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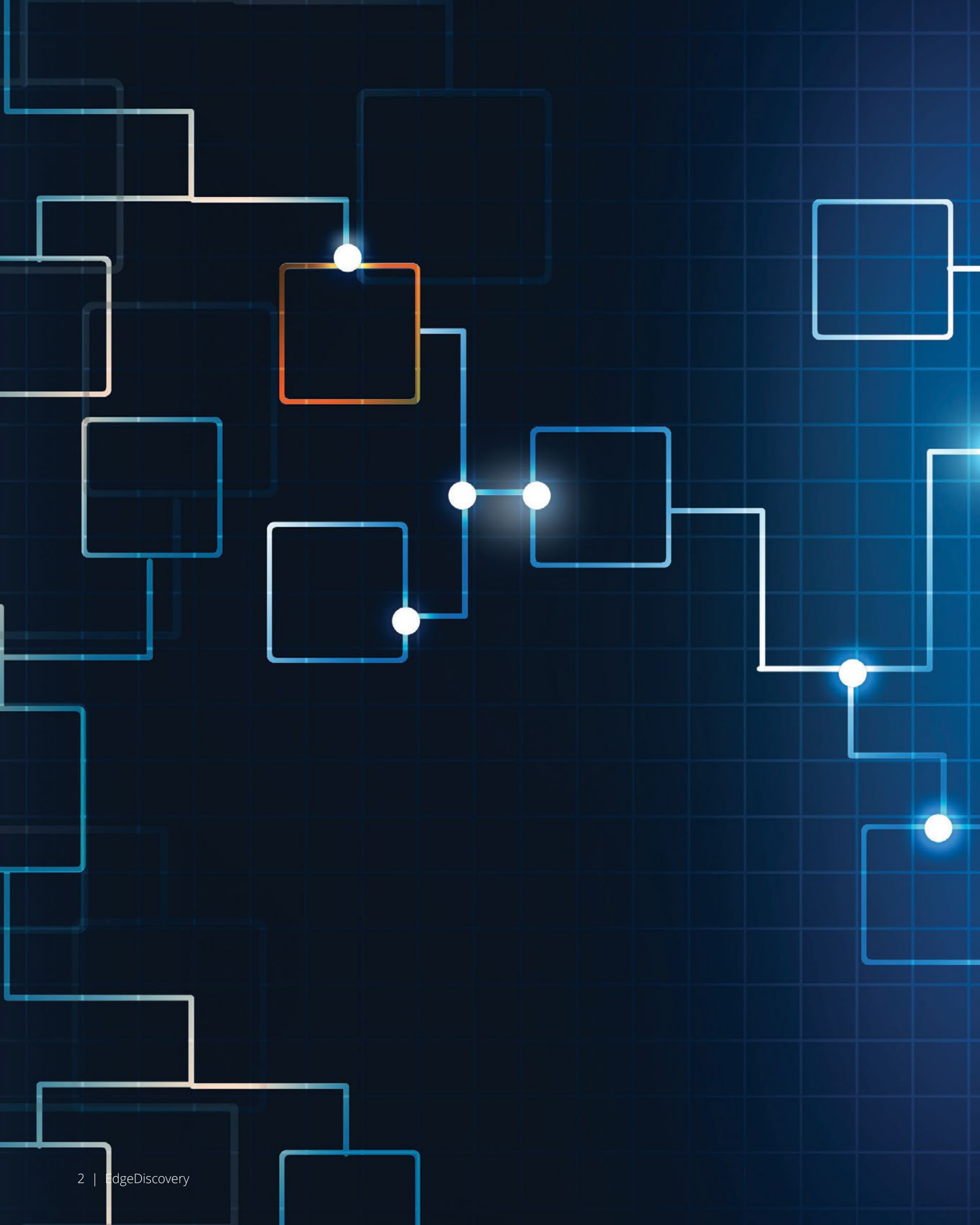
Edge.Discovery

RESEARCH CONNECTIVITY - COLLABORATION - PARTNERSHIPS



FORGING INNOVATIVE PATHWAYS FOR RESEARCH AND DISCOVERY

DR. FOROUGH GHAHRAMANI
Associate Vice President for Research, Innovation, and Sponsored Programs, Edge



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DR. FOROUGH GHAHRAMANI

FORGING INNOVATIVE PATHWAYS FOR RESEARCH AND DISCOVERY



Dr. Forough Ghahramani recently joined Edge as the Associate Vice President for Research, Innovation, and Sponsored Programs bringing a vast knowledge of higher education administration, research collaboration, healthcare, and information technology to the Edge community. As a visionary leader, Ghahramani harnesses the power of research collaboration among academia, industry, and government to help accelerate discovery and innovation across the region.

DR. FOROUGH GHAHRAMANI
Associate Vice President for Research, Innovation, and Sponsored Programs, Edge



A Roadmap to Research

Dr. Ghahramani has over 25 years of experience in information technology leadership roles in both technical industries and in higher education. While earning her Masters in computer science, Ghahramani started working with the IBM System/360 (S/360), a family of mainframe computer systems that were the first of their kind to cover the complete range of applications, including small to large and both scientific and commercial. "While in my program, I became fascinated by the system architecture and memory management system of the VAX-11/780, a new minicomputer that was developed by the Digital Equipment Corporation (DEC)," shares Ghahramani. "After graduating, I began my career as a software engineer, working on the Virtual Memory System, at DEC, and eventually moved onto the Unix operating systems development team." DEC was eventually acquired by Compaq and the HP. Ghahramani's industry career quickly progressed to senior level engineering and management positions at Hewlett Packard and consulting to Fortune 500 companies in the biotechnology, pharmaceutical, healthcare, information technology, and financial services sectors.

"I have had the opportunity to see the evolution of the computer industry from IBM Mainframe systems to minicomputers, to high performance computing (HPC) technologies. Leading talented and innovative teams to bring advances in technology to benefit engineering, research, and education has been most rewarding."

The consulting role, offered a great opportunity to see how the systems she had worked on were applied in a variety of industries. "The healthcare, biotech, and pharmaceutical angle was very synergistic with my background since I started out as a pre-med major in my undergraduate years," says Ghahramani. According to Ghahramani, one of the most significant projects she worked on as a consultant was the human genome project, where she developed expertise in high performance computing and the field of bioinformatics. "It was during the experience of working on the Human



"Collaboration is at the heart of research. I believe Edge can help establish a research ecosystem that can accommodate multi-institutional and multi-researcher collaborations.

— Dr. Forough Ghahramani

Genome project when I realized the important role of advanced computing technologies on accelerating research, and recognized the impact of providing platforms for great minds to be genuinely creative!"

Dr. Ghahramani's experience in higher education began when developing curricula for biomedical informatics and health information technology programs for a DeVry University. In addition to curriculum development, she went on to teach computer science, bioinformatics, and project management courses. She later became a department chair, followed by associate dean positions in several of the colleges and the Keller Graduate School of Management. "One of my most exciting projects in higher education leadership, was developing the neurodiagnostic technology program, in partnership with the New Jersey Neuroscience Institute."

The unique program partnered academia and healthcare and was the only program of its kind offered in the region," explains Ghahramani. With a desire to learn more about higher education leadership, and understand the formal methodologies of research, she returned to school to get her doctorate in Higher Education Management, with a research focus on Innovation Ecosystems and the role of institutions in promoting inclusive pathways for woman innovators in science, technology, engineering, and math (STEM) disciplines. "Throughout my career, I have spent most of my volunteer activities trying to help shape initiatives that provide opportunities for girls and women in STEM." Ghahramani continues to be an active advocate for STEM education by promoting greater diversity and inclusion in these areas of study.

Upon earning her doctorate and prior to joining Edge, Dr. Ghahramani was Associate Director of the Rutgers Discovery Informatics Institute (RDI2) at Rutgers University, where she led the administration of the institute, developed educational programs focused on big data and large scale computing, was responsible for vision and strategic planning for outreach and enhancing research productivity for the institute through industry and academic partnerships, and cross-disciplinary collaborations. Dr. Ghahramani represented RDI2 on many fronts, including in regional and national organizations.

Ghahramani's passion for research continues through her research activities. She has served as the Education Lead for the Virtual Data Collaboratory (VDC), a multi-institutional, multi-disciplinary collaboration project. The VDC is a federated data cyberinfrastructure that is designed to drive data-intensive, interdisciplinary and collaborative research, and enable data-driven science and engineering discoveries. In addition, Ghahramni's research related to women in STEM innovators



and inclusive innovation ecosystems has resulted in several publications, including contributions to a chapter in the book, *GENDER, SCIENCE AND INNOVATION* released January 2020.

"The insight gained from my diverse experience in higher education and working with the research community, coupled with my background in the information technology industry, will be invaluable in my current role at Edge as Associate Vice President for Research, Innovation, and Sponsored Programs."

The Future of Collaborative Research

Edge is a premier regional provider of research and education networking and is deeply involved with the research agenda in New Jersey and beyond. With a focus on creating a platform for peers to network and connect, Edge is committed to helping drive innovation forward by enabling research to take place at a high level. "Collaboration is at the heart of research," says Ghahramani. "I believe Edge can help establish a research ecosystem that can accommodate multi-institutional and multi-researcher collaborations."

Ghahramani's colleague at Rutgers, Dr. Barr von Oehsen, Associate Vice President of the Office of Advanced Research Computing (OARC), also recognizes the importance and impact of research collaboration. "I've had the pleasure of working with Dr. Forough Ghahramani for several years while she was at Rutgers University and I'm excited about working with her in this new role," shares von Oehsen. "Through the support of both Rutgers and Edge, Dr. Ghahramani and I have an opportunity to better support research and education across the state of New Jersey as we develop platforms designed to break down the barriers often encountered through multi-campus collaborations and partnerships and to offer access to local, regional, and national resources and data."

Ghahramani adds that Edge plays an important role in facilitating research by providing access to essential technology and through their involvement with a large range of institutions, from K-12 to the higher education community, including R1 institutions. "The ultimate outcome of research collaboration is innovation and I see Edge playing a vital role in forging innovative pathways."

Edge continues to expand their role in promoting research collaboration and delivering technology solutions. Strategic partnerships, like those with the Eastern Regional Network (ERN), Internet2, the Quilt and the New Jersey Big Data Alliance (NJBDA), introduce important opportunities to Edge members. "Through these partnerships, we can expand the tools available to the research community, as well as raise awareness about the initiatives and projects underway," says Ghahramani. "The next generation of inventors is here, across all levels of education, and Edge aims to showcase the research and innovation that is happening in New Jersey."

Expanding Connectivity within the Community

Edge works with research institutions to expand connectivity to facilitate research collaboration, grant proposal development, recruitment, publication, and communication of the research activities within the state. By doing so, Edge hopes to increase the state's research funding from national agencies and programs, improve recruitment and retention of top students and researchers, and improve the profile and support for research in the region, In addition, Edge strives to increase the quality and connectedness of the New Jersey research community and encourage better allocation of research resources.

To expand connectivity, Edge will continue to host statewide networking forums for New Jersey researchers. "These forums will focus on interdisciplinary research areas, where investigators from the state



and the region showcase their current research in various fields ranging from biomedical and life sciences to energy and the environment, to AI and Quantum Computing," shares Ghahramani. "The desired result is an increased number of multi-institutional research collaborations established and funded." Ghahramani says Edge plans to organize more research working groups to guide research collaboration in various disciplines and industries including life science, energy, and environmental science. "The working groups will invite representatives from the state and the region's research institutions, as well as colleagues working in relevant New Jersey industries to make recommendations that leverage existing research strengths and equipment, and position the state and region to be as competitive as possible for funding opportunities, human resources recruitment, and industry contracts."

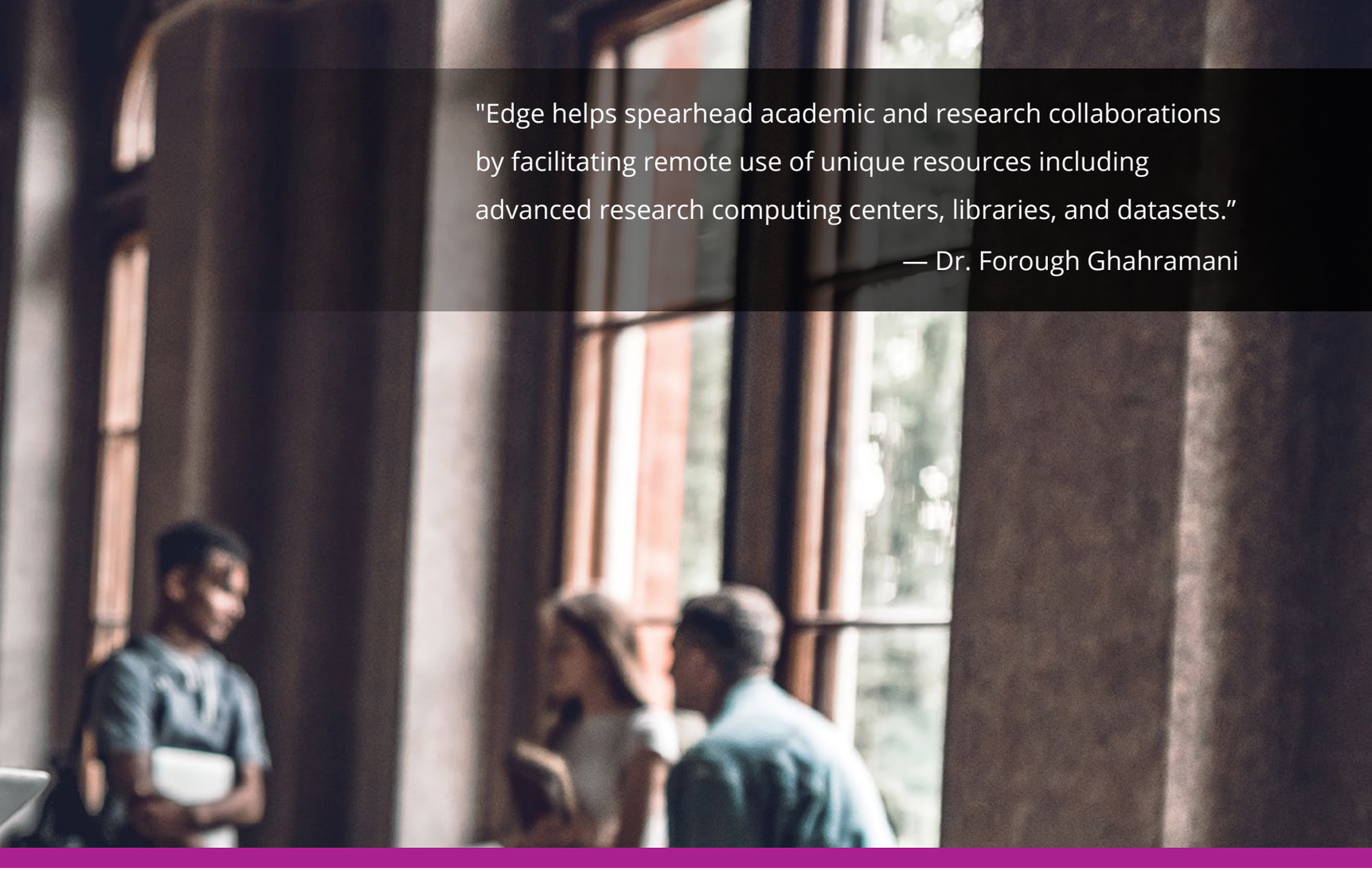
The Evolving Nature of Research

New models for research are emerging — driven by new technology capabilities, high performance networking and computing, and the availability of structured and unstructured data and analytics. "The role of research computing and data in scientific discovery and scholarship across all disciplines presents challenges, as well as opportunities," says Ghahramani. "The challenges are not only for the service providers, but also for the researchers who are trying to keep pace. We must be able to identify the existing roadblocks and understand the research impediments to further facilitate collaboration opportunities. In addition, investing in cross-disciplinary application of data science, artificial intelligence, and quantum computing will create new opportunities for innovation."

The role of Edge is uniquely positioned to partner with colleges and universities to understand their challenges and create a portfolio of technology solutions, while amplifying the strength of all members. "Edge helps spearhead academic and research collaborations by facilitating remote use of unique resources including advanced research computing centers, libraries, and datasets," says Ghahramani. "We will continue to identify and support new collaborative projects in the research and education community, while providing the data-driven high performance networking infrastructure and access to dynamic network services that enable rapid movement of diverse scientific datasets."

Expanding Undergraduate Research

Based on strong partner relationships, Edge provides easy access to a variety of industries, government partners, and universities to identify emerging issues and opportunities for coordinated research projects.



"Edge helps spearhead academic and research collaborations by facilitating remote use of unique resources including advanced research computing centers, libraries, and datasets."

— Dr. Forough Ghahramani

"Universities are redefining how they work with industry partners to conduct research and train students," says Ghahramani. "Our students are key to closing the widening skill gap that has emerged. Edge can help member institutions initiate an undergraduate research program by sharing best practices among institutions, providing the necessary technology and testbeds, and facilitating industry-academic collaborations resulting in enhanced higher education curriculum that is responsive to, and aligned with, the skill sets required in industry.

The list of Research Universities in the Carnegie Classification of Institutions of Higher Education continues to grow in the state of New Jersey. Edge assists member institutions in the advancement of Carnegie classifications by seamlessly connecting research collaborators and resources. "Edge facilitates shared access to low latency and high bandwidth networks, data repositories, advanced computing resources, and specialized research instruments," states Ghahramani. "We eliminate the roadblocks and help accelerate the development of multi-institutional, multi-investigator research projects ranging from those at small, private colleges to large research institutions."

The Opportunities Ahead

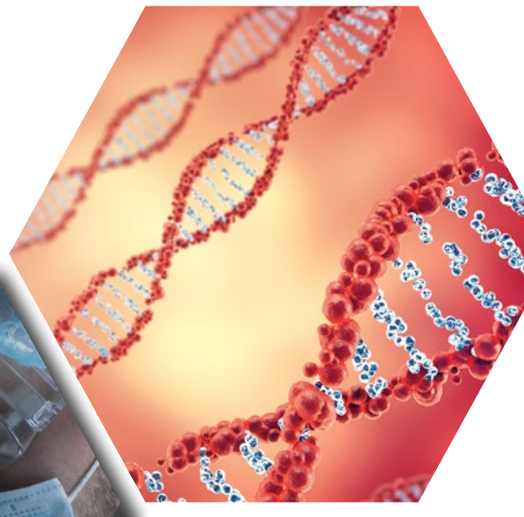
By building bridges across research and IT silos, the boundaries of research vastly expand, allowing new test beds and emerging technology to evolve. "Alliances between science drivers, like medical and clinical research, genomics, climate research, computational social sciences, and systems biology, allow for a surge of new opportunities," says Ghahramani. "Edge supports these partnerships by creating intelligent networks that provide access to research, resources, and technology for the entire educational research community — no matter the size of the institution." Through these connections, institutions are offering insight into methods of storing, processing, and moving data through a shared infrastructure. Edge continues to develop new ways to provide a research and education platform that can support a diverse set of science drivers and educational opportunities.

"The research landscape is changing very quickly," says Ghahramani. "This change is driven by new technology and the need to deliver more rapid, reliable, and sustainable results. I look forward to being a part of the transformative impact on the region's research communities in both small and large institutions and enabling multi-campus partnerships that advance the frontiers of research and innovation, with ultimate impact on advancements in science, technology, medicine, society, and economic growth."

Edge.Discovery

RESEARCH CONNECTIVITY - COLLABORATION - PARTNERSHIPS

















ACCELERATING TIME TO DISCOVERY
IN OUR CONNECTED MEMBER RESEARCH INSTITUTIONS

As noted by today's leading research institutions and funding agencies, the practice of research is changing toward reliance on optimized, federated, regionalized and shared services approaches. As a result, Edge has been actively involved in promoting this new vision for research computing support and is seizing the opportunity for these developments as an ideal entry point to bring current value to the research community. Particularly motivated by the opportunities that the new model represents for democratizing access to research computing capacity and capability, Edge's new research computing service framework, named EdgeDiscovery, provides less well-resourced institutions access to shared computing resources for participating and collaborating effectively with top-tier research organizations across the state, the region, the country and ultimately the world.

As a part of the United States Northeast Region's nexus for collaboration on e-infrastructure and services for research and education, Edge invests heavily in digital infrastructure to aid in solving the burning problems of scientific discovery. The Edge network now serves to ensure high performance network access for member scientists and researchers with a need for high performance compute and data intensive applications to the shared research cyberinfrastructure and e-infrastructure resources available through Edge and its partners. Edge is changing the game by working with its partners to provide on-demand access to multi-institution advanced research computing resources at the local, regional, and national level.

EdgeDiscovery combines the Edge research segmented network with access to advanced computing resources enabling researchers to streamline their research projects, schedule compute cycles, and access applications, analytics tools, and storage resources . The dedicated network segment is designed to optimize configuration and security policies for high-performance scientific applications. Edge's new research network paradigm is accomplished on a common, federated platform that will interoperate with the many research support constructs currently evolving in conjunction with the quest for a standards-based national research platform.

In part, the *EdgeDiscovery* prototype was developed in parallel with the ERN-POC program, which emulates the Rutgers University research support model, and is intended to provide on-demand access to shared multi-campus research computing platforms available to researchers in under resourced organizations otherwise unable to invest in next generation research computing infrastructure. *EdgeDiscovery* will provide connectivity to the ERN and similar regional and national projects under development as the quest for a national research platform model continues. This dynamic framework will provide access to compute nodes hosted in on-premise datacenters or in cloud environments. The *EdgeDiscovery* framework saves the researcher valuable time by allowing them to focus on research rather than advanced computing technology tools. Relying upon automation and best practices for HPC, the *EdgeDiscovery* shared service model will evolve in concert with the requirements of the research community as well as the hardware and software landscape, ensuring access to the latest relevant tools are available through the framework.

With the addition of *EdgeDiscovery*, Edge will enable access to the cyberinfrastructure and e-infrastructure resources required for full participation in the new research computing paradigm via Edge's high performance network segment. Edge resides at the Northeast Region's geographic and technical crossroads in the pursuit of innovation through advancements in next generation networking and research computing. In recognizing opportunities to advance our footprint regionally, Edge will continue to instantiate and evolve in providing high performance access to advanced research computing ecosystem at the local, regional, and national levels, including services in support of scientific discovery, a thriving data economy, research infrastructures, and sustainable, scalable, configurable research computing environments.



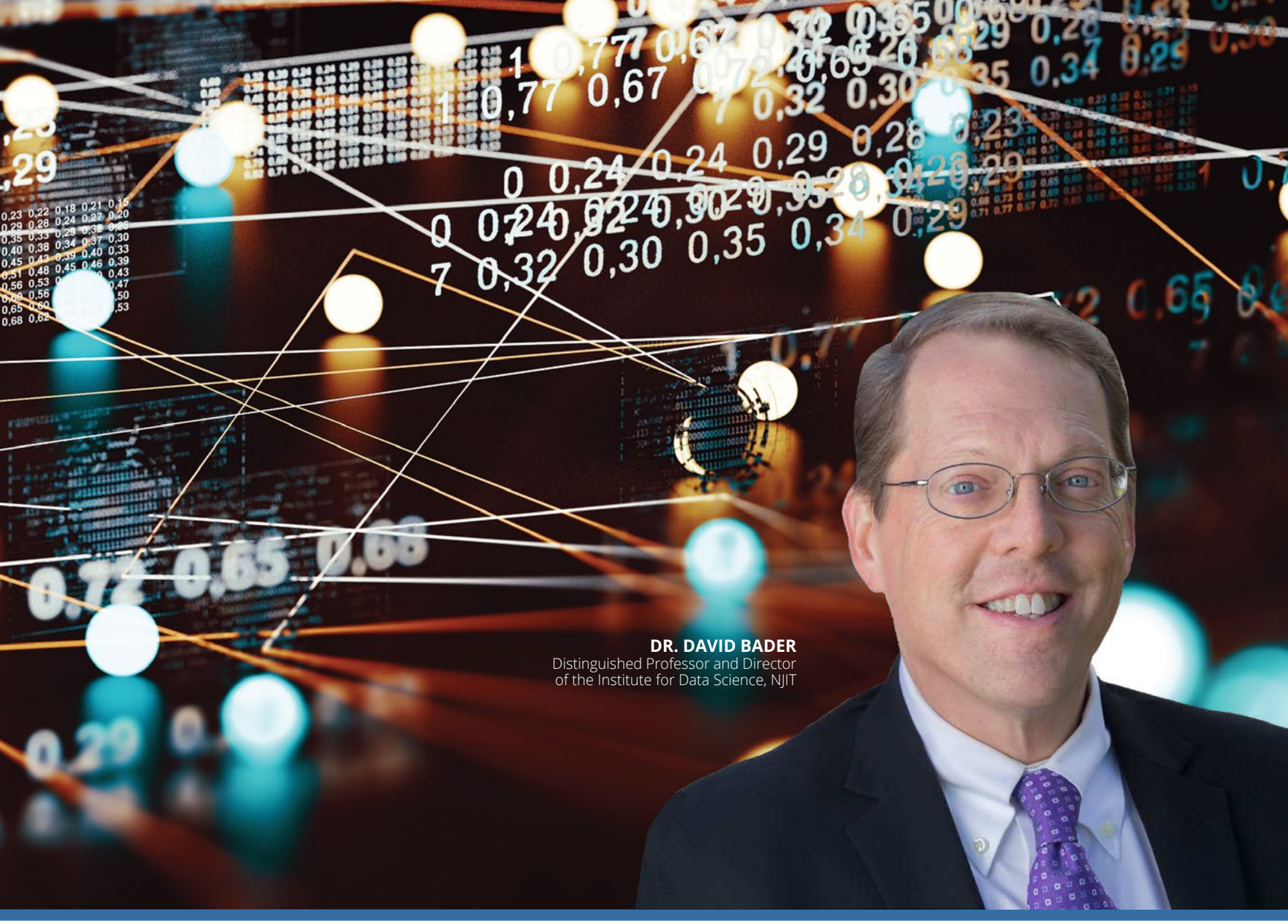
DR. DAVID BADER DRIVING GLOBAL TRANSFORMATION THROUGH DATA SCIENCE SOLUTIONS

New Jersey Institute of Technology (NJIT) announced last summer that the University would establish a new Institute of Data Science, focusing on cutting-edge interdisciplinary research and development in all areas of digital data. To head up this endeavor, Dr. David Bader joined NJIT as a Distinguished Professor and Director of the Institute for Data Science. Previously serving as the Professor and Chair of the School of Computational Science and Engineering at Georgia Institute of Technology, Bader has become a leading expert in solving global grand challenges in science, engineering, computing, and data science.

Bader has built important collaborations across government, labs, industry, and academia with a mission of turning ideas into high-impact technologies that create world-class solutions. Partnerships have included IBM, NVidia, Cray, and Intel, with government agencies like the National Science Foundation (NSF), Department of Defense, Department of Energy, and the Defense Advance Research Project Agency (DARPA). "Data is impacting decisions in every field, from health care to finance, arts, entertainment, and cybersecurity," says Bader. "I am drawn to developing research programs in the emerging area of data science. At NJIT, we are at the hub of all of these areas and the Institute for Data Science brings together faculty from computing, engineering, business and management, and science to develop data-driven technologies."

A New Era of Science

As a graduate student, Bader attended the University of Maryland and was awarded the NASA Graduate Student Researchers Fellowship. Bader's mentor from NASA was the late Jerry Soften, who was NASA's first astrobiologist and the lead scientist on the Viking mission to Mars. "Through this mentorship, I learned a few key lessons about science," shares Bader. "During this time, Soften was pursuing a new field and pioneering as a biologist as he looked for life outside this planet. He had to develop the science needed for something that falls outside our typical disciplines. I have taken that to heart, in that the most interesting research these days is at the interface between traditional academic boundaries."



DR. DAVID BADER
Distinguished Professor and Director
of the Institute for Data Science, NJIT

Bader says as we move towards data science, we are looking at data and the uses and impact of this information across business and management, health, financial services, entertainment, and product development. "We are entering into a new era where we must rethink disciplines and investigate how machine learning and artificial intelligence (AI) will further develop and impact every aspect of our lives."

With an expansive career of pursuing highly competitive research, Bader has managed over eighty projects with an approximate $185 million worth of contracts and grants. "I've worked with industry leaders and often provide the thought leadership for the design of new algorithms and systems, such as doing the hardware software co-design to develop the types of data science solutions that we will need now and in the future," says Bader. "One of the attractions to research is my desire to solve real problems and global grand challenges where the work will have an impact on people in a way that makes their lives better or the world a safer place."

Pioneering Data Analytics

Bader has had a lifelong interest in computing and parallel processing and has worked closely with many of the parallel computers over the last several decades. "Throughout my entire professional career, I have focused on data-intensive, high-performance computing applications," shares Bader. "I explore how the architectural designs of today's machines are savvier for solving data science, machine learning, and AI on massive scale data analytics." Bader's research group has pioneered high-performance data analytics for streaming graphs, where they review real-world observations and the interactions between them. "We explore interactions between people, places, and things," explains Bader. "For example, the network traffic in health care may include patient records and hospital visits. We take these irregular, unstructured datasets with interactions and turn those relationships into the abstraction of a graph where the vertices represent the people, places, and things. The edges represent the interactions, which may have, for instance, timestamps, values, distances, or other attributes,



"I LOOK TOWARDS EDGE AND THEIR ESTABLISHMENT OF RESEARCH NETWORKS IN NEW JERSEY FOR PROVIDING A BACKBONE OF SUPPORT, HIGH-SPEED DATA LINKS BETWEEN OUR ORGANIZATIONS, AND CONNECTIVITY ACROSS THE NATION."

and through this graph space, we then reason about the system."

The research group may also look at a social network and discover the emergence of a new community of interest. "We may examine the network flow or traffic in an organization and try to detect a cyber threat," says Bader. "Or we may be working on areas such as tracking the pandemic spread of disease and making recommendations on the best ways to prevent further contamination."

The Institute for Data Science

NJIT is making significant investments in technological research and development and the Institute for Data Science directly supports the University's strategic initiatives of driving collaboration within the thriving tech ecosystem in New Jersey and surrounding areas. "The Institute is a research focus at NJIT that brings together three existing research centers: one in big data, a second in medical informatics, and a third in cybersecurity research," explains Bader. "We are planning additional centers, including AI and machine learning and data sciences for the financial services sector. The Institute dissolves traditional boundaries and unites faculty, students, and staff across the entire organization to solve global grand challenges. To solve these problems, we need to bring a diverse set of people together with a variety of expertise and experience and NJIT provides a place for this collaboration in the heart of data science activity."

In the year ahead, the Institute will host community workshops and speakers, including evening classes in data science for those wishing to gain more experience. "Recently, we had Chris Wiggins as a speaker, who is a professor at Columbia University and is the Chief Data Scientist of *The New York Times*," says Bader. "We've had speakers from IBM, NVidia, and New York Presbyterian Hospital to share their knowledge and expertise, and we will have a distinguished lecture



in March from Professor Vipin Kumar, of the University of Minnesota, who is one of the pioneers in the technique of data mining and data sciences."

Bader says we are still at the early stages of understanding data science, in terms of the field's usage and how to integrate emerging areas like machine learning and AI. "We are currently at a very exciting stage in data science and we must think about data holistically and how this information integrates into the world around us. We must ensure we look at data science not just as new technology, but explore how the field can affect our day-to-day lives."

Connecting the Community

As a newly minted Research 1 institution, NJIT is at the cusp of growing their world-class research mission. Over eight hundred computing students graduate from NJIT each year, making the institution the largest producer of computing talent in the state. "Our new designation as an R1 school and the *U.S. News & World Report* ranking us among the top 100 schools, shows we are well on our way to being a premier institution," says Bader. "Plus, the establishment of the Institute for Data Science is recognition of the strong researchers, faculty, and students that we have at NJIT and allows the University to continue to attract, recruit, and grow as an organization."

Bader says to further build this momentum and broaden the impact of the research community as a whole, we need to keep developing consortiums and communication networks. "In a data-rich environment, the networks provide the connectivity of the researchers, the datasets, and the equipment that is critical to making progress and achieving success. I look towards Edge and their establishment of research networks in New Jersey for providing a backbone of support, high-speed data links between our organizations, and connectivity across the nation. This network is the differentiating factor that allows us to bring together the resources needed to solve the most data-intensive applications."

As the Director, Bader's vision for the Institute is to create a collaborative hub that reaches all of the faculty and students at NJIT who are using data in their research, teaching, and scholarship. "NJIT aims to produce the skilled career professionals that are needed in our community. I want to help solve the problems we face in Newark and in our surrounding areas so we have higher-quality lives, access to better medical care, safer organizations that are free from cyberattacks, and better entertainment systems. For the Institute to be a success, my goal is to continue to positively impact the community that surrounds us at NJIT and make tangible contributions to the quality of their lives."

NJIT
New Jersey Institute of Technology

Edge

PROVIDING

EDGE-TO-EDGE SUPPORT

TO THE NETWORKED ACADEMIC ENTERPRISE

Two Decades of Commitment to Digital Transformation

When Edge was originally conceived in 1997, the genesis of the organization's formation was based on the burgeoning concept of broadband connectivity as a critical utility essential to advancing the missions of the higher education community in New Jersey. Back then, Chief Information Officers almost fully comprised Edge's membership base. As the technology needs of the higher education community expanded over the past 20 years, so too did Edge's membership, with nearly all of an institution's key roles finding benefit



in the services and solutions provided by Edge. Finding engagement at all levels of the institutional environment is not uncommon. Levels often include Presidents, Chief Information Officers, Chief Financial Officers, Chief Enrollment Officers, Chief Information Security Officers, Procurement Officers, Library Staff, Chief Academic Officers, Enterprise Information Technology (IT) Professionals, and IT Support Staff — to name a few.

Edge's member organizations now rely on Edge in constantly evolving ways to achieve success in today's digital world by transforming how technology serves as enabler and differentiator in the 21st century.



Edge Evolves to Meet the Needs of Sectors and Markets Beyond Higher Education

In addition to the digital transformations Edge has recently witnessed in education, government, and healthcare, digital transformation is now occurring in all vertical market segments, and is bringing about alignment of core functions with how the world now works. In an age of mobile computing, extreme connectivity, secure access, and social business, Edge continues to demonstrate a unique value proposition to member institutions and beyond through secure high-performance optical infrastructure, network services, technology solutions, and economic advantage.

Today's Edge member road map aptly depicts the fact that the Edge team is not one to sit still. The team's collective desire to create and innovate pushes Edge to provide optimal technology solutions. As Edge heads into its third decade of progress, the sky's the limit for members seeking solutions to their most complex technology dilemmas.

Edge Proudly Supports the Following Industry Sectors



Higher Education

Dating back to 1997, Edge's mission has been, and continues to be, to support New Jersey's institutions of higher education in their pursuit of excellence in teaching and learning.

K – 12 Education

To educate tomorrow's learners one must consider the level of sophistication these students have with technology. Services are specifically tailored to address the needs and demands of this constantly evolving segment.

Healthcare Industry

The healthcare industry demands precision technology in medical services and infrastructure to ensure secure support for hospitals and medical facilities.

Libraries and Museums

Our experienced team understands that libraries and museums share common financial resources with other institutions yet have unique needs, requiring an expert approach to identifying funding channels and executing applications to ensure optimal results.

Local, County & State Government

By deploying high-bandwidth services, our dynamic solutions enable government and public safety organizations to operate with improved efficiency and achieve lower operational costs with secured resources.

Research

Accelerating the time to discovery by delivering the next generation of research technology to enable high performance and collaboration at even the smallest research institutions.

ENRICHING THE STUDENT Learning EXPERIENCE

Dr. Phalguni Ghosh, Faculty, Chemistry, Natural Sciences, and Dr. Michael Ansonoff, Associate Chair, Natural Sciences from Middlesex County College, recently presented at EdgeCon 2020 during a Breakout Session focused on *Enrichment of Students' Learning through Big Data Analysis using Biological Networks*. They explored how biological networks can enhance student and faculty interaction, improve STEM retention and success, and offer a low-cost alternative to expensive equipment. As a free, powerful web-based resource, institutions only need computer and Internet access to connect to the research community and life science libraries. The possible areas of research are extensive, including gene regulation, cell signaling, drug interactions, disease pathways, and environmental impact. "In presenting at EdgeCon, we approached big data from a slightly different perspective," shares Ansonoff. "We wanted to show that big data analysis is possible amongst all institutions, even community colleges and non-research organizations, to give students access to research programs in a financially sustainable manner."



DR. PHALGUNI GHOSH,
Faculty, Chemistry, Natural Sciences, Middlesex County College

With the ability to import data from multiple biological databases, researchers are able to understand and evaluate targeted information that would otherwise be cluttered in multiple massive networks. "Big data is very important, especially in a biological context," adds Ghosh. "Biological networks provide a conceptual framework to understand complex interactions of different components in a biological system. Data can be mined to improve human health and cure diseases. Big data analysis using biological networks results in drug, chemical, and disease association. This analysis then enables the prediction of gene regulation, disease pathways, drug interactions, and much more."

The Benefits of Biological Networks

Biological networks provide a conceptual framework to understand complex interactions of different components in a biological system. Students of Ghosh and Ansonoff use Cytoscape, a free software platform that allows the investigation and visualization of integrated diverse networks. Although Cytoscape was originally designed for biological research, the platform is now used as a general tool for complex network analysis and visualization. "While discussing biological networks at EdgeCon, we enjoyed seeing mathematicians and computer programmers embrace the purpose and potential of these systems," says Ansonoff. "Biological networks can help improve STEM success by introducing students to the science community and providing hands-on insight into science careers."

The Future of Big Data

Many people are wondering if the focus on big data will continue to grow or will the field become a passing thing? With the rising amount of data being generated, especially as one considers the increasing number of mobile devices across the globe, we can predict that big data is here to stay and will change how many of us think about the world.

"Big data will continue to grow in the future and will swell new scientific discoveries," says Ghosh. "Data has always existed," adds Ansonoff. "We have always mined data; we just have a much higher volume to analyze." The amount of digital data continues to expand quickly and provide new insights across many industries. "Big data is infiltrating every field," says Ansonoff. "The scientist in me finds this trend utterly fascinating. Students and faculty are gaining the opportunity to apply machine learning, contribute information to databases of research, and build connections that take the human mind where it wouldn't normally go."

The methods of analyzing data will also likely evolve and more tools will emerge. Machine learning is predicted to be an important element for data preparation and predictive analysis in the future. "Having computers that are able to make data connections, independent of human interaction, will lead to insights that may seem counterintuitive at first," says Ghosh. "This possibility is where I'm most excited; the finding of possible unusual connections that normal analysis would not have pinpointed."

Supporting Student Success

Both Ghosh and Ansonoff are passionate about the initiatives and programs at Middlesex County College and are thankful for the funding and support they receive to continue their program. "We are making impressive progress and we are proud that our students are able to conduct research in various disciplines," says Ghosh. "Middlesex County College is primarily a teaching institution rather than a research institution," adds Ansonoff. "Many of our current initiatives and programs are to enhance the way we teach our students. We are trying to focus on ways to make education more relevant to students' lives and undergraduate research is an effective way to achieving this goal."

Ansonoff says another important initiative is increasing the College's footprint in online and hybrid courses and using technology to increase student success. "We are really pushing faculty to utilize and maximize our learning management systems and provide students with as much information as possible through this platform. Not every class is going to be an online course, but we can use that online component to help students be successful."

Students across the learning community are drawn to digital education and the ways this method can boost convenience and enhance the overall educational experience. "We have always used technology in the classroom and laboratory, but we continue to add tools and techniques that students love," says Ghosh. "For example, we use Kahoot!, which is learning software designed to engage students." Kahoot! enables teachers to introduce new concepts, reinforce knowledge, foster teamwork, and connect with classrooms globally.

While technology can open new doors and provide important opportunities, Ghosh says the human element is very important in learning certain subjects. "The teacher plays a crucial role in giving students the right directions. Not all subjects can be learned through online courses or hearing a lecture." Ansonoff says Middlesex is strategic in identifying where technology is helpful, and where the person-to-person interaction is still critical. "There are some situations where students benefit more from hands-on experience and in-person assistance as they first get started with material. Then going forward, we can move them toward more independent learning opportunities."

Preparing Students for Tomorrow

Edge events, including EdgeCon, bring together members of the education community and allow organizations to connect and collaborate on various initiatives. "The innovation that is occurring within Edge member organizations is very interesting," says Ghosh. "Having access to others' strategy planning, road mapping, and organizational goals helps ignite a learning environment."

Middlesex is dedicated to helping today's students prepare for tomorrow's challenges while designing their own path toward a bachelor's degree and beyond. "Our College has an extensive undergraduate program for science students," says Ghosh. "Very few places have this kind of sophisticated facilities for their undergraduate students, like our state-of-the-art research equipment." Ansonoff adds that many students are involved in projects that you would normally find at a four-year college. "Middlesex has vibrant research programs in biology, chemistry, and geology, among many others. However, I feel our greatest strength is our faculty, administration, and staff. As a community college without R1 grants, the research being conducted by our faculty members and their commitment to each student's education is often outside the realm of their normal workload. Each and every person working at Middlesex is driven by their love of science, but most importantly, by the love of their students and we are dedicated to helping each and every student be successful and have a rewarding college experience."



REGIONAL OPTICAL FIBER NETWORK

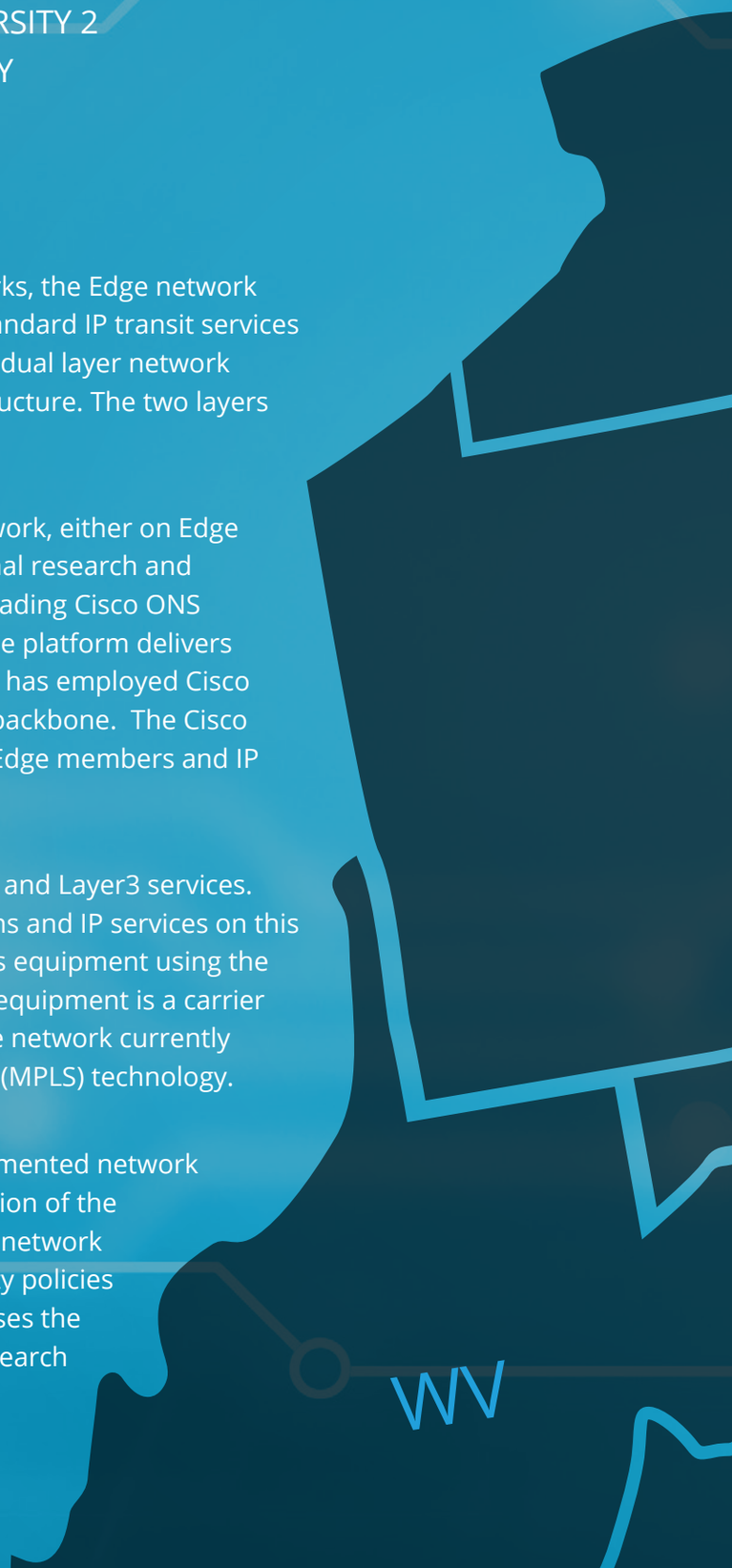
MAJOR NODES

SECONDARY NODES

- RUTGERS 1
- RUTGERS 2
- PRINCETON UNIVERSITY 1
- PRINCETON UNIVERSITY 2
- ROWAN UNIVERSITY
- MONTCLAIR
- POMONA

ROUTES

- 400G
- PLANNED



The Edge Network Technology

As one of the nation's advanced research and education networks, the Edge network serves to support a diverse range of users and services from standard IP transit services to ultra-high capacity data transport capability. Edge has built a dual layer network able to integrate these service demands across a single core structure. The two layers include the Transmission Layer and Packet Layer.

Transmission Layer

The transmission layer is built on the dark fiber core of the network, either on Edge points of presence (PoPs) or on leased wavelengths from national research and education networking organizations. Edge combines industry-leading Cisco ONS 15454 and EKINOPS 360 Transport Platform to light the fiber, the platform delivers rates from 100Mbps to 200G today and can scale to 400G. Edge has employed Cisco ONS 15454 ONS integrated optical amplifiers to drive the fiber backbone. The Cisco and EKINOPS equipment is used to deliver Lambda services to Edge members and IP trunks between the Edge Core routers.

Packet Layer

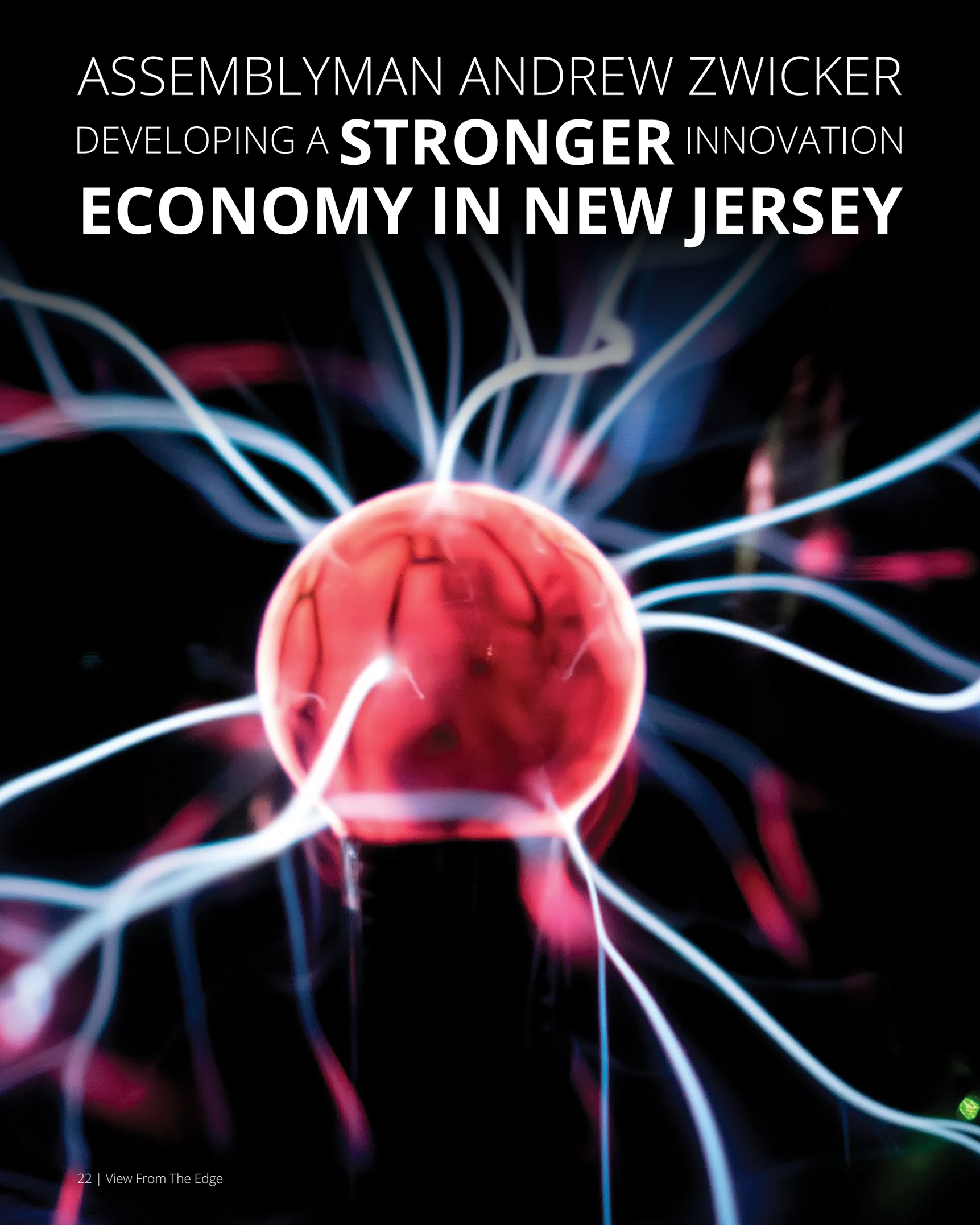
The packet layer is a converged layer that supports both Layer2 and Layer3 services. This design means that Edge can offer both Ethernet connections and IP services on this layer. Edge implements the packet layer with Cisco ASR9K Series equipment using the Cisco IOS® XR operating system. The ASR9K and NCS55X Series equipment is a carrier grade router which supports MPLS and other services. The Edge network currently delivers its Layer 2 services using Multiprotocol Label Switching (MPLS) technology.

High Performance Network Segment Dedicated for Research

Through EdgeDiscovery, Edge provides a high performance segmented network for research. The dedicated research network segment is a portion of the network that is built at or near the campus or laboratory's local network perimeter and is designed to optimize configuration and security policies for high-performance scientific applications. This model addresses the common network performance issues often encountered at research institutions due to the high volume of data and the network architecture easily adapts to incorporate high performance and advanced technologies.


VT
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CLOUD PROVIDERS
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Azure, Akamai
CLOUD PROVIDERS
AWS, Google,
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NEW YORK CITY
INTERNET2
NEWARK
PA
INTERNET2
CLOUD
ACCESS PROVIDER
Epsilon
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NJ
European
Subsea
Cable Route
CLOUD PROVIDERS
AWS, Google,
Azure, Akamai
MD
South American
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CLOUD PROVIDERS
AWS, Google,
Azure, Akamai
VA

ASSEMBLYMAN ANDREW ZWICKER DEVELOPING A **STRONGER** INNOVATION **ECONOMY IN NEW JERSEY**



A lifelong New Jersey resident, Assemblyman Andrew Zwicker has always had a love of learning and a curiosity for science and technology; however, he is not your typical scientist. In recent years, Assemblyman Zwicker has expanded his career in new directions, allowing him to wear two very different hats: one as a physicist and science educator and another as an assemblyman in the statehouse. In addition to his work at the Plasma Physics Lab at Princeton University, Assemblyman Zwicker represents the 16th Legislative District in the New Jersey General Assembly — becoming the first physicist elected to the New Jersey Legislature. In addition to being his passion and profession, Assemblyman Zwicker says science and technology are also key to our economic and academic future.

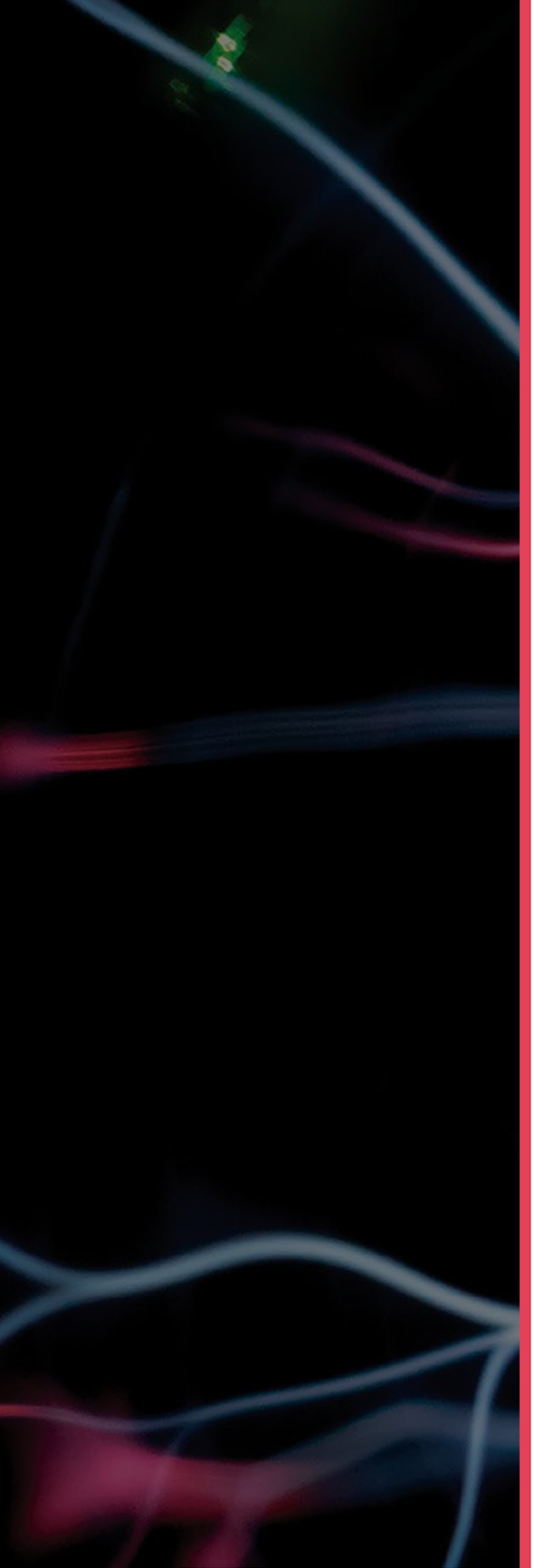
Roots in Science

Assemblyman Zwicker was raised in Englewood, NJ where he graduated from Dwight Morrow High School. He later earned a bachelor's degree in physics from Bard College and a master's and Ph.D. in physics from Johns Hopkins University. Assemblyman Zwicker began his career at Princeton University's Plasma





ANDREW ZWICKER
16th Legislative District Representative
New Jersey General Assembly and
Head of Communications and Public Outreach
Princeton University' Plasma Physics Laboratory



Physics Laboratory 22 years ago and never left. “I’m now the head of Communications and Public Outreach at Princeton University’s Plasma Physics Laboratory,” shares Assemblyman Zwicker. “I've had the opportunity to speak across the country and all over the world about science education and fusion energy. I hope to inspire new generations of scientists and researchers, no matter their background, to pursue careers in physics and other science, technology, engineering, and mathematics (STEM) fields.”

Assemblyman Zwicker’s career transition from research to education was inspired by a high school student in Trenton, NJ. “While I set out to help this student change her life through education, she ended up changing mine. She received a full scholarship to a university, and I learned how rewarding mentoring young scientists can be. I found this experience so enriching; I knew that education is the direction I wanted my professional career to go.”

A New Endeavor

Assemblyman Zwicker has not only been named one of the 75 leading contributors to physics education in the U.S., but is referred to as one of the most promising political faces to appear in the region. He was elected to the New Jersey Assembly in 2015, becoming the first Democrat ever to win in the 16th District. “No one expected me to win,” says Assemblyman Zwicker. “My background as a scientist and as a teacher is not the typical career experience for someone who decides to enter into public office. Fortunately, there were people willing to put aside ideology and partisan politics and consider my candidacy, propelling me to victory.” The transition into public office did not come without certain challenges, as science and politics often have very different influences. “Unlike science which is based on facts, evidence does not necessarily drive public policy,” explains Assemblyman Zwicker. “You often begin with a common set of facts, but you must then work through several stakeholders who have different perspectives, then try to come up with a strong piece of legislation.” Despite these differences, Assemblyman Zwicker says his background in science has made him a better legislator and his experience as a legislator has made him a better scientist and educator. “Since we live in a technologically-advanced world, having a background in science has helped me a great deal. Plus, I think anyone who pursues an advanced degree in science must absorb large amounts of information. These skills have been very valuable in forming public policy and holding elected office.”

Driving Innovation and Growth

The Science, Innovation and Technology Committee was formed to keep New Jersey at the forefront of scientific innovation and entrepreneurship and to ensure the next generation of students and entrepreneurs are being created within the state. As Chair of the committee, Assemblyman Zwicker leads conversations on how to accomplish these goals and promote science and technology locally. “Innovation is an economic driver and New Jersey has a rich history of amazing colleges, universities, and K-12 schools that

“AS A STATE, WE ARE LOOKING FOR WAYS TO ENSURE OUR EDUCATIONAL SYSTEM IS AMONG THE BEST IN THE WORLD AND WE CONTINUE TO LOOK FOR OPPORTUNITIES WHEN CREATING PUBLIC POLICY TO PUSH NEW JERSEY’S INNOVATION ECONOMY FORWARD.”



PRINCETON UNIVERSITY

support invention and science exploration."

A key focus of the committee is finding ways to craft public policies that will help small, innovative companies continue to grow, create jobs, and drive the economy. "New Jersey needs initiatives that support world-class science and technology industries and also protect online privacy and data," says Assemblyman Zwicker. "Members of the committee look for ways to improve our society as technology evolves and ensure New Jersey is on the cutting edge of emerging trends; creating valuable opportunities for future generations."

Assemblyman Zwicker has been a participant and presenter at EdgeCon and says the event provides networking opportunities that are essential to building the community and promoting digital transformation. "EdgeCon brings together all those who are working to do the necessary steps to ensure our research universities, community colleges, vocational schools, and K-12 institutions are interconnected. An innovative economy must have supportive infrastructure to ensure an idea coming from a laboratory has a chance to develop. Without the ability to transmit large amounts of information reliably and quickly, you will not be able to be innovative as an educational community or state. EdgeCon inspires collaboration and allows institutions to share best practices, exchange information, and promote innovation and growth."

A Bright Future

With the rise of competition from other regions, organizations across New Jersey are dedicated to reestablishing the state's prominence as a hub of technology and advanced research. "We see science and technology as two of the fastest growing fields both locally and globally," shares Assemblyman Zwicker. "As a state, we are looking for ways to ensure our educational system is among the best in the world and we continue to look for opportunities when creating public policy to push New Jersey's innovation economy forward."

Assemblyman Zwicker says New Jersey is full of exceptional talent and he is highly optimistic about the road ahead. "I've been fortunate to work for one of the greatest universities in the world for a long time. Over the last few years, I've had the opportunity to visit just about every research university in the state, along with many of our higher education institutions. I am completely blown away by the creativity and aptitude of the students, staff, and faculty. What I see coming out of these laboratories and institutions is utterly remarkable and this insight gives me an enormous sense of optimism. We have some of the country's most highly educated and innovative people right here in our state."

The next few years in New Jersey are critical to delivering on the promises of advancing innovation and further developing the necessary skillsets of students entering the workforce. "As a state, we must build a 21st century infrastructure that's ready for a 21st century economy," says Assemblyman Zwicker. "We have all of the pieces we need to succeed. As we continue to put the public policies and infrastructure in place, nothing can stop our state from becoming a prestigious national leader in science and technology."

"INNOVATION IS AN ECONOMIC DRIVER AND NEW JERSEY HAS A RICH HISTORY OF AMAZING COLLEGES, UNIVERSITIES, AND K-12 SCHOOLS THAT SUPPORT INVENTION AND SCIENCE EXPLORATION."



OPTIMIZING RESEARCH COMPUTING AND COLLABORATION

Advancing research and further spurring innovation requires vision, dedication, and a sophisticated infrastructure to support the mission. The Eastern Regional Network (ERN) aims to do just that by propelling research initiatives forward through streamlined multi-campus alliances and partnerships. Through a collaboration of educational institutions, research facilities, regional network providers, a commercial cloud provider, and Internet2, the ERN creates a federated computing resource that is based on high-performance computing (HPC) best practices. Multiple campuses in the community, no matter the size, can access this regional research platform to connect on certain research projects, coordinate efforts, and use resources to further advance their initiatives. The ERN is designed to support a broad array of science drivers and educational opportunities and creates a safe space for the research community to experiment with new technologies without affecting the enterprise infrastructure. By creating testbeds around new and emerging technology and software, the research community can continue to move forward and embrace every opportunity that lies on the horizon.

Science DMZ

The Science Demilitarized Zone (DMZ) is a portion of the network that is built at or near the campus or laboratory's local network perimeter and is designed to optimize configuration and security policies for high-performance scientific applications. This model addresses the common network performance issues often encountered at research institutions due to the high volume of data and the network architecture easily adapts to incorporate high performance and advanced technologies.

As institutions join the ERN, they gain access to an abundance of multi-institutional resources. The network architecture uses dedicated systems for data transfer and helps meet researchers' needs and expectations, including remote location access and a "friction free" network path. Institutions using the ERN have a Data Transfer Node (DTN) located within the Science DMZ infrastructure, which are dedicated, high performing servers used specifically for data transfers at wire speed. The DTN moves large amounts of data to and from the network and allows the ERN to accomplish the program's mission



of connecting an expansive research community. Edge has partnered with Rutgers University and the Rutgers Office of Academic Research Computing (OARC) to deploy a proof of concept for a HPC cluster that allows institutions to share HPC and storage resources. Overall, using an HPC system frees up researchers' own computers and provides a cost-effective method of tapping into valuable resources they may not customarily have access to at their institutions.

Cloud Technology

Cloud technology is changing the landscape of enterprise computing and allows institutions to focus on providing better service instead of running datacenters and managing hardware. The premier cloud providers give institutions a one-stop shop for computing, storage, backups, and networking and unifies their IT personnel and research community on one platform. In addition, cloud providers offer many tools to manage an organization's infrastructure, helping to improve service availability, reliability, and performance. Edge members have access to cloud providers such as AWS, Google Cloud, Azure, multiple content delivery networks (CDN), and social networks and can leverage Edge's connectivity to cloud technology for a fast, scalable, and secure architecture.

Committed to Advancing Scientific Research

The EdgeDiscovery framework brings value to the member community by helping to democratize access to research computing capacity and capabilities. The framework combines an Edge high performance dedicated research network segment with access to optimized technology stack that is readily adapted and responsive to the requirements of the broader research community. The hardware and software components can be adapted to enable researchers to streamline their research projects, schedule compute cycles, and access applications, analytics tools, and storage resources.

This EdgeDiscovery Framework aims to open doors for organizations otherwise unable to invest in next generation research infrastructure. Through a commitment to providing advanced networking and access to research computing resources, the EdgeDiscovery approach will continue to evolve as technology further develops, ensuring researchers have access to the tools and resources necessary to pursue their passion of advancing research in higher education and beyond.


Rowan University
WHERE RESEARCH MEETS REAL LIFE



A growing leader in innovative research, Rowan University is a Carnegie-classified national doctoral research institution that explores groundbreaking and multidisciplinary initiatives. With a focus on applied research that solves real-world problems, Rowan has a long history of partnering student-faculty teams with businesses, government, and non-profit organizations in the region and beyond to conduct a wide range of research projects. “As Rowan University continues to grow, our faculty members are pursuing very prestigious funding opportunities — and receiving these grants,” says Dr. Beena Sukumaran, Vice President for Research and Professor and Chair of the Department of Civil & Environmental Engineering at Rowan University. “We already have two National Science Foundation (NSF) career grants coming to our College of Science & Mathematics this year. The quality of research is also growing, where we’re seeing significant growth in science and mathematics, engineering, and within our medical schools.”

Rowan research teams bring technical expertise and collaborative experience to address regional, national, and global concerns that affect everyone. “When we talk about the role of research, each initiative must have real-life applications. We like to see research have a tangible impact and contribute to our local and state economy,” says Sukumaran.

Meeting Future Demands

Research cyberinfrastructure provides the highly-connected systems necessary to accelerate discovery and keep researchers competitive in their various fields of study. To improve scholarly productivity, an institution must have data storage, a high-performance network, and technical support. “Rowan University regularly evaluates and assesses the posture of our technology infrastructure in order to ensure we are meeting the current needs of students, faculty, staff, researchers, and clinicians,” says Dr. Mira Lalovic-Hand, Senior Vice President of the Division of Information Resources & Technology and CIO, and Professor of the Department of Civil & Environmental Engineering at Rowan University. “Meanwhile, Rowan continues to strategically position the University to respond to the future technology demands of the organization, which are already happening. Determining these demands is not always easy, especially due to research’s unique nature, but my continued goal is to ensure the University’s technology team is equipped with the latest knowledge to manage the college we have today and, more importantly, tomorrow.”

Rowan is nearly finished with a multi-year redesign of the University’s network infrastructure that has provided all campus constituencies with faster internet speeds, improved performance of cloud-based applications, less downtime of services, and an overall safer computing environment. “As we look to the future of the University,

"When we talk about the role of research, each initiative must have real-life applications. We like to see research have a tangible impact and contribute to our local and state economy."

DR. BEENA SUKUMARAN
Vice President for Research,
Rowan University



the role of technology will play an immense role in supporting our growth and we plan to build on the tremendous work we have completed to date to further expand our service offerings," shares Lalovic-Hand. "This expansion may include establishing high-speed connections to a regional research network due to our increasing research demand."

Connecting with the Research Community

Rowan's Division of Information Resources & Technology (IRT) regularly communicates with stakeholders throughout all levels of the University about the state of technology on campus and the changes that are happening. "Those conversations, which span everything from support requests to meetings of senior management, help inform our day-to-day operations, as well as our long-term strategic investments," says Lalovic-Hand. "We coordinate closely with our academic, administrative, research, and clinical partners to identify, implement, and leverage the power of new technology, when and where appropriate, and refine the use of existing technology to meet new demands." One important way Rowan coordinates with the research community is through a research data management working group that discusses departmental initiatives and strategic investments in technology. This group includes representatives from IRT, Division of University Research, and Rowan University Libraries. "In addition to the research data management group, we also communicate with Dr. Lalovic-Hand's division to let them know that certain equipment or IT infrastructure has been requested during the proposal submission phase," explains Sukumaran. "Typically proposals can take six to nine months to get awarded, so we have time to work towards meeting the researcher's needs. We try to engage in futuristic planning and have constant communication between our two divisions to keep informed on ongoing research proposals."

Facilitating Multidisciplinary Collaboration

Technological change is transforming nearly every area of research, helping to spur new opportunities and ideas. "The days of one principal investigator from a single discipline working on a research problem is a thing of the past," says Sukumaran. "Most funding agencies, as well as the research problems we face, require a multidisciplinary and multi-institutional approach. This movement requires a lot more IT interfacing to make this approach work, especially as collaborative work increases. We pride ourselves at Rowan for being very open to multidisciplinary collaboration and we try to facilitate this goal with our internal funding mechanisms and through the infrastructure we have in place."

IRT is a highly centralized operation, which helps the division move faster and make decisions more efficiently, particularly in response to growing research needs. "Rowan has seen an increasing demand for enhanced lab facilities, including bringing in new equipment that needs the ability to communicate over a network," says Lalovic-Hand. "Many funding agencies and journal publications require data to be accessible to other researchers, including the ability to check data validity. Open access is becoming a growing requirement and I think many of us are struggling with this trend; we're trying to determine how we can move toward integrating this practice successfully."

Rowan has worked closely with Edge since the consortium's inception to unite the technology and education community. "Rowan considers Edge to be a key strategic partner in driving technological advancement, especially involving initiatives that enable research in a greater capacity," shares Lalovic-Hand. "Our partnership is embedded in my division's strategy. Edge brings new and fresh ideas to the conversation and has been a leader in forming a community of individuals who support research across all member

$59 MILLION IN ANNUAL SPONSORED RESEARCH AND GRANTS

6 RESEARCH CENTERS AND INSTITUTES

30 SOUTH JERSEY TECHNOLOGY PARK TENANT COMPANIES

institutions. This community facilitates peer relationships that provide insightful feedback, allows us to draw upon each other's experiences, and validates our approaches to research."

Exploring How Research Informs Education

Throughout Rowan's history, the University has been known as a celebrated college of education, but the institution has since evolved to a comprehensive public research university with two medical schools. "We have a very strong commitment to teaching and learning and we continue to explore how research will inform teaching in the classroom in terms of effective techniques to reach our diverse student body," shares Lalovic-Hand. "Last year alone, we supported our undergraduate students with around $2.5 million in research award money for undergrad research. Many of our students are first generation and come from lower socioeconomic backgrounds; we want them to have the opportunity to get involved in research early on."

Undergraduate and graduate students are essential contributors to Rowan's research, often presenting at national conferences, sharing credits in professional publications, and winning regional and national awards for their work. "Our faculty members and their teams are working on cutting-edge research that tries to solve problems impacting our present society," says Sukumaran. "We believe in conducting applied research and would love to take our discoveries to market. Rowan has internal funding mechanisms to help fund a collaborative, learning-centered environment." In particular, the University founded the Camden Health Research Initiative which has created a $50 million fund to expand research opportunities and collaborations with various healthcare entities in Camden. Areas of study include many fields of health sciences, including cancer, biomedical engineering, neuromedicine, and sustaining healthy communities.

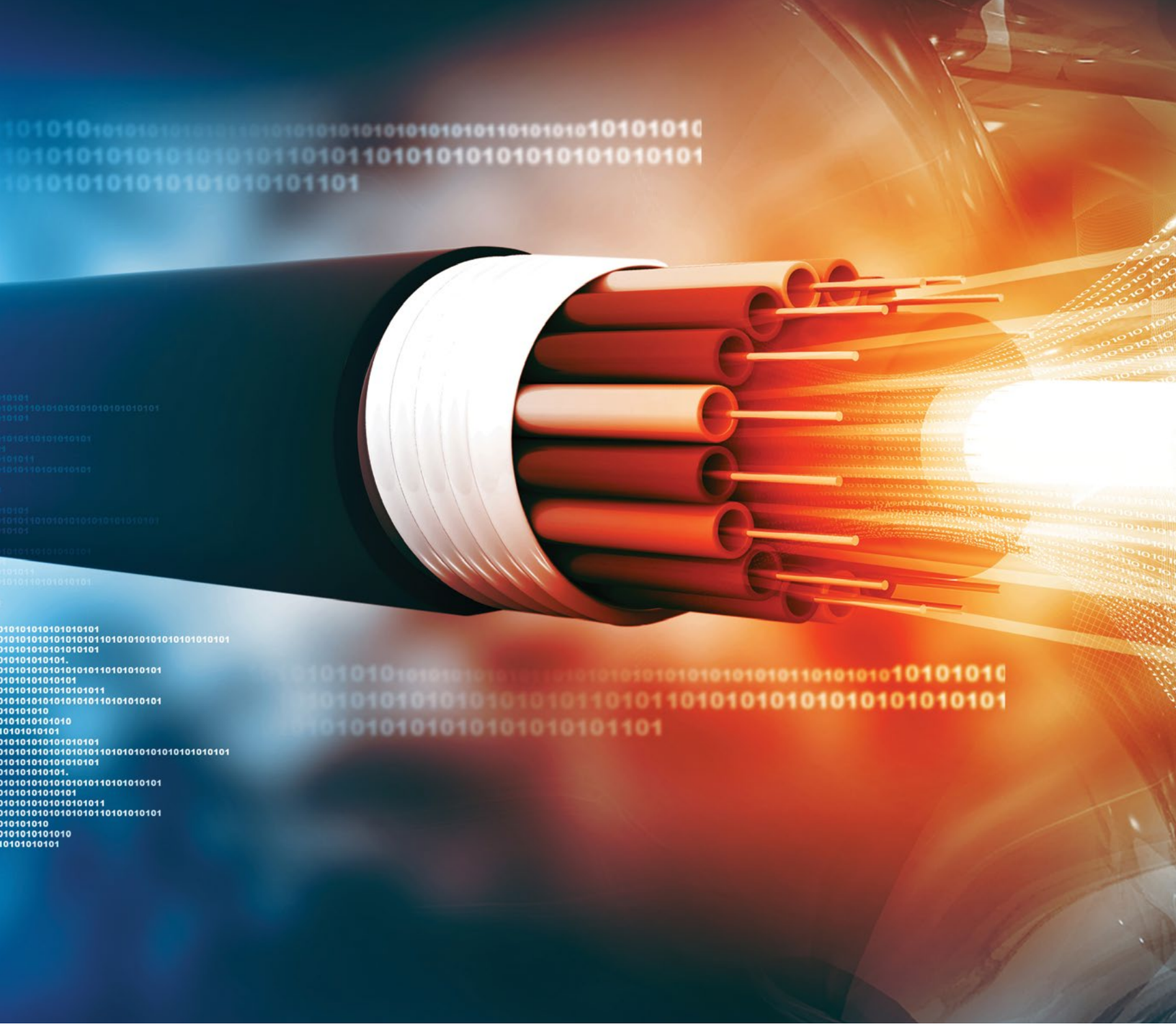
While Rowan is experiencing tremendous growth in research, especially in recent years, the University remains fully focused on the student body, particularly their undergraduate students. "Rowan's undergraduate students remain the core of the University's mission and their success is our top priority," says Lalovic-Hand. "Our research initiatives are not developed to be solely about research; our growing success story is built upon a tight community and promoting the education and well-being of each and every student."

REACH OUT TO EDGE TO LEARN MORE ABOUT RESEARCH CONNECTIVITY AND COLLABORATION VIA NJEDGE.NET.

"Our research initiatives are not developed to be solely about research; our growing success story is built upon a tight community and promoting the education and well-being of each and every student."

DR. MIRA LALOVIC-HAND
Senior Vice President of the Division of Information Resources & Technology and CIO and Professor of the Department of Civil & Environmental Engineering at Rowan University





RUTGERS

HOW A POWERFUL SUPERCOMPUTER IS REVOLUTIONIZING MULTIDISCIPLINARY RESEARCH

Advanced computing, including today's supercomputers and high-performance computing (HPC) platforms, is becoming an essential driver of scientific research and discovery. Institutions with access to such computing power are able to open doors to new opportunities and arm their research community with superior expertise and resources. In 2013, Manish Parashar, the Director of Rutgers Discovery Informatics Institute (RDI2), and distinguished Professor of Computer Science at Rutgers University, along with esteemed researcher, Helen Berman, led the Rutgers-wide strategic planning process to establish a state-of-the-art research computing ecosystem at Rutgers, The State University of New Jersey (Rutgers). Part of this plan included establishing the Office for Advanced Research Computing (OARC), which is dedicated to conceptualizing, deploying, and operating a



"Our team helps researchers successfully transition from working on a desktop computer environment to an HPC system. The OARC research scientists facilitate discussions, help educate on the platforms, and directly work with students and faculty on their workflows."

DR. JAMES BARR VON OEHSEN
Associate Vice President of OARC, Rutgers

world-class advanced research cyberinfrastructure at Rutgers. A historic milestone in achieving this goal was the acquisition of the Caliburn system — one of the most powerful supercomputers in New Jersey.

Driving Science and Innovation

Caliburn has helped Rutgers drive the University's vision for creating an advanced research computing ecosystem that expands beyond the institution's walls and benefits a wider research community. "When Caliburn was acquired, the system was uniquely architected to leverage the state-of-the-art technology, including the interconnect and the memory subsystem, to meet the current and envisioned needs of the targeted research community," says Dr. Forough Ghahramani, Associate Vice President for Research, Innovation, and Sponsored Programs, Edge. "Acquiring a

THE SCIENCE IMPACT: ADDITIONAL RESEARCH CONDUCTED USING CALIBURN

EXAMINING THE STRUCTURE OF PROTEINS THAT CONTRIBUTE TO NEURODEGENERATIVE DISEASES

AB INITIO QM/MM DEVELOPMENT IN THE AMBER MOLECULAR DYNAMICS PROGRAM

COMPUTATIONAL INVESTIGATION OF COKE FORMATION ON PLATINUM ALLOY CATALYSTS

CATALYTIC STRATEGIES OF RNA ENZYMES

HIGH FIDELITY SIMULATIONS OF SHOCK WAVE REFLECTION INSIDE A SHOCK TUBE

LARGE EDDY SIMULATION OF SHOCK WAVE TURBULENT BOUNDARY LAYERS INTERACTION

COMPUTATIONAL STUDY OF MOLECULAR ADSORPTION ON MnO_2 NANOSCAFFOLDS

DIRECT NUMERICAL SIMULATION OF BLOOD FLOW IN PHYSIOLOGICALLY REALISTIC MICROVASCULAR NETWORKS

LARGE SCALE SIMULATIONS OF PROTEINS AND NUCLEIC ACIDS

USING PARALLEL HPC TO DETERMINE RAMSEY-THEORETIC QUANTITIES

supercomputer also positioned Rutgers and New Jersey as a national leader in research computing. Caliburn is a unique asset to the research community, and as one of the most powerful supercomputers with over 23,000 cores, Caliburn has the capacity to perform 800 trillion algebraic operations per second."

To ensure researchers have a smooth transition to the HPC environment, OARC's team of research scientists provide one-on-one training, workshops, and troubleshooting tips. "Along with other computing resources managed by OARC, Caliburn enables student and postdoctoral researchers to conduct modeling, simulation, and the informatics, while receiving support from a team of research scientists," explains Dr. James Barr von Oehsen, Associate Vice President of OARC at Rutgers. "Our team helps researchers successfully transition from working on a desktop computer to an HPC system. The OARC research scientists facilitate discussions, help educate on the platforms, and directly work with students and faculty on their workflows."

The Fight Against COVID-19

During this current tumultuous period caused by the coronavirus pandemic, Rutgers has given priority access to anyone in the research community conducting COVID-19 research who needs high performance computing. "Our systems are currently tied into a national effort," shares Dr. von Oehsen. "The research groups on our campuses are working toward accessing data from hospital patients who have tested positive for COVID-19. Once we have access to the data and store in a protected environment, we will be able to run analysis on the deidentified data within our compute environment." The initiative is driven by the New Jersey Alliance for Clinical and Translational Science (NJ ACTS) that has partnered with several universities to develop information that would be useful to the medical community when treating patients.

Leveraging Advanced Computing for Competitive Advantage

As Big Data and artificial intelligence become more mainstream, advanced computing will continue to have an important role in transforming science and society. In addition, providing access to cutting-edge computing and data capabilities will become increasingly important for academic institutions. "Every area within the University now requires access to research computing," says Dr. von Oehsen. "Researchers go beyond our typical chemists and physicists — we have people from all departments including social sciences and humanities. We're up to 331 different departments and institutes who have reached out to us for help. Everyone is realizing that in order to be competitive with respect to research and grants, they must transition to using advanced computing; there is a move toward data-driven research, artificial intelligence, and deep learning environments."

Acclaimed for the system's balanced architecture and use of innovative technologies, Caliburn has delivered hundreds of millions of computing hours to researchers and the greater New Jersey area. Rutgers hopes to receive state funding to further develop Caliburn, with a greater focus on the deep learning aspect of research. In order to receive future funding, support from the surrounding research community is essential to showcase the value and impact Caliburn provides to the industry. "Having Caliburn available to all of New Jersey allows us to support research across the entire state," says Dr. von Oehsen. "This reach helps us train the future generation of scientists to understand these types of advanced resources. By gaining these essential skills, graduates are gaining a competitive edge as they enter the workforce or go on to graduate school. These computing resources give Rutgers a strong advantage not only in research, but in education; enabling us to secure the grants we need, allowing us to publish papers, and conduct the data mining required by humanities and other disciplines."

Dr. Ghahramani adds that no matter what field researchers are in or which degree students are pursuing, gaining



"Acquiring a supercomputer also positioned Rutgers and New Jersey as a national leader in research computing."

DR. FOROUGH GHAHRAMANI
Associate Vice President for Research, Innovation, and Sponsored Programs, Edge

analytic skills is vitally important. "Helping the research community access advanced computing resources is imperative, along with giving students the opportunity to conduct research and access tools and algorithms at the undergraduate level."

Driving Diverse Areas of Research

Caliburn users have diverse backgrounds, with the system being used to pursue research in a wide variety of fields, including biology, chemistry, engineering, business, and medicine. In one project, a research group from Rutgers–Camden is leveraging Caliburn to execute molecular dynamics simulation at unprecedented scales to study diseases such as epilepsy, addiction, schizophrenia, bipolar, and unipolar depression.

An astrophysicist at Rutgers New Brunswick is using Caliburn to gain a deeper understanding of the physical processes that drive galaxy evolution — one of the primary challenges of 21st century astrophysics. Caliburn allows for a cost-effective and scalable framework to perform the compute-intensive calculations necessary for scientific discovery in the Big Data era of astronomy. Another Caliburn user includes a researcher at the Rutgers Business School who is taking advantage of Caliburn's state-of-the-art technology to advance research on massively parallel optimization methods in machine learning and decision analysis. Access to an innovative machine with a large number of cores per node and fast interconnect is essential to conducting this research and creating customizable, efficient, and reusable implementations of optimization algorithms.

Leading-Edge Computing Capabilities

The research computing ecosystem that includes Caliburn and other OARC infrastructure has fundamentally changed the research computing landscape at Rutgers and for the state, and established models and resources that are on par with leading institutions, both nationally and internationally. OARC is committed to pushing the boundaries of multidisciplinary research and illuminating ways to integrate research, education, and advanced technologies. As a university-wide initiative, OARC enables this computer-aided research and networking by building an environment that fosters collaboration within Rutgers and beyond — building a bridge between research communities.

Caliburn allows OARC to assist research at Rutgers and other universities within the state. "Because OARC is overarching, we work with many different areas," says Dr. von Oehsen. "We are working with the medical school on the design of a protected environment focused on bioinformatics research. OARC also works closely with Rutgers Newark to meet their computing needs; we're also building computing in Rutgers Camden. Caliburn allows us to take care of Rutgers and other universities within the state — providing people with access to a full set of computing systems in support of a diverse set of use cases."

Rutgers continues to create new avenues for providing researchers with essential computing, networking, storage, and data handling capabilities, and students with valuable exposure to innovative learning tools. The University hopes others within the research community will build upon the foundation created by RDI2 and OARC investing in the future of scientific discovery through the support of deep learning and high performance computing. By leveraging state-of-the art-technologies, the impossible becomes possible and knowledge seekers are able to reach exciting new levels of discovery.

To learn more about Caliburn's unique architectural design, we invite you to visit oarc.rutgers.edu.

Interested in tapping into the power of the Caliburn system? You can reach out to OARC by sending an email to help@oarc.rutgers.edu.

CALIBURN
BY THE NUMBERS

704
NODES

23,616
CORES

176
TERABYTES MEMORY

200+
TERABYTES FLASH STORAGE

600
TRILLION FLOATING POINT ALGEBRAIC OPERATIONS PER SECOND

Source: Caliburn: Advanced Cyberinfrastructure Report. Rutgers University. June 2019.

YOU MAY VIEW THE FULL CALIBURN ADVANCED CYBERINFRASTRUCTURE REPORT **HERE ».**



Edge.Discovery

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COMPUTE

CURRICULUM

COMPETENCIES

COMMUNITY

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Dedicated Research Network Segment | High Performance, Resilient, Optical Fiber Network
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For additional information, contact
DR. FOROUGH GHAHRAMANI,
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855.832.EDGE (3343)

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In 2001 a vision was created and funded by the New Jersey Presidents Council of Higher Education that established a high-performance network to support statewide research, education, and economic development.

Flash forward to 2021 as Edge celebrates **20 Years of Collaboration: Vision to Value**. Now more than ever, Edge is committed to remain a national model of excellence in research and education networking, and continually advance the technology agenda in New Jersey and beyond by creating and sustaining a healthy, vibrant, and thriving technology ecosystem and community. With a focus on membership advantage through collective impact and common good, Edge provides technology thought-leadership, infrastructure, and opportunities for professional collaboration and growth.

As a premiere research and education network looking to the future, Edge will continually strive to enhance economic development in the state through regional growth and expansion of a resilient high- performance network, technology products, and professional services that best meet the current and future needs of its members and participants.



JOIN THE CELEBRATION!

Connect with Edge today to order a complimentary copy of the 2020-2021 Viewbook via info@njedge.net.

VDC
VIRTUAL DATA COLLABORATORY

CATALYZING DATA-ENABLED INTERDISCIPLINARY AND COLLABORATIVE RESEARCH



"The overarching goal of the VDC is to transform shared data into a modality for research and discovery. The cyberinfrastructure provides a platform for members of a research community to discover, access and collaboratively work on shared data sets."

— Manish Parashar, Ph.D.





In the research and education community, digital data continues to be a key driver of scientific discovery and innovation. The ability to access, manipulate, and share data is becoming increasingly important and many institutions are looking for ways to form collaborative partnerships and share data to propel initiatives and unlock new opportunities. In addition, educational institutions must properly prepare students to enter the workforce with the data expertise and skills necessary to meet the current and future needs of business organizations. "Many fields are generating a massive amount of data, and this data is often too large to be sent across from different sites," explains Vasant G Honavar, Professor and Edward Frymoyer Chair of Information Sciences and Technology, Professor, Computer Science, Bioinformatics, and Genomics, and Neuroscience Graduate Programs, The Pennsylvania State University. "Analyzing and interpreting the data where this information resides is often the only option, because moving the data around is not feasible. However, many times institutions want to access the data, work on research in a virtual environment, and use the infrastructure as a medium for facilitating this distributed collaboration."

"We conceptualized the Virtual Data Collaboratory (VDC) to address the growing importance of data across all fields of science and engineering, and critical needs to support collaborative data-driven research" said Manish Parashar, the lead and original Principal Investigator for the VDC project.

Development of the VDC was supported by a $4 million National Science Foundation (NSF) grant and is a collaboration among Rutgers, The State University of New Jersey, Penn State, and Temple University. The VDC is envisioned as a federated and coordinated cyberinfranstructure across the Rutgers University campuses in New Jersey and multiple campuses in Pennsylvania and New York by a high-speed network, with the potential to incorporate academic and research institutions across the nation. "The grant allowed us to build an infrastructure where research data created at Rutgers and other collaborating universities could be stored, discovered, and reused," says Grace Agnew, Associate University Librarian for Digital Library Systems, Rutgers University. "A large-scale research data infrastructure is critical for Rutgers to continue to advance as a research institution." The VDC project is in partnership with Edge, the New Jersey statewide research and education network, and KINBER, Keystone Initiative for Network Based Education and Research (KINBER). The advanced peering connection between KINBER's PennREN network and the Edge network allows for greater capacity, speed, and enhanced research capabilities between institutions across Pennsylvania, New Jersey, and beyond.

FAIR
GUIDING PRINCIPLES

FINDABLE
Metadata and data should be easy to find for both humans and computers. Machine-readable metadata are essential for automatic discovery of datasets and services.

ACCESSIBLE
Once the user finds the required data, she/he needs to know how the data is accessed, possibly including authentication and authorization.

INTEROPERABLE
The data usually need to be integrated with other data. In addition, the data needs to interoperate with applications or workflows for analysis, storage, and processing.

REUSABLE
Metadata and data should be well-described so that they can be replicated and/or combined in different settings.

SOURCE: https://www.go-fair.org/fair-principles/



Seamless Data Accessibility
Data sharing is a central component of the scientific process and helping to further expand the field of data science and effectively training future generations. "In the past, a group of scientists gathered around a microscope or a telescope to share insights, enabling great discovery to be made," says Manish Parashar, Ph.D., Director of the Rutgers Discovery Informatics Institute (RDI^2) and Distinguished Professor of Computer Science, Rutgers University. "Now, researchers analyze shared data collectively to make new discoveries. The goal of the VDC was to create a means for members of a research community to similarly access and work on shared data sets collaboratively to drive research and data-driven discoveries." The VDC is a data cyberinfrastructure designed to enable data-intensive, interdisciplinary, and collaborative research and inspire data-driven science and engineering discoveries. The goal of the VDC is to provide seamless access to data and tools that can help educators, students, researchers, and industry leaders foster learning communities and bring Big Data skills into the classroom. In addition, the VDC helps data scientists and engineers develop and apply advanced federated data management and analysis tools for high impact scientific applications. "Research groups have become more interdisciplinary and this trend is a key element for establishing the VDC," says Ivan Rodero, Ph.D., Associate Research Professor, RDI^2, Rutgers University. "While there are currently many data depositories, without access to shared information, we would never know what other discoveries could be revealed. Conducting research individually can be very challenging. By providing access to data, tools, and resources, we can help researchers create new science models and discoveries."

Federated Data Management
To further enhance the research ecosystem and assist both humans and machines in scientific discovery, a set of standards was developed called the FAIR Guiding Principles. Created in the academic community, these standards have since been embraced by scientific



funding agencies and are meant to improve the findability, accessibility, interoperability, and reusability of digital assets. Rutgers University played an important role in conceptualizing and constructing the VDC and creating access to FAIR data. "At Rutgers, we recognize the challenges and importance of sharing FAIR data," explains Parashar. "In a conversation with Dr. Honavar and his team, they were thinking about similar issues and we found research cases where sharing data would make sense. For example, Dr. Honavar was working on a proteomics use case with a dataset at Rutgers that they needed to share. Similarly, there was a use case around smart cities with CUNY. Driven by these science needs and a shared vision, we realized we needed to at least double such an environment like the VDC to support the science and research people wanted to do. This shared vision and need led to the proposal that we submitted to the NSF."

Data sharing allows researchers to review, confirm, or challenge each other's findings, as well as test alternative theories and explore new avenues of reasoning — all with the purpose of driving scientific discovery. "Moving data around is not really feasible," explains Parashar. "One option is to keep the data where the information originated and connect the data in a federated environment, which was the motivation for architecting the VDC the way we did. While making data discoverable, we must determine how institutions maintain the ownership of data."

Enabling optimal use of research data and methods also requires a level of harmonization in terms of multiple interfaces and management mechanisms. "One of the challenges is that data cannot leave certain sites, either due to ownership constraints, the data set is too large, or the bandwidth is simply not enough to move the data around at a necessary rate," adds Honavar. "If an institution has a large depository, they likely do not want the resource replicated in numerous places. Plus, data analysis often takes place at multiple sites. The VDC strives to address these challenges and help researchers in many different scientific fields find relevant data and the tools needed for successful analysis."

Ensuring Data Discoverability

Rutgers University Libraries are a key part of the VDC team and worked with the lead department, RDI², to implement the data services layer according to their design. The Libraries engage with and support Rutgers users across the spectrum, from incoming first-year students to faculty members engaged in groundbreaking research," says Agnew, "We understand and represent user needs. We were tasked with designing the data services layer which is the user-facing part of the project. Our design encompassed adding, discovering, and reusing data. We took a unique approach to ensuring the discoverability and reuse of data by designing an interface that links data with the person who created the information, the tools used to analyze the data, and the intermediate research products that are created around the data before the peer-reviewed publications begin. We designed a



strategy that not only supports the workflow of the researcher, but helps other researchers, perhaps in other disciplines, understand the context of the data and how the information is used as part of the discovery process."

Education and Outreach

An important focus of the VDC is to help train the next generation of scientists and instill the skills and knowledge necessary for them to leverage data and cyberinfrastructure to address important research problems. Educational programs are delivered across multiple disciplines and academic levels and are available through universities like Temple University, Rutgers, Penn State, Drexel, and CUNY, as well as through high school workshops and post-graduate seminars. "The bulk of our effort has been devoted to building up the VDC infrastructure and demonstrating the use cases," explains Honavar. "The broader use of this infrastructure is leveraging the VDC platform to deliver educational programs focused on an interdisciplinary aspect of research, connectivity to external repositories, and collaboration."

The VDC extends beyond the platform's collaborating institutions and leverages NSF investments to provide cyberinfrastructure typically not available to community colleges, state-associated colleges and universities, and regional liberal arts colleges and universities. "As part of the NSF-funded VDC project, the RDI^2 is developing educational modules to help researchers solve their data issues and increase the impact of their research. Through a variety of programs including high school workshops, undergraduate learning modules, and online seminars, educators can help foster the next generation of data science researchers and professionals. Internships are also available to provide an opportunity for students to work with VDC mentors to develop their skills. Students are able to gain hands-on experience in their prospective field, enhance their career potential, collaborate in globally-influential projects, and learn more about Big Data and artificial intelligence (AI)." Forough Ghahramani, Education and Outreach Co-Lead for the VDC project. According to Ghahramani, "The educational material is shared on the VDC website, datacollaboratory.org, so that it can be used in courses and programs across NJ, PA, and beyond. A goal is to foster increased use of the VDC while building sustainable data science peer-learning communities."

Network Connectivity

The VDC is available to other universities through the Internet2 high speed networking facilities, KINBER in Pennsylvania and Edge in New Jersey. "The VDC is also designed to bridge to existing collaboratories, such as the Protein Data Bank," shares Agnew. "So much of the data in the VDC will be 'virtual' because the information exists in other collaboratories but is accessible via the VDC."

Central to the VDC vision is the regional data science DMZ network that provides services to enable efficient and transparent access to data and computing capabilities, as well as a flexible and scalable architecture for data-centric infrastructure federation. "A critical element of enabling a virtual data collaboratory is providing the network bandwidth and connectivity to allow the seamless access and sharing of data," says Parashar. "Edge allows us to achieve this goal through their regional high performance optical network. The organization is a very important partner because they provide the fundamental infrastructure that we can further build upon."

Honavar says institutions like Penn State and Rutgers have significant infrastructure, and there are smaller colleges and universities that are interested in taking advantage of these large datasets and analysis expertise that they may not have access to. "Providing the connectivity and access to resources like the VDC can help broaden the reach of every institution's research efforts."

Creating Synergy

Going forward, a main focus of the VDC will largely be on further developing educational programs that leverage the VDC platform. "When we first developed the concept, we asked ourselves, can this idea help research and enhance education, connectivity, and outreach activities?" says Parashar. "Our experience has shown that the VDC is accomplishing these goals. Now, we want to build upon these conceptual ideas and put together a more coherent deployment of the VDC



that can enable the science that we envisioned. We look to build use cases that can start using this platform. The next step after that is to look to the VDC as a model for building something that could be used at a larger scale. We want to investigate similar deployments in other places and build upon a complementary infrastructure that exists like the Pacific Research Platform (PRP) to create a more national or international infrastructure."

Honavar says the VDC was a proof of concept exercise that showed this idea could be successfully achieved. "The lessons learned will inform anything we do going forward. When you think about collaborative discoveries, the process would involve not just sharing of data, but sharing tools and expertise and integrating people as part of the ecosystem. You can imagine scientists at different locations contributing different tools that would weave together into a collaborative workflow that operates across data at multiple locations. By scaling up these kinds of efforts, this vision would be feasible." Public funding, like the grant provided by the NSF, will also be critical for accomplishing the goals set forth by the VDC. "We are working to find synergy with the industry and using resources in the Cloud to help support our mission," says Rodero.

As the VDC evolves, Parashar says further building the community is vital to gaining insight into the tools that are needed to conduct the research projects of today and the future. "We cannot possibly provide every tool that every discipline may need, so a model of co-creation for the next generation of the infrastructure will be essential. For example, a community of biologists that uses a particular kind of data may get involved in the creation of the next generation of tools in collaboration with people who have computer science or infrastructure expertise." As a state-of-the-art data-intensive computing, storage, and networking solution, the VDC will continue to integrate existing data depositories and help to blaze new trails that support interdisciplinary research, expand access, and increase the impact of data-science worldwide.

"You can imagine scientists at different locations contributing different tools that would weave together into a collaborative workflow that operates across data at multiple locations."

— Vasant G Honavar, Ph.D.

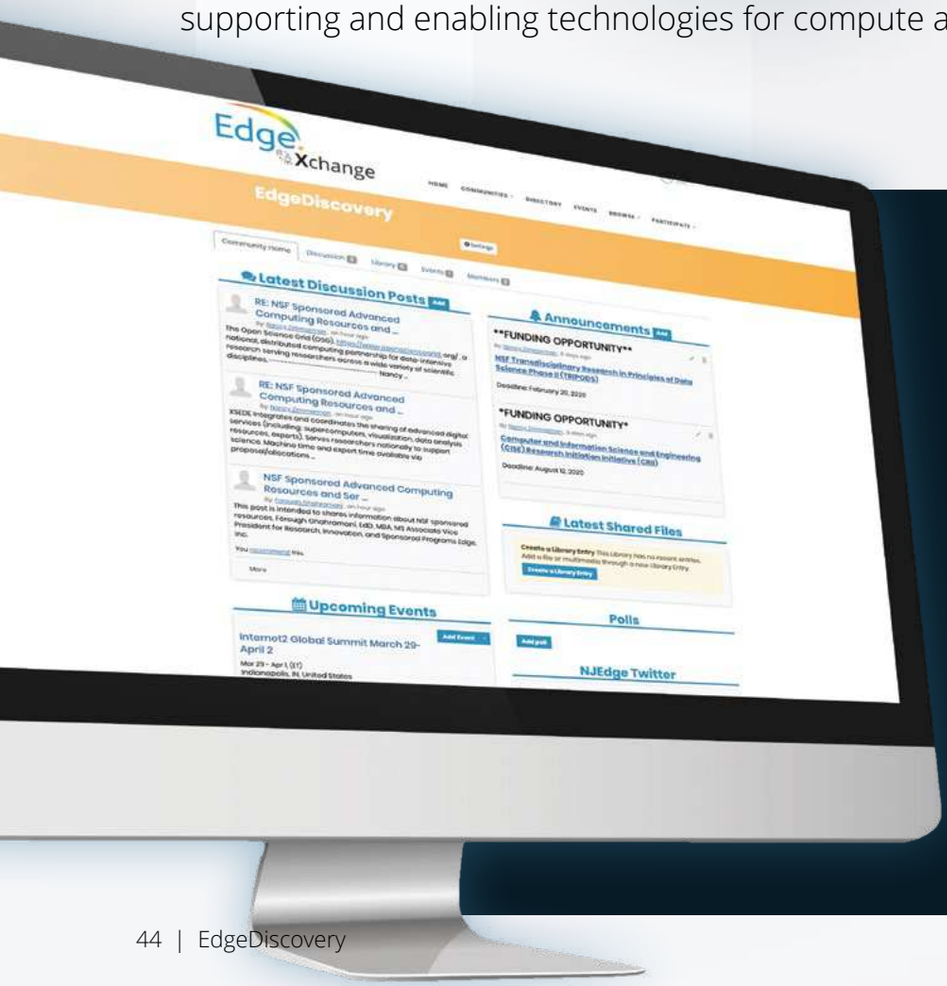
To learn more about gaining access to a high-performance optical fiber network, research networking, and Cloud connectivity capabilities, **visit NJEdge.net.**

CULTIVATING RESEARCH COMPUTING COMMUNITY ENGAGEMENT WITH

Edge Xchange

This past spring, Edge launched EdgeXchange, a state-of-the-art online member community where members can engage with one another, deepen relationships, discover insight on improvements, and explore the latest product and service offerings. This community focuses on connecting members and giving them a more dynamic way to engage one another and take advantage of their most valuable resource: each other.

The EdgeXchange Research Computing Community brings together researchers and research computing experts to help navigate the complicated, diverse, and rapidly changing research computing landscape. The community of professionals work together to advocate for, and help make sense of the available resources and service offerings across the research IT ecosystem for compute and data intensive research and education. In addition to identifying research collaboration opportunities, and opportunities for sharing best practices with the broader network of experts, EdgeXchange Research Computing Community provides professional development opportunities for the professionals associated with supporting and enabling technologies for compute and data intensive research.



Building a Network of Peers

Edge believes all members, no matter their role in an organization, deserve a supportive environment that helps provide valuable networking opportunities, fosters the sharing of great ideas, and focuses on the gratification that comes from exchange of knowledge. Edge members have been pleased with the ease of use and peer collaboration opportunities EdgeXchange has provided. The most recent EdgeXchange community is the Research Computing Community. Chief Information Officers in the NJ-CIO Forum Community, the Librarians within the VALE community, Chief Information Security Officers in the Security Community of Practice, and Education Technologists in the Ed Tech Community of Practice are among some of the members who have enjoyed sharing knowledge, experience, and ideas with a network of peers through EdgeXchange.

ABOUT EDGEXCHANGE

Connecting on Key Issues

Ambassadors and discussion moderators keep the content and discussions engaging and members are encouraged to contribute their own thoughts and guidance on the topic introduced to the community. The situations and deep discussions are relevant to members across the industry and members can look to one another for insight and advice on real issues they are trying to solve. Typically, individuals have to sift through a vast amount of discussions and information in search of the answers or user reviews they need; now with EdgeXchange, the answers and information are in one, concise location and are provided by trusted peers.

EdgeXchange allows members to browse dynamic discussion groups and join a conversation with like- minded people who are enthusiastic about what they do. All interactions are in real time, so when one person posts a question or asks for a recommendation, other members are ready to share a vetted solution or offer resources and tools they found useful. Additionally, members can explore the extensive research library to find content and media on industry best practices, sample documents, spreadsheets, pictures, and videos.

Extending the Community

EdgeXchange will continue to expand the reach of this virtual community to more Communities of Practice and create an interwoven web of relationships between Edge members worldwide. Edge anticipates rolling out virtual Communities of Practice for Women Leaders in Technology, Chief Information Officers, Procurement Managers, and Edge's Board of Directors. EdgeXchange helps members form real relationships and when they connect at industry events, the camaraderie and conversation can continue in person. A network of passionate people is a powerful resource and EdgeXchange is dedicated to providing members with the partnerships and knowledge they need to be successful.

If you would like to be invited to join an EdgeXchange Community of Practice, please email Nancy Zimmerman, Executive Director for EdgeEvents and Print Communication at nancy.zimmerman@njedge.net.



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