OFFICE OF RESEARCH AND ECONOMIC DEVELOPMENT
2017 STRATEGIC PLAN
Core Computing/High Performance Computing (CC-HPC)

Continuing advances in computing and analytics greatly affect almost every aspect of human endeavors. The impact will grow in the coming decades permeating all aspects of human life. Research in exascale computing, data analytics, cognitive science, and cybersecurity are among major priority research areas of multiple federal agencies. In addition, data analytics plays a key role in interdisciplinary biomedical research, personalized medicine, cognitive computing, and all major resources such as food, energy, and water. Recognized research strength at LSU is the faculty expertise in areas such as high-performance computing systems research (systems research in compilers, runtime systems and libraries), computational mathematics, coastal modeling, computational materials science, cultural computing, video game design, etc. Recent and planned investments in cybersecurity, big data, and computational biology and bioinformatics have raised LSU's strengths in several new areas. For LSU to remain competitive and at the forefront of high-performance computing (and all aspects of computational science and engineering), cybersecurity and big data research, it is imperative that LSU invests in cutting-edge cyber-infrastructure and advanced data analytics. These investments will also help LSU fulfill its role as the main flagship university in Louisiana that can attract the best and brightest undergraduate and graduate students in computationally intensive majors and research thematic areas providing substantial benefits for economic and workforce development efforts.

The primary engine for LSU's computational efforts is the LSU Center for Computation and Technology (CCT) that serves as the "heart" of the computational needs of not only LSU A&M, but also fulfills the major computational infrastructure and data analytics needs of all other LSU campuses.

At the ORED Retreat, held October 27, 2016, faculty identified three areas as critical to enhancing the future computing and HPC research goals of LSU. A follow-up ORED Town Hall meeting occurred on December 2, 2016 for faculty to discuss these topics:

Cognitive Computing. The primary goal is to develop advances in data science and engineering through an interdisciplinary approach bringing together a team of faculty and researchers in mathematics, computer science, and statistics. Formation of an interdisciplinary, focused program in data analytics spearhead by CCT and supported by multiple Colleges and Departments will enhance efforts in multiple fields including: health data analytics and bioinformatics, science and engineering, community resilience from disasters, materials discovery, and manufacturing. Advanced data analytics (or "big data") poses additional challenges, such as: (1) Demands of data mining and machine learning; (2) Integrating data from large and heterogeneous data sets; (3) Distributed data over centralized computing clusters; and (4) New forms of data representations such as in-memory graphs. To support this effort, there is a need to hire a cluster of faculty with expertise in data analytics and invest in cyber-infrastructure specifically targeting data storage and retrieval systems, new HPC systems, etc.

Exascale Systems. The fast pace of development in high-end computing systems bring significant advances in science and engineering. At the same time, this has placed an enormous burden on software development for computational and data science. Specific areas of interest include: (i) Computer graphics and visualization, (ii) Computational and applied mathematics; (iii) Exascale computing research: Architecture, compilers, runtime systems, libraries, Networking, and storage research. What should drive new hiring is building collaboration with CCT in these

areas in that complements existing strengths in compilers, runtime systems, and numerical software; LSU successes include HPX, ATLAS, TCE, Pluto, Einstein Toolkit, etc.

Cybersecurity. Cyber-attacks, especially advanced targeted attacks, pose significant threat to today's civil and industrial enterprises. Launched by organized attackers for financial gain and intelligence collection, these attacks tend to be stealthy, low-and-slow, and sometimes disguised via psychosocial campaigns. An interdisciplinary research faculty cluster and overall research will focus on the forensics of cyber-attacks against enterprise environments. It will address broad themes such as: (1) understanding the intent, strategy, and detailed steps and targets of attacks; (2) collecting various types of evidence for possible legal proceedings; and (3) revealing hidden impacts of an attack to minimize loss and to prevent similar attacks. Additional areas of translational interest include: 1) protection of industrial computers and networks, as well as critical equipment that utilized for environmental measurements throughout the coastal zone. Beyond the requirements for accurate measurement and the need to operate in harsh environments, this measurement infrastructure is also highly vulnerable to attack, as components communicate through a variety of wired and wireless networks and are plagued by poor industrial security practices, such as the use of hard-coded passwords and unencrypted communication. Efforts in strengthening the cybersecurity posture of the coastal measurement infrastructure by conducting a detailed security assessment study, cataloging deficiencies, modeling the potential effects of cyber-attacks, and finally, developing a custom solution called "digital levees" to harden the coastal measurement infrastructure. Without proper cybersecurity measures, these instruments are potentially vulnerable to stealthy cyber-attacks that could seriously undermine important decision-making.

Cyber-infrastructure needs. Currently LSU and CCT support a number of **supercomputers**: SuperMike-2 (CCT/ORED/HPC@ITS), SuperMIC (NSF + CCT/ORED), QueenBee-2 (BoR – operated by LSU), Delta-IBM machine (CCT/ORED/LBRN); in addition, we operate **high-speed network and storage,** such as the 100 Gbps LONI network (BoR). Continued investments must support and sustain LSU's research strengths and to replace HPC equipment every 5-7 years.