Article

UC San Diego, The Military and Building a Unique, Diversified Economic Growth Ecosystem

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ABSTRACT

San Diego's economy, fueled by its innovation ecosystem, has experienced meteoric growth over the past several decades, with the region now ranked amongst the top life sciences clusters in the world. This growth has been inextricably linked to the military presence over the decades and the region has benefited from the symbiotic presence of both the military and private and public sector innovation partners, creating an ecosystem that may be unique in the nation. This unique combination of market forces is turbo-charging the creation of "multi-use" technologies and startups, through regional collaborations and associated programs that align the research discoveries and capabilities of universities, with the strategic needs of the government, while feeding the growth of commercial industry partners and the economy as a whole. One key to the continued competitiveness and success of San Diego will be to strengthen this virtuous cycle, to drive productivity and propagate the impact of the engagement across multiple innovation sectors or clusters.

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A HISTORY OF (LINEAGE OF INTERCONNECTED COLLABORATION)

The origin of the San Diego (technology) and (innovation) cluster can be traced to the establishment of the Marine Biological Association of San Diego by Ellen Browning Scripps in 1903 – this was the precursor to the Scripps Institution of Oceanography, which in 2012 became part of the University of California. Almost 20 years later, in 1922, the United States Naval Base San Diego was established and has become what is now, the largest naval presence in the world. Following WWII, there was enormous growth in the overall defense sector, with the establishment of several leading contractors such as San Diego's own General Dynamics in 1954. In parallel, as the city and surrounding communities grew in population and influence as both a desirable (vacation-retreat) destination and industrial center, a new university was being envisioned by a group of regional influencers, under the leadership of Roger Revelle, Director of The Scripps Institution of Oceanography and a nationally prominent scientist and educator. Armed with a generous gift of 63 acres of land from the City of San Diego coupled with a donation from General Dynamics, UC San Diego was founded on November 18th, 1960 on what was formerly the Navy's Camp Matthews. Herbert York was named the founding Chancellor in 1961 and the first undergraduate students were admitted in 1964. In 1965, the first of UC San Diego's colleges was named Revelle College in honor of Roger Revelle, considered the "father" of the university.

Built on this foundation of collaboration between the public and private sectors, the following decades saw steady growth of technology innovation with the founding of companies such as Linkabit (which gave rise to Qualcomm), by UC San Diego Professor, Irwin Jacobs in 1968, a prime example of next generation leading communications technology consulting contractors, and Hybritech, a pivotal life science company, a groundbreaking biotech company that developed the first blood test for porstate cancer, by UC San Diego Professor Ivor

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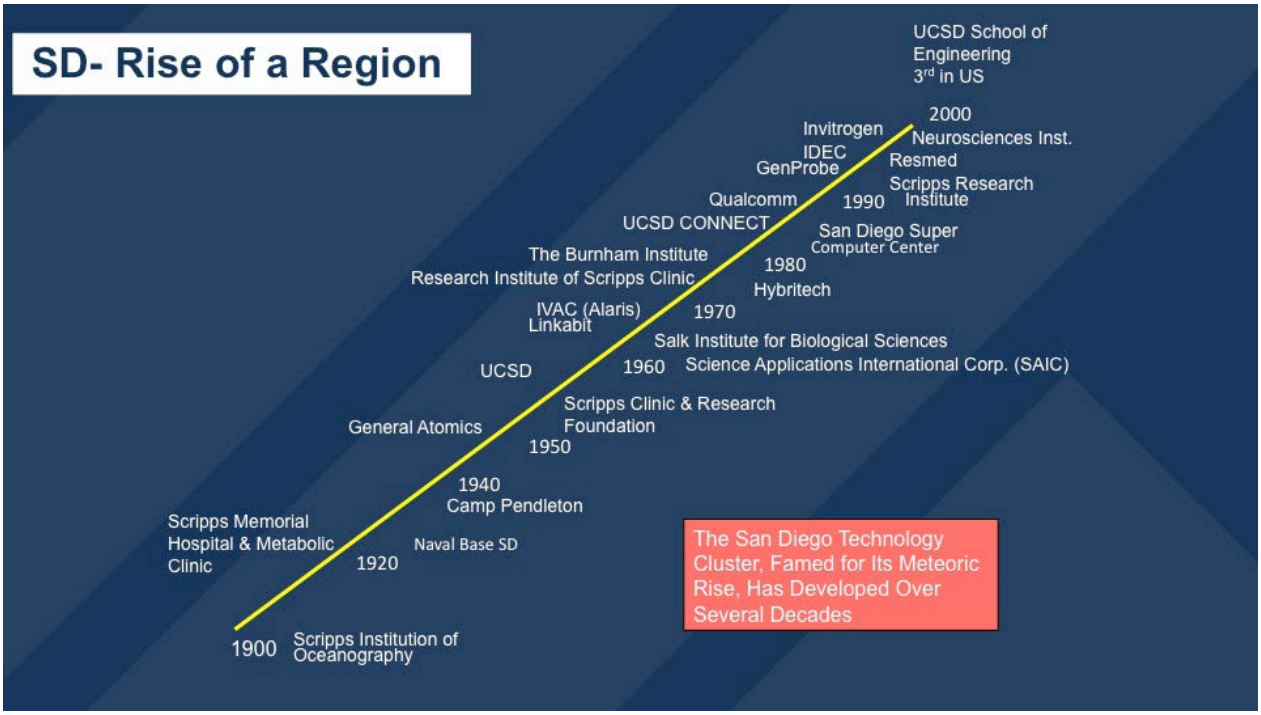


Royston, in 1978. The entrepreneurial ecosystem that currently exists in San Diego can be directly attributed to these innovative and visionary companies and their prolific subsequent spin-outs and acquisitions. Hundreds of startups can trace their origins back to these founders, senior management, and technology leaders who were instrumental in these and other early successes. It is this extremely interconnected lineage that has greatly contributed to the success and uniquely (impactful) degree of entrepreneurship and collaboration that is a core strength of the San Diego Innovation Ecosystem.

WHERE ARE WE NOW? (TODAY'S SAN DIEGO/TWENTY FIRST CENTURY INNOVATION)

Significant Military Infrastructure and Workforce

Today, the greater San Diego region is home to the nation's largest concentration of military personnel with more than 100,000 active duty personnel split roughly evenly between the Navy and the Marine Corps. Equally as important, there are approximately 250,000 military veterans in the region, making up 13% of the population of the county. These veterans are comparatively young and well educated, compared to the national average (35% hold a Bachelor's degree or higher), with training and expertise acquired during their service careers, that are particularly well suited to leadership and entrepreneurship. The combined military presence contributes over $50 billion, or roughly 25% to the regional economy annually.

Growing Innovation Economy

San Diego is known for cutting-edge life science, telecommunications, software, and defense industries and for its significant innovation ecosystem. A 2018 study of San Diego's innovation economy, supported by 80-plus educational and research institutes, reported that 362 new startups were founded in the county that year, resulting in over 1,600 jobs and over $19 billion in payroll, with an average salary of $116,000. 2019 saw the region attract almost $3.5Bn in Venture capital across over 200 deals in biotech, energy, software, defense and other sectors.

Much of this growth has been supported by one of San Diego's most valuable assets – its highly collaborative innovation ecosystem fueled by an interconnected network of support organizations. One of the first among those was Connect San Diego, one of the nation's first statup accelerators, founded in 1985 by the University of California San Diego to bring together people interested in new ventures and furthering individual companies in order to support the overall innovation economy. This revolutionary organization recently merged with San Diego Venture Group, originally founded in 1986 and, together the two have been providing access to mentors, investors and education for the past 35 years.

Biocom, founded in 1995, works on behalf of over 1,300 members to drive public policy, build an enviable network of industry leaders, create access to capital, introduce cutting-edge workforce development and STEM education programs, and create robust value-driven purchasing programs. Other dynamic organizations dedicated to the regional innovation economy include Cleantech San Diego, Startup San Diego and incubators such as Evonexus, Biolabs and Jlabs, to name but a few. These and other organizations contribute to what may be San Diego's greatest strength – its collaborative spirit and willingness to give back to the community by helping those in the ecosystem who need it. Rarely will an entrepreneur find a closed door in San Diego.

The significant assets of the San Diego Region to support innovation have not gone unnoticed: San Diego has been ranked first for concentration of military and defense assets in the world (Brookings Institution) and second among the world's most inventive cities (Forbes 2013). In 2014, Forbes ranked San Diego as the "Best Place to Launch a Startup".

University of California San Diego – Research Engine and Powerhouse

Recognized as a top 15 research university globally, UC San Diego has launched, created, or developed technologies for well over 1,000 companies contributing to an estimated $16.5 billion annual economic impact for California. With an annual spend of $1.5 billion, it is one of the largest research enterprises in the nation, with internationally recognized engineering, science and oceanography programs, medical school and healthcare systems. Initiatives in entrepreneurial education, technology commercialization, and startup acceleration, developed by campus organizations such as the Institute for the Global Entrepreneur, (IGE) (a partnership between the Jacobs School of Engineering and the Rady School of Management), the California Institute for Innovation and Development, and the University-wide Office of Innovation & Commercialization (OIC) support and leverage the university's resources and talent in driving economic and social prosperity in the region. UC San Diego is deeply engaged with regional resources and is working with them to connect the pipeline from university research to innovation to startup creation and accelerate the development and scaling of innovative solutions. Over the past 5 years, through coordinated partnerships across the campus and across the community, the university has doubled the number of startup companies launched into the marketplace.

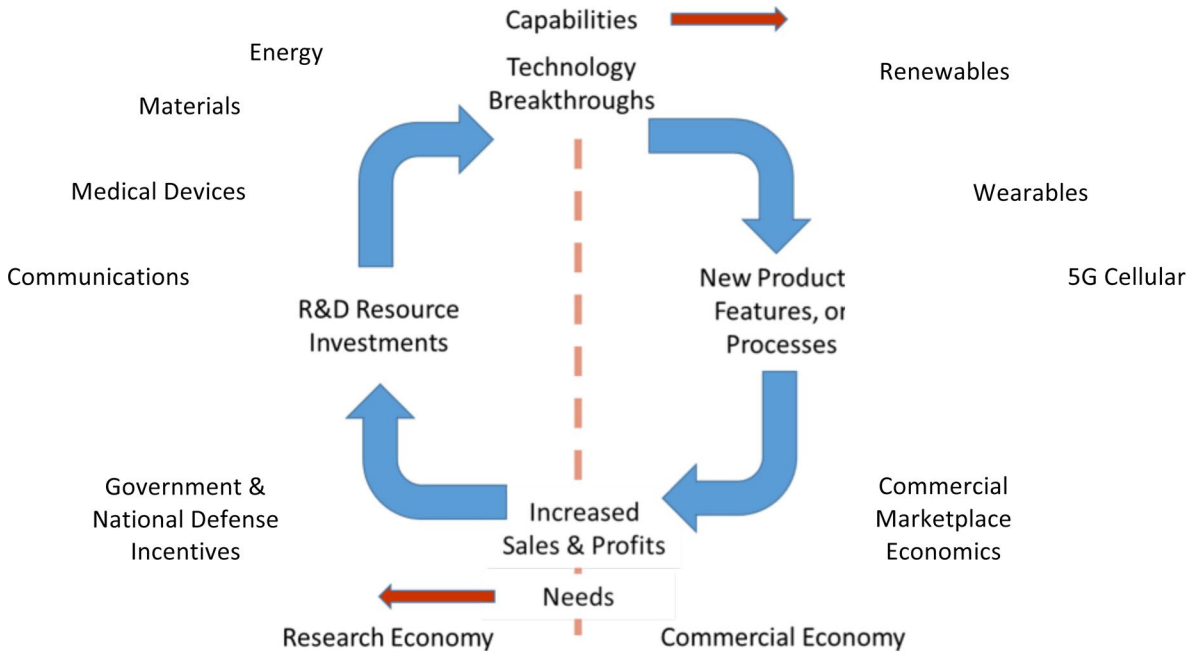
The challenge, which San Diego is uniquely suited for, is to harness these market forces to sustain a vibrant, growing ecosystem.

SAN DIEGO'S PROVEN TRACK RECORD (HOW IT APPLIES TO THE CYCLE & INCENTIVES FOR GROWTH)

An innovation ecosystem can thrive and grow when the resources invested in the research economy (either through private, government, or direct business investment) are replenished by innovation induced profit increases in the commercial economy, See Figure 1. This feedback loop creates a virtuous cycle that matches the capabilities of the research community with the needs of the market. The challenge to creating growth in such a system is figuring out how to turn breakthrough R&D efforts into startups and products that lead to profits.

Traditionally, government agencies have invested heavily in basic fundamental research to act as a catalyst or driver of innovations for the public good. A great example of this are the National Science Foundation's Engineering Research Center (ERC) proof of concept testbeds. The (ERC) program has funded potentially transformative engineering systems and supports the development of associated innovation ecosystems. Originated more than 25 years ago, the program is still going strong and has been successful at developing sustainable ecosystems for a wide variety of impactful technologies in many areas, including energy, communications, and healthcare. It's safe to say that in today's fast-changing technology landscape, one could easily consider the strategic needs of the federal government as a market force. Aligning the incentives of researchers, targeted governmental agencies, and the commercial industry economy, can power the virtuous feedback loop and drive growth. It's a logical progression to extend this cycle to strategic DOD priorities, especially those that overlap with commercial markets – energy/power resilience, healthcare, communications, internet security (both financial and critical infrastructures).

To this end, San Diego is uniquely positioned to sustain this virtuous cycle, and to create and prove the efficacy and impact of such a model. It's possible to grow and sustain such initiatives because three critical market forces are active in San Diego. Home to the largest concentration of military assets in the world, San Diego's regional economy has a robust ecosystem of national security practitioners, academic research organizations, and entrepreneurs in all the major areas of emerging technology. The region is a hotbed of startup companies and a biotechnology and healthcare hub for the nation,



What is an Innovation Ecosystem – Deborah J. Jackson

Figure 1. Innovation Ecosystem Virtuous Cycle.

and the source of many healthcare innovations. San Diego is also one of the nation's strongest regions for higher education and research, with one of the largest R&D workforces. All three ingredients are readily available to actively promote collaborative programs to align research capabilities with targeted government needs and strategic industry partners.

COUPLING ENTREPRENEURIAL EDUCATION, ACCELERATION, AND TECHNOLOGY TRANSFER TO STRATEGIC OBJECTIVES

An effective strategy for developing a pipeline of innovation is to find ways of lowering the perceived risk for entrepreneurs, partners and investors. Through proven entrepreneurial education and focused acceleration programs, researchers can benefit from foundational workforce development and leadership training and collaborate with multi-disciplinary campus resources and industry partners, leveraging their first-hand knowledge of market sectors and the unmet needs that deep tech university-based technologies might potentially address. Such targeted accelerator programs are currently underway on the UC San Diego campus at the IGE. The IGE MedTech Accelerator focuses on technology commercialization and the launching of startups developing medical devices, diagnostics, and therapeutics. The accelerator program is tightly coupled to the newly formed, NIH funded, Device Acceleration Center in the Altman Clinical Translational Research Institute and draws on resources from the School of Medicine, the Galvanizing Engineering and Medicine (GEM) Program and the Accelerating Innovation to Market program, housed within the Office of Innovation and Commercialization. Other targeted sectors under consideration include smart transportation, and 5G/6G Communications.

These programs also address the problems that many startups launched from research labs often encounter – a lack of resources after initial government catalyst sources are exhausted. This gap in resources for technology demonstration and development is commonly known as the Valley of Death. It is within this valley that many potential innovations die for lack of the resources to develop them to a stage where industry or the investor community can recognize their commercial potential. A combination of acceleration and collaboration with follow-on resources, such as connections to manufacturing partners, facilitated by governmental organizations may lower the entry costs for start-ups and raise their probability of success rates. In this context, university research can drive the initial development of innovations, buoyed by government assistance, that have the potential for delivering solutions to strategic problems while simultaneously generating economic growth.

CONNECTING THE DOTS

Entrepreneurial education, focused acceleration, and collaborations form the basis for driving research from the lab to the market. In addition to focusing on the advancement of Medical Technologies, San Diego and smaller sub-regional cities have demonstrated a commitment to host living laboratories and test-beds for innovative, broad based smart city technologies, including advanced communications, and energy distribution systems, combining their assets and capabilities with the major regional Navy and Marine Corps installations to create a connected community with a significant real-world testing and deployment capacity. Additionally, there are several on-going public-private collaborations focused on strategic governmental initiatives that are part of this overall virtuous cycle.

Energy: CEC EPIC Program

Created by the California Public Utilities Commission (CPUC) in December 2011 – to support investments in clean energy technologies that provide benefits to the electricity ratepayers of Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE). MCAS Miramar, in partnership with the University of California San Diego (UCSD), was granted $5M from the CEC which funded a 3 MW / 1.5 MWh battery sited next to the microgrid power plant. The battery was installed and incorporated into the microgrid in 2020. The base also modified its existing Area Wide Energy Management System (AWEMS) to enable base wide HVAC load shedding capability.

Data Sciences: National Information Warfare Center (NIWC) Pacific – UC San Diego Fellows Program

This program embeds employees of NIWC in UC San Diego's Halicioglu Data Science Institute to work side-by-side with faculty and students. The goal is to build up more core competencies in the most cutting-edge techniques in data science to bring back to NIWC Pacific, and also work closely on recruitment and interaction with data science students, setting up events like hackathons, and running scenarios using game theory. Building the innovation workforce of the future may be the most impactful and sustainable way to build resilience into our economic and national security supply chains.

Communications: 5G & 5G Enabled Emerging Technologies

In the 2020 Appropriations Bill (more info), Congress funded $5M to pilot and evaluate 5G enabled technology on the "5G Installation Next Network", established by Verizon, utilizing the assets of Marine Corps Air Station Miramar. This collaboration was enabled through a Collaborative Research and Development Agreement between the Department of the Navy and Verizon. The Congressional investment expedited the evaluation of the 5G network and the "enabled" technologies, such as connected autonomous vehicles, digital fortress, drone delivery, and energy connectivity all in pursuit of resilient installations. This effort highlights potential "dual use" technology being developed for commercial applications, while also having implications across national defense. Congressional support along with national interest in expediting U.S. based 5G technology, has alleviated many bureaucratic barriers to adoption across DOD, thereby expediting 5G as a dual use technology as well as the coming tide of emerging tech that will be enabled by 5G.

(PRIMING THE PUMP) – CURRENT INITIATIVES

San Diego National Security Catalyst Program

A first of its kind, a broad-based collaborative effort, coordinating the activities of Homeland Security, US Coast Guard, the Departments of Justice, Interior, Energy, the Center for Disease Control, and other First Responders in addition to the Department of Defense. Its mission is to improve the transition of innovative multi-use-use research and technology to national security users by leveraging San Diego's unique security, technology, business, and university environment and to provide practical, effective policy recommendations to eliminate barriers to innovation and improve national security competitiveness.
Additional goals include:

- Raise national and international awareness of San Diego's rich entrepreneurial environment.
- Increase student exposure to national security agencies and challenges through positive, practical, multi-disciplinary problem solving.

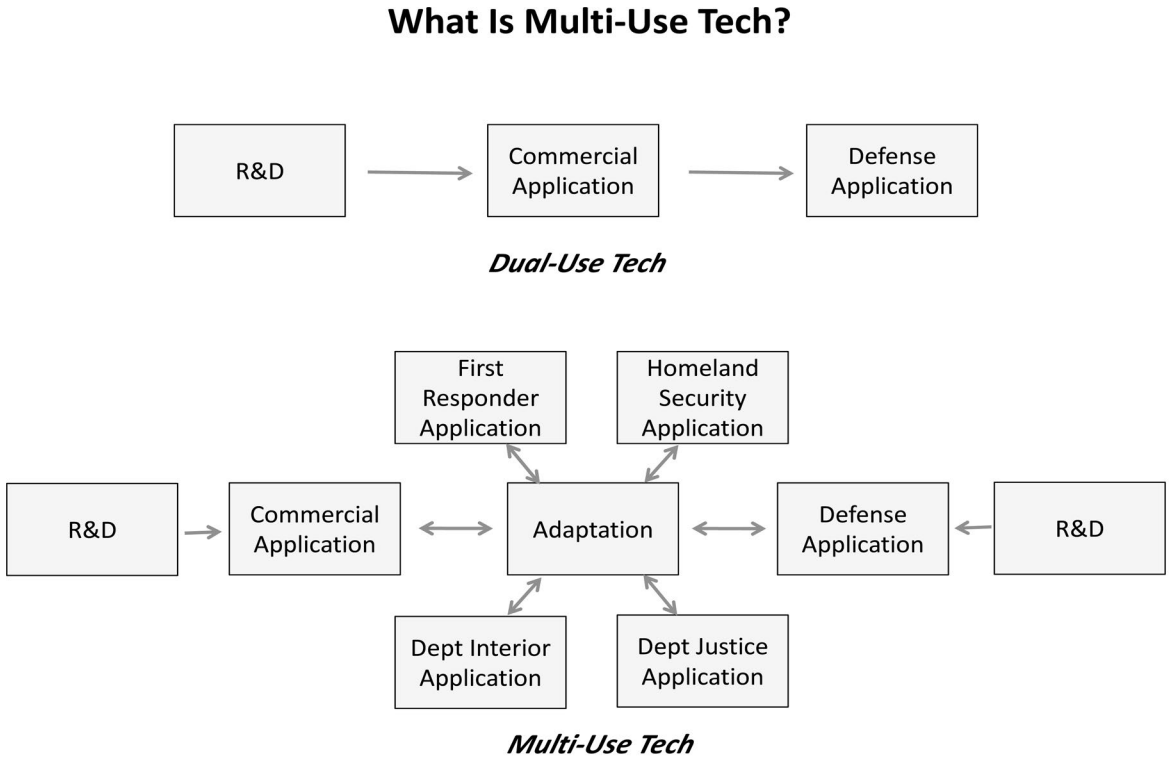


Diagram courtesy of San Diego National Security Catalyst

- Building on collaboration models developed to cope with the challenges of the Covid-19 pandemic to improve the long-term civic resilience of San Diego.

Multi-Use Research & Entrepreneurial Ecosystem Concepts

Multi-Use Startups are a rich source of valuable technology and expertise which, to date, has not been efficiently tapped by the defense sector. Through the efforts of the university and "Catalyst" initiative, a number of startup companies have been meaningfully connected to the national security enterprise, including:

- Regenica Bioscience: Prevention and cure against nerve agent chemical substances
- NeuroTrainer: Human performance (reflexive decision making) improvement
- TruGenomix: Genetic pre-screening for PTSD susceptibility
- EVT: AI-based training, briefing, VI enhancement
- OceanAero: Autonomous SUV/ USV platformsSeaPort Techologies:

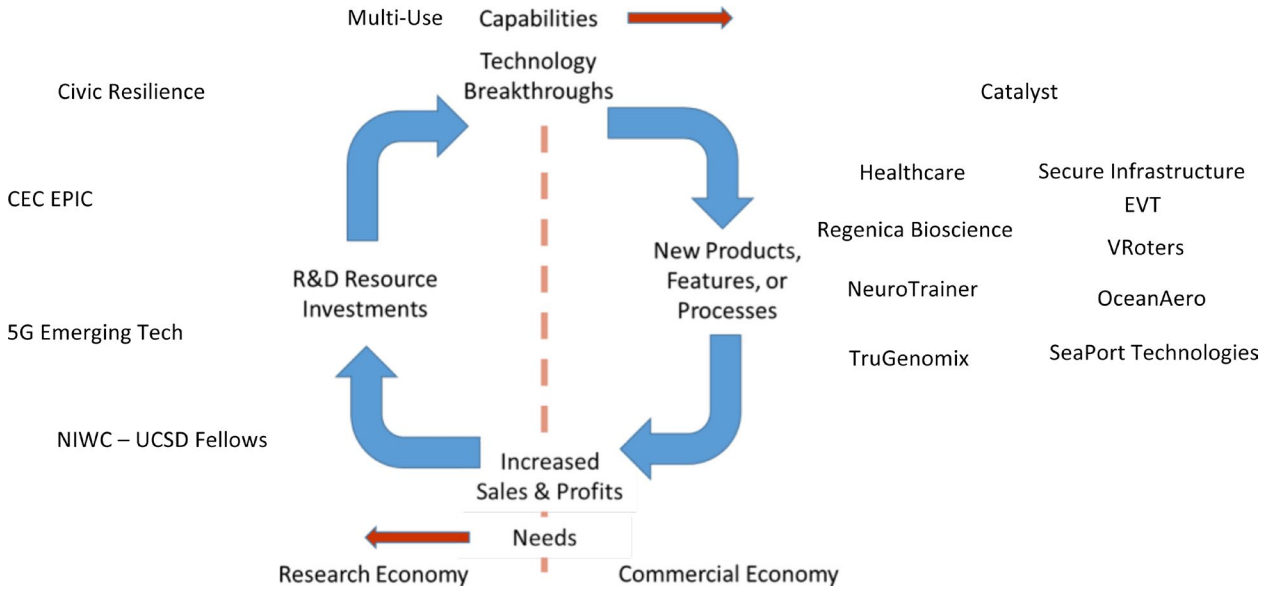
Extreme data security and performance improvement for remote work

Through more integrated efforts, these companies have developed substantial engagements with operators within the national security sector to accelerate the development of technologies that will have value both in the national security and civilian markets.

THE PANDEMIC

The COVID-19 crisis has made at least two things clear: *First*, in a world that is likely to face systemic shocks of increasing intensity, scope and frequency, our society must quickly become more resilient to shocks whether they be natural or man-made in origin; *Second*, the public-private partnerships that blossomed in the crisis, if sustained and more effectively structured, can provide both rapid and effective response in times of crisis, and tremendous value in non-crisis periods through collaborative innovation that accelerates national security and economic development.

While the pandemic has underscored the power competition between nations, this struggle did, of course, predate the crisis. It was already apparent that the United States is at potential risk of losing its technological superiority to foreign government and private-sector



competitors due to insufficient agility to address new threats and slower innovation to generate new ideas in response. This deficit is paired with warranted concern of losing technology to global competitors through both legal and illicit means. Now, more than ever, it is critical that we build resilience into the technology supply chain, which will require a combination of new technologies, policies, and economic models.

The COVID-19 emergency has highlighted the importance of resilience at all levels of our society and the imperative for effective, standing partnerships between government, academia and private industry, to ensure the long-term sustainability of our economy and National Security Complex. Resilience is needed at all levels: an agile "dual use" workforce that continuously cross-trains and collaborates, and can rapidly adapt to crisis situations; agile and persistent partnerships between Federal, State, Local governments with academia and private industry that provide innovation during 'steady state' periods and can very quickly mobilize in response to major challenges; and infrastructure and supply-chains that can quickly respond to disaster situations; and an underlying social fabric that is deliberately strengthened in stability to survive and provide community resilience in times of stress.

RESILIENT INFRASTRUCTURE: CIVIC RESILIENCE PUBLIC-PRIVATE PARTNERSHIP

A robust group of founding partners, including Arizona State University, UC San Diego, NSIN, Naval-X, Marine Corp Installations West, USA Ignite, and others have joined to create a new evolving regional private-public partnership to develop, sustain and organize a coordinated network of regional cluster groups – specializing in the key functions required to strengthen the technological supply chain for both civilian and military purposes.

The objective of the Civic Resilience Partnership is to build a pipeline of expertise around specific problems to strengthen the technological supply chain for both civilian and military purposes in a way that is both deployable across the military and economically sustainable. This approach will strengthen the resilience across respective markets, enhance regional and local economies, and ensure the nation has a dynamic capacity to accelerate technology and create an agile workforce for national and economic security that can be used to rapidly respond in a time of crisis. The Partnership will initially focus on 5G enabled communications and autonomous systems and power resilience with opportunities to expand to Healthcare and Energy resilience. As the partnership evolves, other likely key functional areas of focus will include: Crisis Response, Power & Infrastructure, Homeland Security, Cyber, Logistics & Operations, Fire Fighting & Damage Control.

The overall function is to cultivate an ecosystem that is comprised of capital, research, knowledge, capabilities, policies, incentives, and people that turns ideas into innovations and transforms discoveries into useful technology and products that increase resiliency and protect our national security. Specifically, this will include:

- Operationalize a coordinated network of regional resources that persistently links national security practitioners, State and Local crisis response organizations, academic research organizations, dual-use

companies, entrepreneurs, and related non-profits to provide mutual benefit in normal times and rapid mobilization during crises.
- Strengthen supply-chain resilience, both civilian and defense, by helping small to medium dual-use companies gain access to government or defense contracts while developing products and services that also have a commercial application.
- Cultivate an ecosystem of proactive regional collaboration to transform discoveries into high-growth job creation within industries of the future; and build a more resilient and adaptable workforce through skills training.
- Strengthen regional infrastructure (such as 5G) required for broad-based resilience in the region
- Support research organizations to develop dual-use technologies for transfer to industry partners.

LESSONS LEARNED FOR SUSTAINED GROWTH

San Diego's innovation economy was born and has sustained long-term growth in many respects due to the symbiotic relationship between its military, academic, government, and industry sectors. Over the decades, this relationship has, in part, given rise to one of the most robust and unique innovation clusters in the world.

Leveraging our strengths and the relationships between our military and innovation sectors will be key to ensuring San Diego's continued competitiveness in the future. This will require new, creative and "out-of-the-box" thinking.

Existing models and frameworks for the interactions of these sectors, while helpful in the past, are now outdated and not sufficient to enable each sector to take full advantage of the fast pace of disruptive or transformational innovation in our current markets. New models are needed. We believe the time is right for this.

1. The defense sector has recognized the need for a new approach in the creation of initiatives such as DIU, Naval-X, NSIN and AFWERKS.
2. The academic research sector has displayed a willingness and flexibility in understanding and meeting the needs of the national security sector – particularly in areas of multi-use technologies, where civilian markets are also addressed.
3. The industrial sector is moving faster than either of the other two in the development of disruptive solutions and is eager to develop the defense sector as an additional market.

Military and Economic Growth Innovation Ecosystem Testbed

Taking advantage of all three markets forces that are active in San Diego, in the true spirit of entrepreneurism, we're experimenting, testing, and putting into practice, initiatives such as the Catalyst program to turbo-charge a sustainable virtuous cycle of innovation. A living laboratory / regional testbed is now active in San Diego – aligning the incentives for advancing research based on governmental and defense priorities, while simultaneously creating companies, products, and services that also meet the needs of the commercial economy. We're addressing strategic and tactical supply chain DOD priorities, especially those that overlap with commercial markets – energy/power resilience, healthcare, communications, internet security (financial and critical infrastructure).

Testbed Characteristics

1. Collaborative programs to align research capabilities with targeted government needs and strategic industry partners.
2. A pipeline of intellectual property based innovation filled through Entrepreneurial education for students, faculty, alums, and affiliated startups
3. The creation of Multi-disciplinary advisory working groups, leveraging Medical, Business, Engineering, Data Sciences, Materials, and Supply Chain Expertise
4. Focused Acceleration in key market sectors: Medical Devices, Smart Transportation, Energy, Security
5. Targeted Industry partnerships – Healthcare, Regulatory, Infrastructure
6. Deploying the resources and funding to develop Multi-use companies to solve strategic and tactical DOD problems and while competing successfully in commercial markets.

We are optimistic that these steps will propel, not just San Diego, but other regions across the country, who might test and adapt these concepts and initiatives

in their particular innovation ecosystem. We extend an invitation to additional partners and welcome the opportunity to collaborate with other regional ecosystems toward greater entrepreneurial and economic global competitiveness and success.