable spectrum co-existence between high power airborne radar and commercial 5G systems.
Cognitive Multi-User Detection for Advanced Tactical Networking Waveform (CAMICA)	NAVY	April 2021	$140K	Develops Multi-User Detection (MUD) Techniques to boost the capacity for the Advanced Tactical Networking Waveform .
Intelligent Network Function Virtualization and Policy-based Routing Engine	NASA	May 2021	$1.3M	Develops Network Function Virtualization based on Network Policies for NASA' s Moon Mission in 2024.
Securing Compartmented Information with Smart Radio Systems (SCISRS)	IARPA	Sept. 2021	$2M	Develops innovative techniques to automatically detect and characterize RF anomalies in complex RF environments.
Operational Spectrum Comprehension Analytics and Response	Navy	Oct. 2021	$300K	Intelligent Spectrum Management
MUSCET	AF	Oct 2022	$150K	Develops Multi-Channel Multi-Functional UHF-50 GHz Cognitive Transceiver
Biological and Chemical Threat Prediction and Reasoning System	DTRA	May 2023	$423K	The BiCEPS System leverages Artificial Intelligence and Machine Learning techniques to analyze the data from wearable devices to detect biological threats.
Dynamic Spectrum Management	NAVY	June 2023	$1.37M	Dynamic Spectrum Management will provide architecture and technologies to enable spectrum sharing between Radars and 5G Systems.
S^3OS	NAVY	Sept. 2023	$1.44M	Intentional overlapping of the transmit channels and leverage advances in Multi-User Detection (MUD), to provide significant (>2X) increase in capacity.
Army Modernization	ARMY	July 2023	$445M (Contract Vehicle)	AiRANACULUS is part of the Draper Labs-led Team for this contract vehicle. A total of Ten teams have been selected. Draper-AiRANACULUS will respond to Army Requests and compete with other teams for the Task Orders
SCORPION	ARMY	July 2024	$2M	Interference detection, characterization and mitigation for GPS signals.
FULCRUM	NASA	July 2024	$150K	Provides an overall framework for robust and resilient 5G on the Lunar Surface.
Space Force DYNAMO	SF	Feb 2025	$180K	Provides secure, robust and resilient 5G Terrestrial and Non-Terrestrial network to enable alternate modality of communications to the Space Force.
OUSD COMET	OUSD	Feb 2025	$300K	Leverages 5G O-RAN interfaces to perform monitoring of Cross Layer Statistics to detect network anomalies and enhance cybersecurity.
SYNAPSE	ARMY	March 2025	$2M	Uses Generative AI techniques to develop synthetic data sets and signals for AI and Machine Learning for Signals Intelligence and Electronic Warfare training, testing and validation

Figure b.18. Federal investments in maturing and leveraging Cross Layer Optimization and Network Slicing technologies thus far. Matching funds from investors.

- Autonomous detection, characterization and mitigation of interference and network congestion
- Autonomous network adaptation for secure operation in contested or remote locations
- A modular, software-based platform ready for deployment across defense, smart infrastructure, industrial IoT, and other high-reliability environments

Key to ARC's differentiation from existing solutions is it's Zero Touch Operation. Existing solutions require manual intervention to solve interference and congestion issues. This includes manual characterization of the interference using RF hunters to locate and identify the cause of the interference and congestion and the need for specialized experience and resources to effectively mitigate it. This is a time consuming and costly endeavor that may take days or weeks to resolve and impact the QoS, leading to a loss of subscribers and SLA fines. ARC's built-in intelligence can detect and characterize the issue, autonomously recommend the mitigation solution and apply it within seconds to minutes; ultimately reducing operators OPEX, improving the subscriber's experience and meeting SLA requirements.

Figure b.19. AiRANACULUS Resilient Cell (ARC) is a software stack that makes ANY 5G O-RAN system robust and resilient to interference and congestion.

AiRANACULUS APP Store: AiRANACULUS software products may be found our website at (Link). AiRANACULUS App Store provides a cost effective and industry proven methodology for creating an ecosystem that drives value creation – e.g. Apple iOS App Store & Google Play Store. It also has the added benefit of reducing the overall systems integration and maintenance costs for end users, applications developers and network & infrastructure providers by providing a standardized infrastructure and methodology for development, verification, validation, deployment, policy enforcement and distribution of applications and the system. For RECHARGE, we intend to develop and provide access to this infrastructure to our partners as part of the program. The vision for this infrastructure is:

- SDK to provide the tooling and frameworks for development of xApps, rApps and custom Service Models to support the developer's needs.
- Remote access to ARC systems and testing infrastructure so that in-lab testing, and validation can be performed prior to deployment. This can be done in conjunction with the VT's OTIC lab, a RECHARGE partner. The long-term vision is to include features such as:1. Developer Portal with CI Integration, 2. Automated Policy Enforcement Checks, 3. Automated System Testing and Pre-Submission Checks
- App Store to provide the distribution and monetization infrastructure to enable quick discovery and deployment and to implement a revenue share model that will be used to maintain and expand the SDK and infrastructure. The long-term vision is to provide: 1. Automated App review process, 2. Code Signing and Provisioning, 3. Monitoring and Analytics for application providers, 4. Revenue share for application providers. In addition,

AiRANACULUS has been able to assemble world's leading companies to participate on this project:

- ***Abside Networks*** represented by Laurant Perraud (Founder and CEO) and Doug Hutchinson (Chief Products Officer) demonstrates strong qualifications in developing, integrating, and deploying solutions that leverage Open RAN interfaces, providing valuable solutions across various industry verticals. Furthermore, the fact that they have received funding from programs like the NTIA's Wireless Innovation Fund NOFO2 to support their Open RAN developments, reinforces their position as a serious producer in this area. This backing shows that their work is valuable in the progression of open radio access networks.
- ***Anterix*** represented by Abhinay Sinai (Director, Technology Development) is the largest 900 MHz spectrum holder across the US , enabling US Utilities to build foundational private broadband networks – utility owned and operated, secure and resilient. O-RAN offers advantages for US Utility 5G Private networks through greater vendor flexibility and cost-effectiveness. Open and interoperable architecture will allow utilities to select best-in-class RAN components from various vendors, avoiding vendor lock-in and potentially reducing infrastructure costs.
- ***Juniper*** represented by Arda Akman (Director of Software Engineering) provide RICs that are most mature and technically advanced across the industry. What differentiates Juniper RIC solution is the support for full O-RAN standards compliance, being designed from ground up based on O-RAN architecture and modern cloud design principles. Juniper RICs are very resource efficient, secure, reliable products with auto-scalability features to scale up/down based on load. They can be deployed on-prem or on cloud services providing flexibility to the MNOs. With it's fully open and extensive APIs, many 3rd party r/xApp developers have developed their apps on Juniper RIC platform, helping us establish the "***O-RAN Appstore***". Additionally, Juniper is one of the leaders in O-RAN

Alliance, chairing multiple groups, has made significant contributions to RIC architecture, A1 and E2 interfaces and is the editor of several RIC related specifications.

- ***Radisys,*** represented by Richard Russell (Vice President) headquartered in Oregon US, is part of Jio Platform Solutions which is a division of Reliance Jio (Largest Mobile Operator in India). Radisys has 100+ 5G O-RAN customer design wins with largest ecosystem support (multiple platforms). Radisys is also the winner of various US DoD and NTIA 5G Challenges. AiRANACULUS has signed a Memorandum of Understanding (MOU) with Radisys to jointly market its technologies.
- ***VT and NCSU professors*** (Prof. Nishith Tripathi and Prof. Vijay Shah) have published the world's first multimedia book (Link) on 5G and a book on O-RAN. Their expertise will be exploited to design xApps and rApps. Additionally, extensive 5G O-RAN testbeds will be exploited to optimize xApps and rApps. The xApps and rApps will enable the 5G system to meet the service requirements of diverse commercial real estate use cases.

Table b.5 provides a Summary of the Unique Aspects and Benefits of RECHARGE

Table b.5. Unique Aspects and Benefits of RECHARGE

	UNIQUE ASPECTS AND INNOVATIONS OF THE PROPOSAL	BENEFITS TO 5G O-RAN ECOSYSTEM AND THE US ECONOMY
1.	Enables Resilient Commercial Real Estate using 5G O-RAN. All industry verticals require commercial real estate and buildings.	• RECHARGE will transform the ***$1.2 Trillion commercial real estate market***, by enabling resilient communications through 5G O-RAN.
2.	RECHARGE ***opens a Brand-New Frequency Band n106*** to provide 5G O-RAN enabled MMTC / IoT in 900 MHz for Smart Grid.	• RECHARGE Partner, Anterix owns nationwide rights to use the 3 MHz by 3 MHz spectrum in the n106 Band. This project ***paves a pathway to deploy 5G O-RAN in n106 spectrum not just across the entire United States, but entire World***.
3.	RECHARGE ***leverages and builds on NOFO2 successes*** with increased production and market penetration of US O-RU.	• ***Grows the domestic O-RU, O-RAN products and solutions*** increasing the US ORAN talent pool and US economy
4.	RECHARGE ***enhances multiple Industry Verticals*** – Power / Energy, Smart Manufacturing, Biotech, Aerospace	• Enables RECHARGE Team to drive ***business logic and decisions*** making via xApps and rApps, which is vital to recharge industry verticals.
5.	RECHARGE leverages E2, O1, A1 Interfaces to Provide ***Autonomous Intelligent Reconfiguration through Cross Layer Sensing.***	• Enables ***Configuration Management, Fault Management and Performance Management*** for a gamut of Applications (xApps / rApps Store) to drive various Industry Verticals.
6.	RECHARGE includes the design and integration of a software solution across a network, leveraging O-RAN components to access O-RAN innovations, such as the RIC	• RIC brings intelligence and openness to what used to be closed RAN, it enables not only closed RAN vendor but industry-wide innovation. ***New business models*** enabled through the application of RIC and use cases to vertical industry solutions is expected to provide benefits to US Economy.
7.	Radisys and Fujitsu 5G CU / DU stack supporting O-RAN E2 and O1 interfaces and advanced features like network-slicing.	• Radisys and Fujitsu O-RAN stack is highly interoperable, and the capabilities can be leveraged in this project to build variety of use cases.
8.	VT / VTES plug-and-play O-RAN infrastructure, new xApps for monitoring build state, security monitoring.	• Lower energy costs, resilient infrastructure, greater security, maximize grid efficiency, increase spectrum utility. • Enables design of optimal network slices, new xApps and rApps to address the requirements of commercial real estate
9.	RECHARGE architecture has cybersecurity and Zero Trust Architectures built in ensuring security-by-design.	• Establishes Open RAN as the leading architecture for mission-critical, private 3GPP communications.
10.	AiRANACULUS Resilient Cell (ARC) xApp/rApp provides ***autonomous detection, characterization and mitigation of interference, congestion and cybersecurity threats.***	• Enables ***spectrum and network situational awareness for heterogeneous multi-vendor network***. • Enables ***Link Optimization*** (e.g., Dynamic Spectrum Access / Dynamic Channel Assignment, Dynamic Bandwidth Adaptation).

11.	***API-enabled network data analytics*** and prediction-enhanced network optimization.	• Enables Zero Touch operation and management of 5G communications infrastructure, which ensures network uptime, performance and meets SLA and security requirements.
12.	***Network Slicing*** over a heterogeneous wireless network ***(World' s First)*** allows the Operators to maintain Quality of Service (QoS) for a wide variety of applications in challenging scenarios.	• ***10x improvement in communications quality*** in presence of interference and congestion. ARC is an Agent-based solution that uses ***well defined 5G O-RAN interfaces such as E2 / O1***, for cross-layer optimization and Network Slicing orchestration.
13.	***Dynamic Generation and Configuration of Policies.***	• This allows ***deterministic operation of 5G O-RAN network in situations*** for a myriad of applications ranging from Power Grid Communications, Robotics, Manufacturing, Healthcare etc.

e) Facilities & Equipment

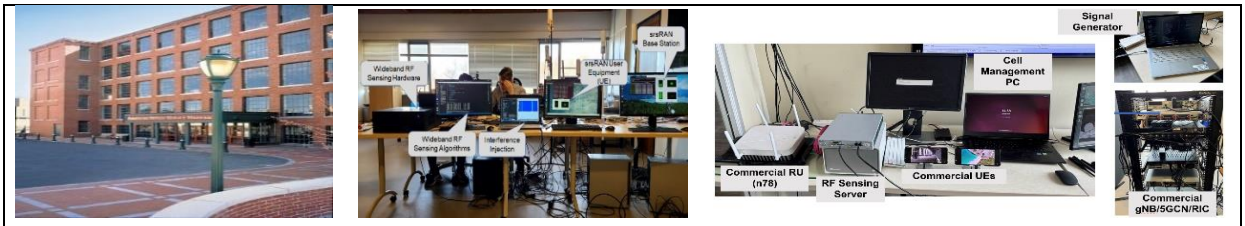


Figure b.20. AiRANACULUS Facilities. [LEFT] AiRANACULUS Office Space, [MIDDLE] AiRANACULUS lab space [RIGHT] AiRANACULUS Commercial 5G Testbed.

RECHARGE team possesses state-of-the-art facilities and equipment that will be leveraged during project execution. Companies such as ***Juniper, Fujitsu, Radisys, Abside Networks*** have been selling commercial grade products the telecom market for decades. All these companies are premium vendors of state-of-the-art 5G O-RAN solutions and have large lab spaces.

AiRANACULUS: AiRANACULUS, a SME and the Prime, has 3500 Sq. Ft., office space in Lowell, MA as shown in (***Figure b.20***). This facility also contains AiRANACULUS 5G/6G research labs consisting of Lanner and Dell Servers as a Network in the Box hosting the Radisys DU/CU/Core, Juniper RIC, Intel FlexRAN, and FOXCONN Radio Unit. Their facilities include hardware and software that supports wide variety of cognitive radio architectures consisting of wideband RF sensors using advanced direct digital transceiver technology that can perform RF sensing from UHF to Ka Bands, N320, X310 and B210 USRP Radios, Signal Hound radios, Signal Hound arbitrary waveform generators (AWG) etc. AiRANACULUS is building the Lab areas which include NVIDIA GPU and Intel CPU Server Farms that assist in implementing statistical signal processing and machine learning algorithms. AiRANACULUS currently has $3M of equipment procured through various DoD, NASA, and intelligence programs.

Radisys O-RAN CU/DU L2/L3 software is tested for interoperability with partner and 3rd party network elements. Their RAN CU/DU L2/L3 software has been interoperability tested with multiple PHY/radio partners, core network implementations, commercial handsets and UE test equipment. They continue to showcase their solution interoperability in various industry events like O-RAN Plug fest and through OTIC lab activities.

Abside Networks: Abside Networks will make its New Product Introduction partially available to assist in the project RU initial phases. Their NPI radio facilities include: 3 ESD safe labs totaling 1500 square ft.., 3 sets of Rohde and Schwarz RF signal generator and signal analyzers, and an anechoic chamber ranging from 2.5GHz to 5GHz. This NPI facility is part of Aside's R&D office space totaling 6100 square ft. Abside will also rely on the facilities of the selected CMs. Aside's current CM has 175,000 square feet of flexible space.

VT/VTES: Virginia Tech's comprehensive 5G O-RAN facilities and equipment and capabilities will enable the project team to execute the project successfully and cost-effectively. Due to the extensive multi-million-dollar 5G O-RAN infrastructure available at VT, the project can be executed with only incremental cost of the equipment. Additionally, the availability of 5G and O-RAN materials for knowledge and xApp and rApp skills development at VT will facilitate the work of this proposed project. They plan to use three major 5G O-RAN testbeds at Virginia Tech: xG testbed/OTIC in Northern Virginia, CORNET in Blacksburg, and Portable O-RAN Testbed for 5G and Beyond (PORT5+). Virginia Tech also possesses the Open AI Cellular (OAIC) framework to accelerate xApp development.