

Introduction:

The Research Empowered Advanced Communication Hub (REACH) will be an interactive network of research on new applications for advanced information communication technologies that builds the backbone of 5G, 6G, wifi6, wifi7, Blockchain, Web3, HPC, Edge, IoT, AI, and Quantum computing. This network of critical intelligent infrastructure experts will secure the technological resources required to innovate, navigate the digital age, and support growth and efficiency within industry verticals already strong on the island. The potential industry verticals are unlimited as new technology applications are designed, but for the purpose of this submission the Engine will be focusing on Resiliency/Port Management, Aerospace/New Space, and BioScience/Digital Health. The focus will include both development of the industry verticals, and related intersections.

Puerto Rico has a history of advanced, high-compliance, clean rooms environment manufacturing, but has struggled to coordinate partners on the island in collaborating on next gen research applications related to critical intelligent infrastructure. This Engine will develop a shared technology access vision within the network using methods developed at the 'Agile Strategy Lab' at University of Northern Alabama. It is a new strategy discipline specifically designed for open, loosely connected networks. Unlike strategic planning, which was developed primarily to guide strategic activity in hierarchical organizations, this approach is designed for situations in which nobody can tell anybody else what to do. Even in companies in which there is a "central authority," often the work of innovation – moving into new markets, products, or transforming an institution – requires a different kind of collaboration.

REACH proposes to build upon work done to map the innovation ecosystem on the Island by "Echar Pa'lante". The aligned partners will customize various digital tools to connect emerging technology, talent and products developed in Puerto Rico to national and global markets. Interactive technology will connect the regional ecosystem partners to each other, to global best practice data, and to real-time global market intelligence. They will create the tracking, accountability, and transparency that has previously hindered the region. We are primarily integrating is TDP decision platform, a database with millions of source documents from federal and global sources. TDP decision platform works with corporations to turn opportunities, disruption, new technologies, and adjacent markets created by innovative startups into financial returns.

We embraced the BAA call to be creative and impactful and included many partners ranging from academics and government to non-traditional partners like students, established industry, and start-ups. We did this with the philosophy that it is better to design an innovation culture WITH our partners rather than FOR our partners.

Proposal

Puerto Rico as a Testbed for Critical Intelligent Infrastructure Deployment

The Research Empowered Advanced Communication Hub (REACH) will be an interactive network of research on new applications for advanced information communication technologies that builds the backbone of 5G, 6G, wifi6, wifi7, Blockchain, Web3, HPC, Edge, IoT, AI, and Quantum computing applications. This network of critical intelligent infrastructure experts will secure the technological resources required to innovate, navigate the digital age, and support growth and efficiency within industry verticals already strong on the island and enable new industry attraction. The potential industry verticals are unlimited as new technology applications are designed, but for this submission, the Engine will be focusing on Resiliency/Port Management, Aerospace/New Space, and BioScience/Digital Health as examples. The focus will include the development of the industry verticals and intersections of those sectors.



- Create a connected system of specialized technology innovation labs on the Island.
- Deploy a customized AI enabled collaboration tool that allows for optimized referrals, tracking, accountability, and decision making.
- Map ecosystem and establish milestones using national and global best practices as the 10 year goal.
- Develop a transparent process for prioritizing investment in the engine and within the ecosystem.

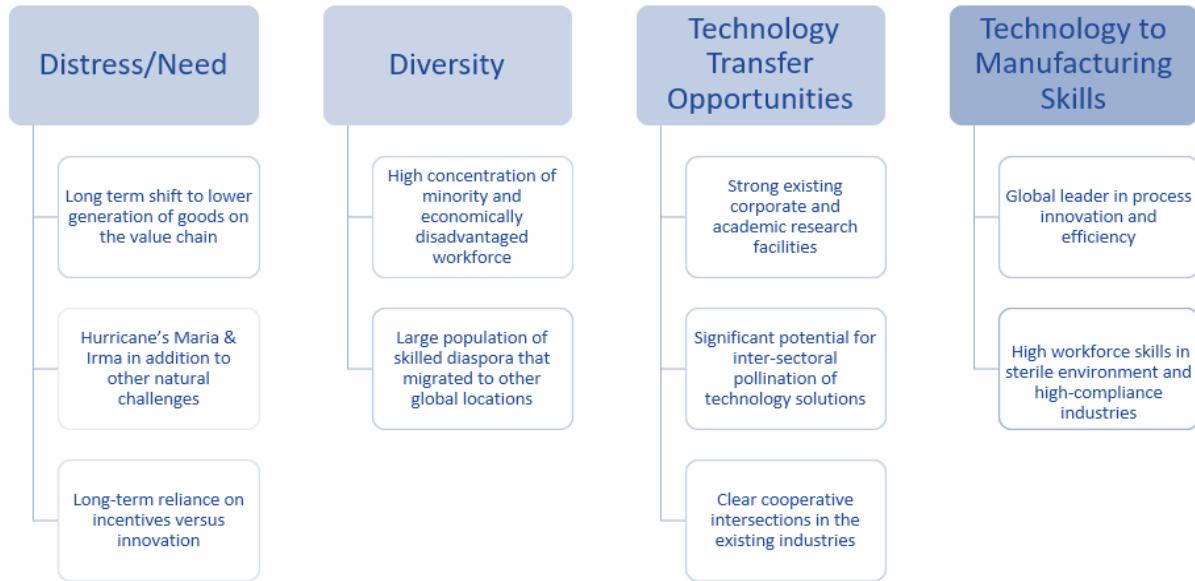
- Research
- Empowered
- Advanced
- Communication
- Hub

REACH will be managed by the Puerto Rico 5G Zone + Blockchain Ignition Lab which manages open-use ZTA secured laboratories providing entities with low-cost access to advanced data management tools like High-Performance Computing, an IoT validation Platform, Cloud Computing, and multi-network convergence. These labs are linked to other research facilities at Texas A&M, Purdue, the Pacific Northwest Lab, and a Depart of Defense Lab in Hawaii. REACH additionally has an extensive network of over 100 expert entities, in addition to access to gig-economy workers with communication-based technology expertise. The proposed region of service is Puerto Rico with Phase I evaluation of including the US Virgin Islands.

REACH will work with partners to identify problem statements from an industry, economic, and social impact perspective, and catalog technology solution providers to weave together solutions that match the individual circumstances. The cross-pollination of these technologies and solutions can then be tested in the proposed secure lab system before being deployed in validation pilots on the island.

Puerto Rico as a Qualified Region

A quick snapshot of Puerto Rico mapping to the qualifying objectives of the Engines program reveals that Puerto Rico strongly aligns with the qualifying criteria established. It also demonstrates the unique characteristic of a region where success and challenges co-exist in a melting pot of cultural diversity.



Data supports each of the statements made in the graph above individually. For 'Distress/Need', a 2021 study conducted by the Pharmaceutical Industry Association of Puerto Rico and Invest Puerto found that Puerto Rico was being outpaced in research assets by comparative regions both nationally and globally. To support that, the study states that in a comparison of NIH funding for 2019 between Puerto Rico and Connecticut, both of which have a comparative geographic size and general population in Connecticut which employs roughly 24 thousand people employed directly and indirectly in the bioscience industries and Puerto Rico employing 49 thousand direct and indirect jobs, Connecticut received approximately \$600 million in related research funding whereas Puerto Rico received approximately \$60 million or approximately 10% despite having almost double the workforce in the industry.¹

This small amount of research on new product development on the island has resulted in the loss of investment in infrastructure and the migration of talent to other jurisdictions, placing at risk 1/3 of the GDP with potential plant closures. An example of this is the recent closing of the Roche plant in Ponce which produced diabetic test strips that new continuous glucose monitoring (CGM) is replacing as a technology. Simultaneously, DDEC negotiated an incentive to Medtronics for equipment and train employees to produce CGM on the island², emphasizing the non-virtuous cycle of incentives creating cost competitiveness rather than research and innovation creating locational advantage.

The research funding disparity is an opportunity for the REACH project to deliver parity in research funding which in turn creates jobs and innovation and commercialization and at the core will be workforce development to perform the 10X research levels. This can be factored as economic value created from the innovations from the research using traditional economic modeling.

Adding a diversity perspective, according to Data USA, Puerto Rico is 98.7 percent Hispanic.³ Seemly in contradiction, the Census Bureau reported in 2020 that 60% of the population identify as 'White', 11.3% as 'Black or African American', 9.7% as 'Two or More Races', and only .02% as American Indian, however, these numbers reflect the complex diversity even within individuals own self-identify.⁴ Historically Puerto Rico has been a destination of migration from Europe, Africa, and South America.

¹<https://www.investpr.org/wp-content/uploads/2022/02/Benchmarking-PuertoRicos-Pharma-Sector-PIA-InvestPR.pdf>

² <https://www.desang.net/2021/08/medtronic-next-gen-cgm/>

³ <https://www.desang.net/2021/08/medtronic-next-gen-cgm/>

⁴ <https://www.census.gov/quickfacts/PR>

But diversity is not just about ethnic heritage, it is also about socio-economic diversity. The 2020 census data also reveals complexity in other markers of diversity such as age, sex, education, and income showing an estimated 40% of the population living in poverty, with a median income of \$21,053, and yet 26.7% with a Bachelor's Degree or better. Comparing that to Arkansas which has similar education attainment but only 16.3% living in poverty and a median income of \$49,479, it shows not just diversity, but the disparity in the correlation between those data points where despite high rates of poverty there is a relatively high percentage of college educational attainment, but correspondingly low wages.

The short answer to why there is such disparity lies in the significant out migration of educated diaspora seeking better opportunities. This skilled diaspora is eager for opportunities to return to their home, but cannot find opportunities on the Island aligned to their skill attainment. A recent analysis by the Washington Post shows that Puerto Rico is not alone as all US Territories face the same dilemma of failing population rates, brain drain, and resultant economic implosion due to low tax revenues and related capacity to incentivize stimulation.⁵

Despite the distress Puerto Rico feels from the erosion of high-value chain production and outmigration, the Island is still one of the strongest Pharmaceutical and Medical Device manufacturing locations in the US. According to INDUNIV, the Island's Biosciences Innovation Cluster partner, Puerto Rico has the highest global concentration of Life Science Companies by area engaging in the highly regulated Biopharmaceutical environment manufacturing for over 50 years. Additionally, it is the largest US exporter of bioscience products, shipping to over 120 countries.⁶ This concentration has created related technical expertise as evidenced by Johnson & Johnson in Puerto Rico being the first pharmaceutical company to shift from batch to continuous process manufacturing, starting a global efficiency revolution in the industry.⁷

Yet of 384 Metropolitan Statistical Areas, as defined by the US Census Bureau, San Juan by population would be in the top 30 regions, however by innovation ranking applied by TDP decision tool, a database of millions of key economic markers, San Juan is ranked 164th. The TDP Data Science team developed integrated and custom algorithms, using R and Python, combining multivariate linear, logistic, and Poisson regression models with Bayesian probability concepts to develop ranking algorithms. It employs support vector machines for vector space, cosine similarity, and other complex computational algebra and machine learning models. It then models cross-validation metrics that utilize more than 100,000 simulations to provide information about the range of expected errors of the model. Since TDP models are updated in real-time and at the point of query as the data sets are refreshed and queried, the models are continually relevant. REACH will be able to track each metric and ranking based on composite score.

Rank	City	Capacity to Generate Basic Research	Research Commercialization	Capacity to Train and Develop Workforces	Capacity for DEI & Accessibility	Composite Score
1	New York	8.8	9.9	6.8	8.1	8.4
2	Boston	8.7	8.6	8.6	6.5	8.1
3	Chicago	7.9	9	7.3	7.9	8
4	Austin	6.8	8.7	8.5	8	8
5	Los Angeles	8	9.2	5.5	9.1	7.9
6	San Francisco	8.6	9.8	6.1	6.2	7.7
7	Dallas	6.7	8.3	6.9	8.7	7.7
8	Houston	7.3	8.6	5.7	9	7.6
9	San Diego	7.5	8.5	4.9	8.1	7.2
10	Atlanta	7.1	8.5	6	6.5	7
...
164	San Juan	4.1	3.5	4.3	4.7	4.3

⁵<https://www.washingtonpost.com/business/2022/09/23/american-territories-population-loss/?fbclid=IwAR03bi1B2elF5wafLDN3GuAvcHmOvFrZ4TdD-SjqDVzjpMEyjdPyNVhx8ys>

⁶http://www.induniv.org/wp-content/uploads/2022/08/Brochure_Induniv_PuertoRico.pdf

⁷<https://www.tradeandindustrydev.com/industry/bio-pharmaceuticals/how-continuous-processing-impacting-us-drug-13749>

This tool gives us benchmarking to design solutions based on moving the needle for the metrics used to establish this ranking. They are as follows:

Capacity to Generate Basic Research including a) presence of universities and research institutes in the MSA, b) volume of research generated by research institutions in the MSA, d) Impact of the research from the MSA, e) Citations of research and when the research has been cited and geography of where the citations are coming from.

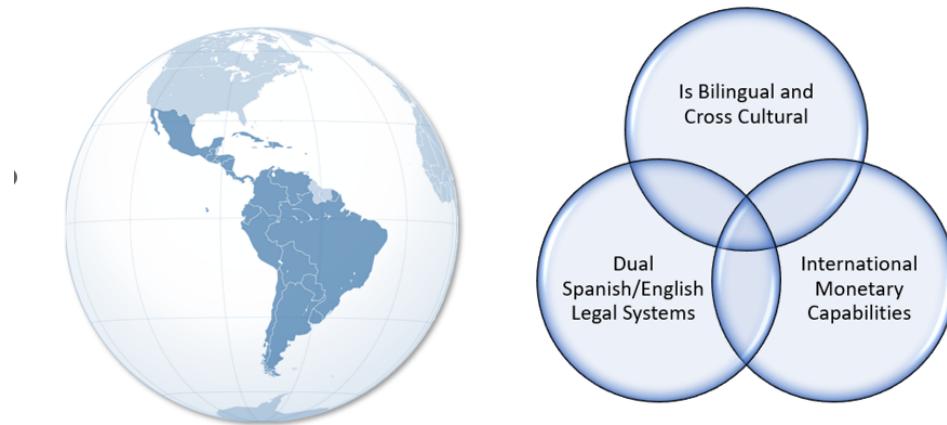
Research Commercialization Tracking that provides a) a score on how much the research generated from the MSA is captured commercially, b) a score on the commercialization potential of research generated from institutions in the MSA, and c) presence of entrepreneurial researchers/professors in the MSA.

Capacity to Train and Develop Workforces measuring a) presence of unions and other labor organizations, b) employment statistics and job placement from local universities, c) diversity of Industry of the Labor Market, and d) education and training levels of the workforce

Capacity for DEI and Accessibility Engagement through a) presence of Minority Business Entities in the MSA, and b) Demographic diversity (race, ethnicity, and religion) of MSA.

The results of this analysis shown in the table above reflect both the disparity in funded research on the Island and the challenges presented in comparisons based on the nomenclature used for data collection sources that may not translate appropriately in the ranking. It also provides REACH an appropriate comparative outline by which to design milestones and measure the progress, making Puerto Rico an appropriate location for an NSF Engine based on program objectives. Below shows a snapshot of unique assets that make Puerto Rico a significant opportunity to create rapid success measured in economic impact, social impact, and national needs in life-critical products and technology security.

Geographically, Puerto Rico is the furthermost location forming the eastern boundary of the United States and the southernmost boundary in the Atlantic at Parallel 18 close to the equator and shipping lane to the Panama Canal. This positions it to be the United States gateway to markets in the eastern hemisphere and Latin America, for all of Europe and Africa. Conversely, Puerto Rico's export capabilities show it is an established trade partner with over 120 countries. As supply chain disruptions in the pandemic highlighted, reshoring is a critical national need and Puerto Rico is uniquely positioned to provide it.

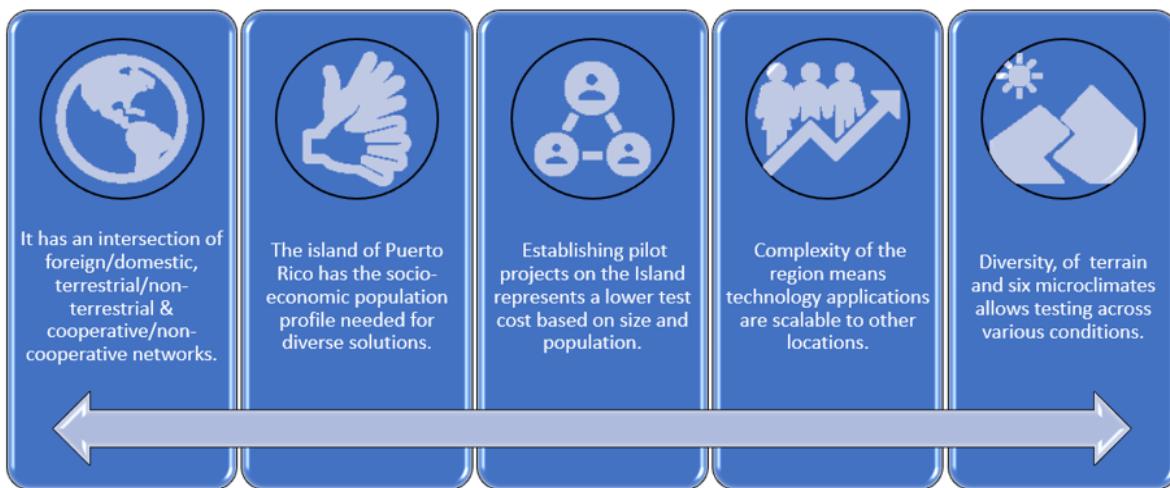


Puerto Rico is the only location in the US that operates simultaneously on English-based and Spanish-based law making it an optimal destination for efficient negotiation of contracts and licensing agreements. The embedded bilingual mastery of Spanish and English in professional services on the Island facilitates trust in these negotiations and collaborations. Plus, as a territory, it has international monetary and exchange capabilities not available in the continental US. These three points together make Puerto Rico an important asset to US technology transfer efforts, trade development, and international relations with the 500 million people in Latin America.

This role has increased dramatically in the last six months as international tension with Russia and China has escalated. Several important factors have caused this shift which includes, 1) Nicaragua announcing a military alliance with Russia and expanding missile launch capabilities in Venezuela⁸, 2) heavy investment by China in strategic port and energy infrastructure in Caribbean nations⁹, including the Dominican Republic Port and 3) Increased national security threat represented by misinformation from malicious communications.¹⁰

Thus, Puerto Rico's role as a trusted partner in an increasingly unstable Latin American region, and the imperative to reduce reliance on China for pharmaceuticals and other key elements, is critical to national security. Correspondingly, national investment and advice on creating a strong and stable hub for research, development and manufacturing on the Island secure the island from nefarious infiltration by neighboring nations. It also creates a sanctuary for international collaboration on US soil. Finally, it establishes economic and social transformation in a controlled 'sandbox' that can be replicated in other areas of the country and world, much like Singapore had become an example of economic reversal to be emulated.

The chart below illustrates the key factors in why Puerto Rico can serve as this national and global 'sandbox' based on a collection of assets as qualifiers not available anywhere else.



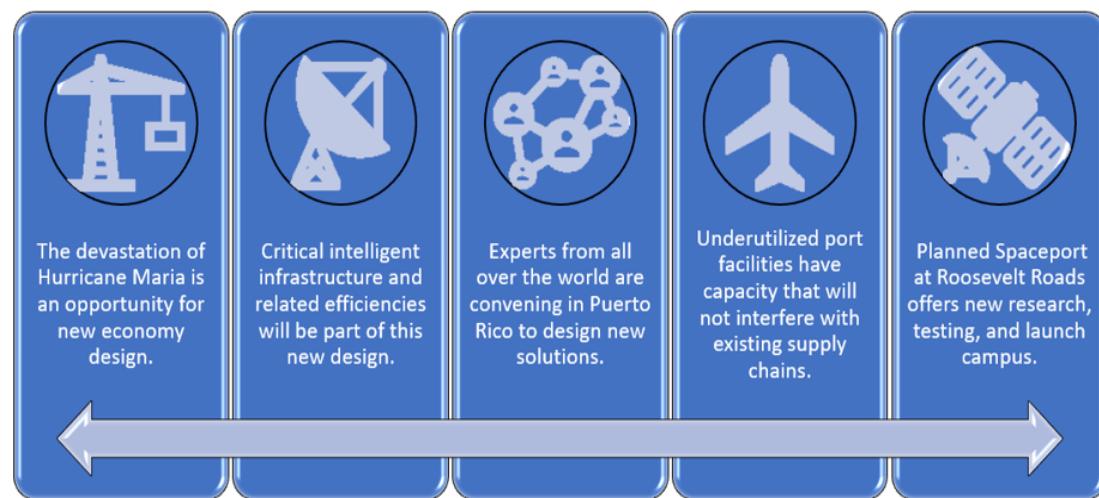
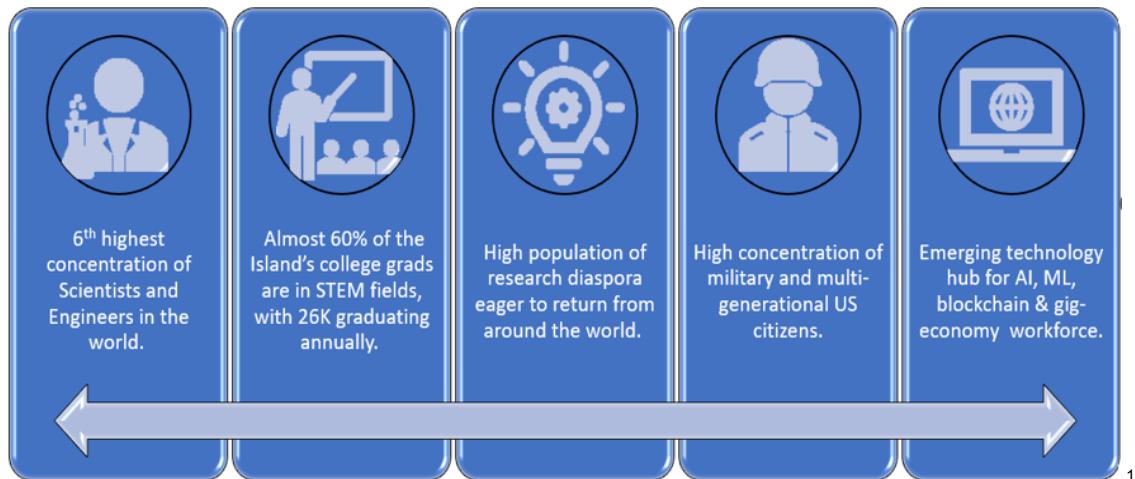
Puerto Rico is the only place on US soil that has the unique network environment listed above. Additionally, it is the only location that has DoD rated ZTA-secured research on an open use, publicly-owned research platform, Hub Advanced Network. Perhaps most importantly, it has a predictable supply of challenging events, for which solutions can be applied and tested and which then can be scaled to social impact needs nationally, and market demands globally.

The two charts on the next page further demonstrate the uniqueness of the environment which has an incredibly rich talent pool of skilled workers, STEM educated graduates, emerging globally recognized blockchain expertise, and many critical intelligent infrastructure challenges and related funding to fix them. This will serve as a magnet to attract and retain the skilled workforce, previously evidenced as fleeing the island. While there is no data evidence that Puerto Rico diaspora has a greater desire to return to their island home, interviews with successful diaspora consistently reinforced their strong sense of independent nationalism to Puerto Rico and desire to return if there were equitably paying roles with interesting problems to solve in their beloved homeland.

⁸ <https://www.cbsnews.com/news/nicaragua-gives-permission-for-russian-troops-to-enter-country/>

⁹ <https://gop-foreignaffairs.house.gov/china-snapshot-project-the-caribbean/>

¹⁰ <https://www.gao.gov/products/gao-22-104714>



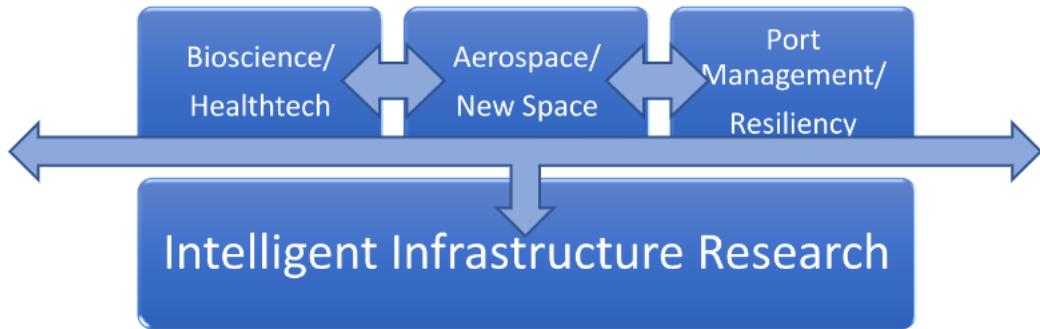
According to Statistica, 48.24% of Puerto Rico's GDP in 2020 was from Advanced Manufacturing, a strength that has been consistent for the last 10 years.¹² Primary sectors within Advanced Manufacturing are Bioscience (composed of pharmaceutical, medical device, agbio, medical research, and its supply chain) and Aerospace (composed of avionics, electronics, and maintenance), which are "AT RISK" from other providers trying to entice companies to relocate operations. The sector focus was determined by the premise that ALL industries on the island of Puerto Rico will be positively impacted and differentiated by the development of intelligent critical infrastructure, with the greatest impact being felt in the area of current industry strengths and future industry opportunities. REACH recognizes the interdependence of sectors and the potential for technology transfer and collaboration opportunities between industries as an economic driver.

The working group's result was **Research Empowered Advanced Communication Hub (REACH)** designed to use the unique quantified assets for secure, advanced communication applied research as listed previously to collaborate with key driver industries on creating customized technology applications. As the country's largest exporter of bioscience products, and a location subject to disruption from climate

¹¹ https://www.investpr.org/wp-content/uploads/2021/11/IPR_TalentinPuertoRico__11.19.2021_FINAL.pdf

¹² <https://www.statista.com/statistics/1078535/manufacturing-industry-share-gdp-puerto-rico/#:~:text=In%202020%2C%20around%2048.24%20percent,generated%20by%20the%20manufacturing%20sector>

fluctuations, the critical pillar of Port Management and Resiliency was added to the industry beneficiaries. The result is illustrated below.



By the raw numbers, over 37 billion in aggregated economic impact is represented within these industries.¹³ While each of these industries is individually significant on the island now, the potential for intersecting research applications has tremendous potential to impact growth in industries of the future. As an example, currently, more than a third of all International Space Station research is sponsored by the pharmaceutical industry and utilizes zero gravity benefits.¹⁴ With Puerto Rico's proximity to the equator and recent efforts by the Governor to establish a spaceport at the vacated Roosevelt Roads Naval Base on the east coast of the island, it's not hard to imagine future opportunities for Puerto Rico to be a new economy logistics/distribution hub based on bioscience and aerospace assets.

Puerto Rico also possesses all the strategic elements necessary to become a US National Security Drug manufacturing & Stockpile Center Depot. With over 50 years of development, manufacturing & distribution capabilities of drug substances and drug products for small and large molecules, the Island is the ideal safe location, within 2 to 4 hours away from the US East coast, to develop, manufacture, store and distribute critical products during a Public Health Emergency. With the development of the Pharmaceutics Research and Manufacturing Institute (PRMI), Puerto Rico will close the gap between drug discovery to drug development using advanced manufacturing technologies. REACH is key in providing the necessary tools for the implementation of the PRMI Industry 4.0 and future 5.0 capabilities. Puerto Rico's strategic location and orbit access presents a compelling national security opportunity for the US through connected network of information and operational assets including space-based knowledge and horizontal launch capability.

Problem Statement- Learning from the Past

Assumptions of critical intelligent infrastructure as a foundational piece of economic and social good were validated by looking at Puerto Rico's past. Multiple catastrophes in Puerto Rico have shown the importance of resilient and interconnected structures – both private and governmental. Without reliable energy and secured communications, the known ways of succeeding are at risk including the ability to attract and retain industry. Aggregating industry, private sector, and governments is more critical than ever.

Like many areas in the United States Puerto Rico grew and prospered back in the 1940s when the military dispersed the US manufacturing production from the coasts inward to places like Arizona and New Mexico and outward such as Puerto Rico and Hawaii. Puerto Rico and Hawaii were and continue to be "forward bases" expanding the US Military Reach in the Atlantic and the Pacific Ocean, respectively.

Access to the Panama Canal (on both sides) and access to Space will be key elements going forward as logistics become ever-more important. Instead of refueling airplanes in flight the next 5 years should

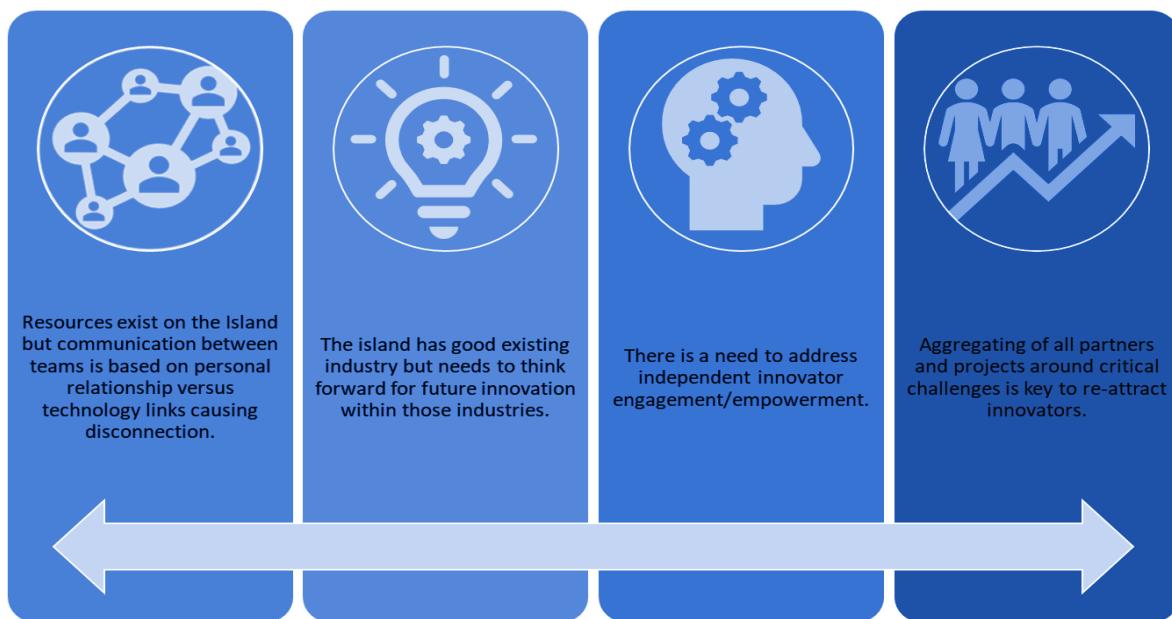
¹³ <https://www.ddec.pr.gov/en/industries>

¹⁴ <https://www.the-scientist.com/bio-business/pharma-looks-to-outer-space-to-boost-drug-rd--68183>

witness a transformation in Point-to-Point Military and Cargo Logistics whereby Spaceports will be needed for logistic/transmodal hubs for spacecraft to move cargo anywhere in the planet within 90 minutes.

Logistics alone won't guarantee success. Countries like the United States and the territory of Puerto Rico will need to foment, develop and transform their critical infrastructures such as Energy, Telecom, and Cybersecurity to protect the United States hard-earned patents, innovations, and defense systems. Competitors and even enemies know the growing reliance on data, GPS systems, and ground communications to the point that road maps, navigational charts, and even telephone listings on paper no longer are used. Everything is virtual now. Even accessing Government Aids requires a computer, internet, and Wi-fi communication.

By doing this analysis a challenge statement was designed that the 'engine' could solve. The issues stated in the graphic are the primary findings from the empirical and anecdotal research. This was used to inform the design for an engine that would break the existing barriers



Puerto Rico was a communication hub before interconnecting underwater telecom cables between the US, the Caribbean, Europe, and even Latin America. It can be an innovation hub and testing center AGAIN for the latest telecom technologies to develop and protect US assets. Once the overall concept is in place, then the Universities will play a big role in innovation, foreseeing the creation of Defense Institutes affiliated that will help attain the mentioned goals.

The Strategy

The **Research Empowered Advanced Communication Hub (REACH)** proposal is designed to stimulate 'New Economy' and 'NextGen' smart manufacturing growth through communication-dependent applied research and development specifically in 5G, 6G, IoT, Blockchain, and Web3 technologies. Technology advancements in Artificial Intelligence (AI), Machine Learning (ML), and Quality Assurance (QA) require highly secure and sophisticated regional communication infrastructure, both in physical assets and human capital expertise, to remain competitive in advanced product and service development. Puerto Rico has a unique national profile with resident foreign/domestic, terrestrial/non-terrestrial, and cooperative/non-cooperative networks converging on a publicly owned fiber-optic network that operates

the Island's Internet2 research network all with open High-Performance Computing access. It will use this nationally differentiated platform as the foundation for an innovation ecosystem starting with several high-potential focused industry applications. REACH is a strategy for the future - to retain and attract industry, academia and governments from around the world.

The proposal positions Puerto Rico 5G Zone + Blockchain Ignition Lab (PR5GZ), and its 100+ member Advisory Board of global experts, as the engine applicant. The PR5GZ is an independent Puerto Rico-founded research network that currently operates two zero-trust architecture (ZTA) secured research labs on the Island. These labs provide low-cost access to the digital tools needed for innovators to develop, test, and validate rapid data management-related solutions for all industries. With regional partners including The University of Puerto Rico, The Puerto Rico Science Trust, INDUNIV Biopharma Cluster, as well as over 66 institutional or business-based entities, a design for an ecosystem will be created that seamlessly interfaces ideation, culture, acceleration, training, and market needs. Additionally, secured advisory guidance from entities like the Autonomy Institute, a federal non-profit based in Austin, will assist in applying best practice design related to smart technology adoption strategies for industry and cities creating digital inclusiveness throughout the Island.

The devastation after Hurricane Maria brought to light critical infrastructure challenges in Puerto Rico, including a catastrophic communication network breakdown. In subsequent analysis, it was revealed that while over half of the Island's economy is manufacturing based, and there is a growing sector for high-technology service companies, Puerto Rico has not kept pace with the global competition in providing local technology infrastructure research and deployment. This impedes the Island from being an innovation hub and has instead led to reliance on low-cost production (specifically through lower wage rates) to remain competitive. As a result, high innovation skill individuals trained on the Island have migrated towards higher wage global regions, and factories producing discontinued generations of products have closed.

A Regional Innovation Engine in Puerto Rico focused on research and development of advanced communication-based applied research specific to 5G, IoT, & Blockchain technologies would reverse this brain drain by providing new opportunities in producing goods and services higher on the value chain. Puerto Rico's unique capabilities as a location with multiple unique network convergences make it singularly qualified as a national research engine for this work. The high concentration of multinational corporations, and the influx of new infrastructure investment post-Hurricane Maria, make Puerto Rico an ideal testing environment.

Additionally, the concentration of industry and percentage of the disadvantaged population, which is 98% OZ qualified and 82% HubZone qualified means the targeted beneficiaries of the project will align with Federal objects. Finally, the Island of Puerto Rico experiences a significant disparity in federal research funding to stimulate innovation, which has disadvantaged this important national industrial center, specifically related to the foundational technologies required for NextGen/New Economy development.

The regional definition would include Puerto Rico, and USVI, with technical support linkages to Texas and Florida. Additional positive elements for the proposal would focus on:

National Security Interests: PR is the United States trusted national security nexus to the Caribbean Basin, and Central and South American Countries through aligned language, legal structure, international banking, and cultural synergy. Puerto Rico has an advantaged location to defend against technology and information warfare within the Americas. Establishing a hub with ZTA-secured research facilities and an industry-facing Secure Confidential Information Facility (SCIF) would provide a strategic environment for public-private partnership.

Available Global Talent Pool: PR has a significantly high concentration of Scientists and Engineers, cited by WEF as the 6th highest concentration in the world. Almost 60% of the Island's college grads are in STEM fields, with 26K graduating annually. Additionally, the island has a significant documented

population of the skilled diaspora who are mid-career researchers eager for an opportunity to return from around the world.

Undergoing Infrastructure Redesign: The entire infrastructure of the Island has been tested by Hurricane Maria and deemed inadequate for current and future industry demands. As the redesign occurs there is a strong recognition that this is the opportunity to build new economy designs, making Puerto Rico a high-profile live test-bed for these new designs and the related efficiency in critical industries. New development opportunities in underutilized port facilities in Aguadilla, Ponce, and the expansive 8000-acre vacated Navy base at Roosevelt Roads offer opportunities to develop ground-up smart designed research and testing campuses.

Cost Efficiency of Puerto Rico: The island of Puerto Rico has all the diverse complexity of other locations, but establishing pilot projects on the Island represents a lower test cost based on size and population for technology applications that are scalable to other regions. This diversity, both of people and terrain, plus 'ideal size' provides greater flexibility on the Island than in other regions of the country.

The engine would include focused research on the following three industry applications.

Aerospace & New Space Industry- Because of the highly favorable geographic and national security value, Puerto Rico has the ability to successfully develop a Spaceport with related product foci in satellite development, drone and autonomous technology development, geospatial data management, sub-orbital and near-space transportation and research, laser optimized communication, and off-shore horizontal or vertical launch capability. All these applications are dependent on a highly secure data management and communication platform which will need to grow as rapidly as the technologies do. The combined market size is in the double-digit billions with some estimates of global growth exceeding 16% annually. Space enabled data is an application which has unlimited potential. "Big Data" from space-based assets enables communication and information from logistics and disaster relief/management to informed decision making and assessment for agriculture and commercial activity to national security and climate management.

Port Management/Resiliency – The Island's history of resiliency in a variety of disaster scenarios provides institutional experience and testing from a logistics perspective. Management of complex data sets will be necessary to effectively and efficiently manage the distribution of the high-value goods Puerto Rico can produce. Smart port development will include optimized IoT for tracking life-critical goods, secure management of temperature fragile products, and urban air mobility solutions for first-mile/last-mile transport.

Biosciences / Digital Health (Telemedicine)- The Island has a strong representation in secure pharmaceutical and medical device manufacturing, with specific expertise in continuous manufacturing and miniaturization. All these products, drug development, and product quality assurance are increasingly dependent on big data analysis to bring products to market faster with the digital formulation. Simultaneously the Island and the US Hispanic population suffers from disparity in medical services delivery to the rural populations. Digital Health represents an opportunity to accelerate discovery while also creating secure product/service delivery models for disadvantaged populations. Data collection in these technology modeling tools have special security needs aligned with HIPAA regulations, and technology transfer from experts with the existing corporations has a high potential to spin out into telemedicine applications. This industry is currently cited as exceeding \$60B and has projected growth rates exceeding 13%.

The development of the Engine planning structure, will be accomplished using the methods designed by the 'Agile Strategy Lab', with Dr. Ubaldo Cordova as the certified facilitator. The objective would be to create an interactive design for innovation support service referrals to entities currently operating on the Island. Designing cross-pollination between sectors will be very important to accelerating the rate of discovery and commercialization. The development of industry partnerships based on Echar Pa'lante's

ecosystem mapping will help us in common challenge identification and product testing and validation through a structured series of roundtables with private industry partners.

UPR Facilitation Methodology-Agile Strategy Lab

Complex challenges surpass current ability to respond in a timely fashion. To meet these challenges a system that enables many to collaborate and use resources, skills, and assets from a wide array of networks and organizations is needed. Collaboration enables us to develop solutions. This strengthens the ecosystem. Relying on a model of ecosystem development developed and tested by the Agile Strategy Lab at Purdue University. The model focuses on developing collaborations across four strategic focus areas: brainpower (technology and talent); open networks; quality, connected places; and opportunity narratives. Taken together, collaborations across these four areas form a new type of “civic infrastructure” in communities. This infrastructure, designed for a knowledge economy, fosters, educates, and enables all people, regardless of location, education, socio-economic status, or technical sophistication, to thrive. The following paragraphs explore the challenges and potential solutions for developing entrepreneurial ecosystems in Puerto Rico.

The main challenges or problems for developing entrepreneurial ecosystems in Puerto Rico are: (1) weak collaboration: assets are not shared within most communities and new ideas often provoke an immune response. (2) ambiguity: inability to explain how the ecosystem works in a clear, practical, and visual way. (3) learning difficulties: it is often difficult to understand how the ecosystem is built and to decide what works for the different practitioners. (4) weak metrics: practitioners often lack access to data that is dynamically evolving, (5) hidden networks: not being able to visualize the networks and the assets within them. While there are difficulties overcoming these barriers, success is being found with some approaches.

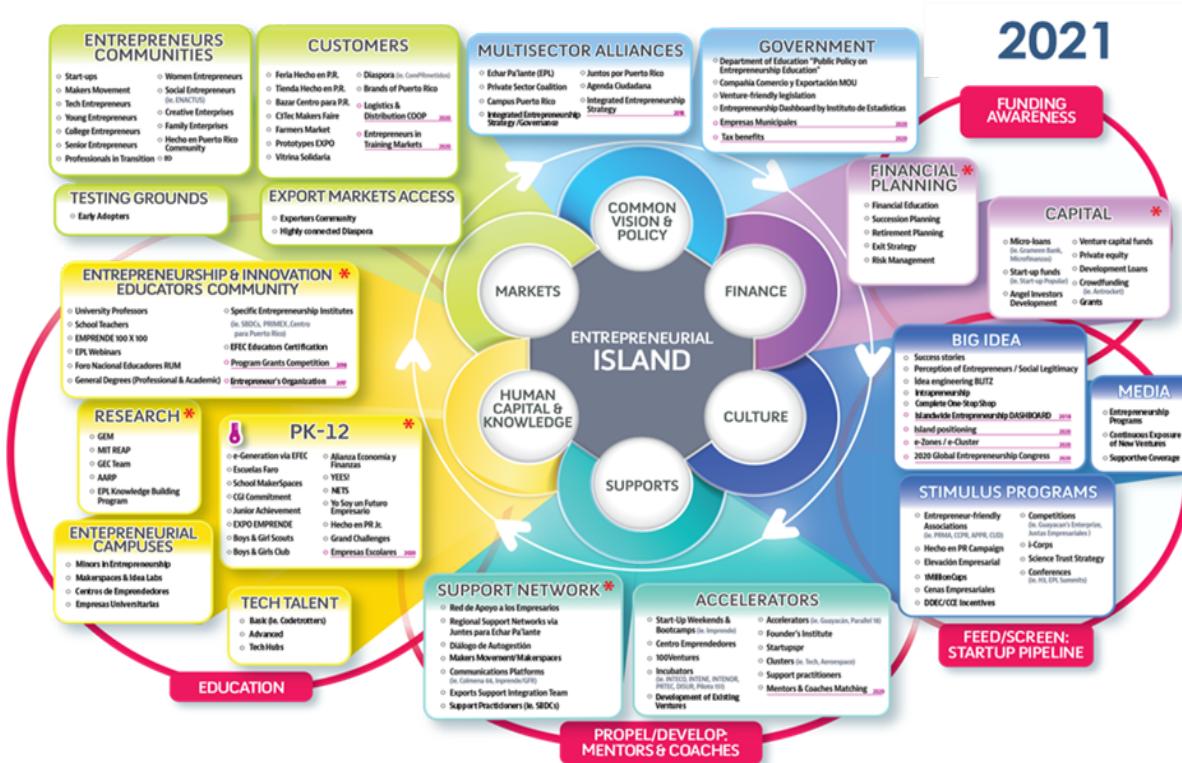
A focus on learning faster about what works to develop effective entrepreneurial ecosystems is critical. More is learned from early pilot projects failures through adjustment. REpeated trials establish skills and develop stronger ecosystems. The following steps have already been taken. (1) A program was started to teach Strategic Doing, the skills to form complex collaborations quickly and connect them to an ecosystem. (2) Strategic Doing workshops were developed, guided by trained practitioners. Through these workshops multiple collaborations were launched; collaborations kept on track, as they developed. (3) This has created a stable information architecture for gathering data on an ecosystem as it develops. Now it is possible to now compare data to provide a basis for learning, evaluation, and research.

It is time to expand this work in ecosystem development to university and community college campuses throughout Puerto Rico. By leveraging what has been earned, new avenues can be explored to strengthen these relationships and identify opportunities for collaboration between the university and companies. This work includes teaching the skills of collaboration, forming initial collaborations, drawing network maps, and developing metrics for a healthy ecosystem. This process of ecosystem building will start with initial surveys and web-based forms. Next will be conducting a secondary data search, developing the baseline network model, and designing an initial strategy workshop. By following this protocol, opportunities can quickly identify where to connect assets across ecosystems in different geographical regions.

Ecosystem builders face multiple challenges. They have difficulty keeping track of assets and the opportunities that arise when they leverage and align these assets. Guiding collaborations through simple project management also poses challenges. They can lose track of key narratives. They miss opportunities to learn from their experience. Zebra, an open-source learning platform, provides us an opportunity to accelerate ecosystem development in Puerto Rico. This learning platform will expand ecosystem development to underserved communities, support a community of ecosystem builders in Puerto Rico, and provide primary data for evaluation and research. Zebra is a new and essential type of civic infrastructure that will enable us to track the performance and operation of entrepreneurial ecosystems, as they develop. Also, Zebra will make evaluation easier, clearer, and more concise. It provides us the opportunity to capture longitudinal data consistently as the ecosystem forms. Most

importantly, Zebra will support connections, reduce gaps, and support collaborations that will form the foundation for a more prosperous, inclusive, and sustainable economy in Puerto Rico.

The foundation to be used is an ecosystem model developed over the past ten years by Echar Pa'lante. Its mission is to integrate multi-sector efforts and accelerate the development of a global culture of entrepreneurship, innovation, resilience, and sustainability that will help restore growth, well-being, and prosperity on the Island. The model developed is based on engagement with key innovation districts nationally and globally including Singapore, Silicon Valley, and Kansas City.



Their vision includes Puerto Rico as a digitally integrated multi-sectoral learning and collaborative community that guides the development of the local business ecosystem. One that focuses on certifying K-16 educators and professionals who support local entrepreneurs, entrepreneurship, and innovation. Where schools, universities, and municipalities are transformed into entrepreneurial and resilient communities that promote sustained socioeconomic development.

In a recent presentation to the Federal Deputy Secretary of Commerce, Echar Pa'lante had several 'asks' related to the deployment activities necessary to implement the strategy. This REACH proposal has embedded those requests into The planning activities for Phase I of the Innovation Engine intending to prioritize them in the resultant Phase II proposal. Because of the maturity of the ecosystem design created by Echar Pa'lante, their inclusion as part of Phase I planning is important in determining an optimal organization to manage Phase II activities, with the expectation that Echar Pa'lante could potentially serve that role.

Specific company case studies will be included for each area of focus to demonstrate the applications or products that partners bring to accelerate the network. This demonstrates why this engine would have value from a social and economic ROI, and also shows that already companies are positioned for 'success' as a result of efforts that can be measured.

Planning will then develop engagement strategies for these case studies so that Phase II can begin with an active pipeline and process. REACH has already cataloged over 100 different locally engaged technologies, and the TDP tools would add exponential options for technology use case evaluation. A use case examples would evaluate solution intersections such as these:



Lead Org Role and Responsibility

Gail Nolan=PR5G Zone + Blockchain Ignition Lab- Will serve as fiscal agent managing funds, deliverables, invoice compliance, and audits. Will be responsible for the management of all funding distribution to sub-recipients and adherence to the Gantt Chart. Will manage content delivery on training exercises and training related to tool adoption. Will assess progress and adjust activities accordingly. Will manage technology solution catalogs, data tools, and case study development.

Co-PIs for Organizational and Advanced Communication Applications Research/Development

PI Ubaldo Cordova=University of Puerto Rico-Mayaguez-Academia- paid to provide cooperative facilitation of partners in the development of the deliverables. LOC will specify the amount of T&E and hosting of the meeting facility for 4 meetings. There will be one meeting per month. They will also provide access to the lab at UPR-M for training seminars on advanced lab data tools. There will be a total of 6 training sessions at UPR-M. They will also provide detailed budgets on Phase II involvement including but not limited to facility expansion, additionally sponsored faculty, and new curriculum development.

PI Apurva Mody=Airanaculus- Will provide technical expertise on lab hardware design, optimized use packages, and satellite network security protocols. Will make 2 trips to the Island and participate in the remaining meetings remotely. Will develop a training event on redundant network development and an internship program for advanced communication.

Partner Roles

PI Junaid Islam=XQ Message- Will provide technical expertise on lab design, optimized use packages, and security interface protocols. Will make 2 trips to the Island, and participate in the remaining meetings remotely. Will develop a training webinar on smart city design based on the Purdue model, and zero trust architecture.

Nelson Perea= PRTEC-Aerospace and Resiliency- Will attend meetings and align PRTEC and related workforce program development to detailed budget and SOW for Phase II.

Elizabeth Thelen= AeroX Accelerator- Will attend meetings and create training webinars for the AeroX training program with a detailed budget and SOW for Phase II.

Ivan Lugo= INDUNIV (Industry University Research Center Inc a 501c3 organization)-BioScience Industry Engagement- Will attend meetings and align INDUNIV Biopharma cluster and related bioscience grant development to detailed budget and SOW for Phase II.

Maria Levis= Impactivo-Healthtech Deployment- Will attend meetings and engage networks to identify technology adoption challenges and create a detailed budget for network deployment in Phase II.

Nicolas Billeaud= DexGrid- Resiliency Technology- Will attend meetings and provide detailed analysis of shared needs in critical infrastructure for Puerto Rico and the Virgin Islands.

Ramesh Radamoss=IEEE Blockchain Technology- Will attend meetings and provide training on Blockchain applications and provide perspective on global competitiveness in delivering blockchain support to industry.

Linden Dalecki- Exemplar- QA Technology- Will attend meetings and provide research with industry on needs in high compliance environments and create training on Test Secretary Additionally, will guide awareness campaigns.

Tetteh Akita=Exemplar- Will attend meetings and guide on integrating diagnostic technology into critical intelligent infrastructure networks.

Arnaldo Soto- VAS Corporation- Will attend meetings and provide input on new space industry needs and create a catalog of space industry challenges needing specific communications technology solutions

Jim Beddows- TDP Decision Platform- Will support NSF BAA's requirement in A.5.2. Data Management Plan, TDP will provide access to its platform and data. TDP's platform provides for i) custom data sets (up to 3 per quarter (non-accrual) based on keywords provided to TDP by the user, ii) data analysis (scorecards and trend downloads; list and trend downloads), iii) project management (for internal/external collaboration within a project; in-project messaging; business development/market outreach tracking), iv) knowledge management (asset tracking and sharing within a project), v) metrics tracking, vi) predictive analytics, and vii) TDP tier 1 & 2 support.

Phase I Planning Goals/Deliverables

1. **Establish a clear structure for management and decision-making regarding a Phase II Engine proposal.** This structure will have documented buy-in from the partners identified as critical to the success of the engine as defined in the objectives established by NSF for engines. This deliverable includes the following elements:
 - a. An updated road map of the ecosystem partners, roles, and capacity that are benchmarked against national and global best practices with established milestones for each entity to reach best practice status.
 - b. A sustainability model with multiple public/private revenue sources for continuity of operations post NSF funding timeline.
 - c. Adoption of a data management platform that connects partners, tracks progress and establishes interactive accountability.
 - d. Defined governance and decision-making protocols for the cooperative management of the hub, agreement amongst partners, and flexibility in shifting efforts to maximize collective social good.
2. **Coordinate REACH and Echar Pa'lante efforts so that Echar Pa'lante leads the education and workforce training based upon the structure already developed.** Since 2012, the Echar Pa'lante Multisectoral Alliance has gathered hundreds of organizations and thousands of volunteer Allies, as well as national and international experts, to collaborate in the design and implementation of systems to foster entrepreneurship in schools, universities, and communities. They believe that addressing education needs is foundational to economic stability and growth on the Island. Echar Pa'lante has a vision that the REACH partnership believes needs to be embedded in the final engine design. The key elements that will be defined for inclusion in the future engine are:
 - a. Training educators in innovation and entrepreneurial development strategies. These strategies would include education and training, as provided by REACH, on the latest communication technologies and applications being used by the industry.

- b. Establishing a design thinking maker space in every high school on the island so that students can have hands-on experience in creating solutions and new products. REACH would propose adding access to technology and data management tools like the ZTA secured labs and access to high-performance computing.
 - c. Echar Pa'lante recognizes the gap in data collection, management, and related data-led decision making, and REACH believes this critical issue needs to be solved with new customized data tools and applications, available within the membership, like blockchain, secure software, and software integration research.
3. **Coordinate activities with Lightweight Innovations for Tomorrow (LIFT).** LIFT is a Department of Defense-sponsored national manufacturing innovation institute, a member institute of Manufacturing USA (Department of Commerce) acting at the intersection of materials science, manufacturing process, and digital and virtual systems with the intent of driving advanced manufacturing technology and talent development into the future for US national economic growth and national security. LIFT is in the process of launching a regional technology and talent development facility in San Juan and has a great interest in working with PR5G and their ecosystem in the areas of:
- a. 5G+ and 6G for the manufacturing shop floor
 - b. High-Performance Computing (both distributed and edge computing) for real and near real-time manufacturing applications including the prediction of as-made material properties on the fly during advanced additive manufacturing processes and ICME (Integrated Computational Materials Engineering)
 - c. Engaging in Puerto Rico (including PR5G) the 15 sister national manufacturing innovation institutes with LIFT acting as the integrator within Puerto Rico of that institute network and their wider ecosystem – through this bringing many thousand companies interest into Puerto Rico as well as their collective scientific capabilities.
4. **Coordinate with Cambridge Innovation Lab and Captains of Innovation** to identify best practice strategies.
5. **Define pathways for Student and Diaspora engagement in the Engine.** The Universities on the Island of Puerto Rico have a strong pipeline of STEM talent that is not being well leveraged for job opportunities on the Island. Additionally, a significant migration of expert talent has been occurring in the past 10 years, exacerbated by Hurricane Maria in 2017.
- a. REACH proposes to design an activity to inventory existing organizations and clubs working to create active pathways for communication of job opportunities to Puerto Rican diaspora and university students.
 - b. Develop a plan for an outreach campaign to the diaspora using PSAs, social media, and earned media.
6. **Develop sample engagement plans for each of the case studies outlined in this proposal representing each of the sectors focused on.** These engagement plans will be designed to be immediately deployed upon approval of a Phase II award. At the same time catalogs of companies within each discipline will be started to create a ‘menu’ of choices from which to design new disruptive solutions.
7. **Establishing national and global partnerships for research on security convergence of foreign/domestic, terrestrial/non-terrestrial, & competitive/non-competitive networks for rural and commercial users in the following industry applications.**
8. **Planning facility expansion and collaborative lab network to meet the individual case use needs for research environments.** This would include designing physical Infrastructure, mapping technical service capabilities, identifying key staff network contacts, and establishing industry-specific acceleration and training activities. This would include structures to map and manage advanced technology-related capital sources, aligned skill workforce programming, and best practices on innovation deployment. Coordination partners on the island would include existing university research labs, Hub Advanced Networks, Everynet, Engine-4, Liberty, Rubidex, and the Department of Defense to design a lab network that serves every security and technology readiness level.