



## NATIONAL PHOTONICS INITIATIVE

# PHOTONICS: LIGHTING OUR FUTURE WITH INNOVATIVE APPLICATIONS



## DEFENSE & NATIONAL SECURITY

Optics and photonics greatly enhance the United States' ability to gather intelligence, defend its citizens and protect its troops in the field. Optical sensing technology makes surveillance and reconnaissance possible, and it identifies chemical, biological and nuclear threats to the homeland. Photonics makes laser-guided weapons more accurate, provides lasers for critical missile defense capabilities and permits personalized use of flexible display technology, which allows our men and women in uniform to remain informed and safe during operations with night vision, GPS and physiological feedback. Coordinated investment and associated technology development in remote sensing, photonic integrated circuit manufacturing, high-power lasers and cybersecurity will ensure military and economic security.



## COMMUNICATIONS & INFORMATION TECHNOLOGY

The next time you send an e-mail, Skype with your family or post on Twitter, remember that without photonics, the Internet as we know it would not exist. Optics and photonics increased the capacity of the Internet by nearly 10,000-fold over the past two decades. Bandwidth demand is expected to grow another 100-fold, and possibly more, over the next 10 to 20 years. Without improvements to address the cost, power consumption, data rate and size, demand will outstrip capacity, which may lead to higher costs and possibly even constrain the greater US and global economy. Those countries that invest in solving these challenges will gain a sizeable national security advantage by advancing the infrastructure that enables our Internet-based economy.



## HEALTH CARE & MEDICINE

From laser eye surgery to CT scans, photonics is responsible for medical advances that save and dramatically improve millions of US lives. Photonics plays a key role in next-generation health care, both in enhancing the ability to observe and measure symptoms and the capability to treat patients earlier with less invasive, more cost-effective methods. Photonics-based health care tools offer sensitivity, precision, speed and accuracy, which enable rapid diagnosis and effective therapy — key ingredients for high-quality, cost-effective care. Further investment in biophotonics will result in smaller, more portable, automated, point-of-care diagnostic devices that have the potential to improve outcomes and the ability to reach patients who lack access to health care.



## ENERGY

Photonics increases the efficiency and safety of US energy production and consumption. The renewable energy sector is an area of potentially significant job growth and a space in which photonics research can help lower US energy consumption and reduce our reliance on foreign oil, thus strengthening national security and revitalizing the US economy. The oil and gas industry increasingly uses optical systems to monitor wells, thereby increasing production and mitigating risks. Additionally, solid-state lighting, such as LEDs, developed through photonics research, could cut US lighting electricity usage by about 45 percent by 2030, with forecasted energy savings of \$30 billion dollars at today's energy costs and a reduction of greenhouse gas emissions equivalent to 40 million cars. Global demand for new energy sources represents a significant growth opportunity for US manufacturers and producers. US companies will need continued research and development investments and structural support to lead the world into a clean, secure, efficient energy future.



## ADVANCED MANUFACTURING

Advanced manufacturing is vital for the economic well-being of the country; it is a sector in which substantial job growth is possible. Though the majority of display and photonics component manufacturing has moved overseas, the United States can be a leader in new and innovative areas of manufacturing involving a new generation of high-power and low-cost ultrashort pulsed lasers, as well as 3D printing. 3D printing allows machines to make a range of customized products directly from electronically transmitted designs, saving costly material in the process. These advanced printers can create objects ranging from prosthetic limbs and functional human tissue to jet engine parts and shoes. While the United States may struggle to compete successfully in high-volume, labor-intensive, low-cost manufacturing, our nation can be a strong competitor in custom, precision and high added-value manufacturing.



## EDUCATION & WORKFORCE DEVELOPMENT

Hands-on problem solving has made the US globally dominant in technology commercialization throughout our history. By invigorating technical education through hands-on learning, the US will foster an education pipeline that will better prepare the optics and photonics workforce and improve the translation of research results into innovative commercial applications for the benefit of the nation's economy, security, health and competitiveness. The current demand for hands-on learning at the community college and undergraduate levels will increase dramatically with the application of optics and photonics technologies in next generation products and services across economic sectors. Investment in programs that provide hands-on experiences for students pursuing post-secondary degrees and certificates will invigorate technical education in the US.



## QUANTUM SCIENCE & TECHNOLOGY

A global quantum revolution is currently underway. Quantum science and technology (QST) will open new scientific, technological and economic avenues. It will improve security and privacy in digital communications systems that connect our world; enhance navigation in demanding environments; advance sensors for geological resource exploration; and, drive superior computational capabilities for complex simulations and modeling of new pharmaceutical drugs and solar-energy-harvesting materials. Research and development (R&D) in optical science continues to develop new enabling technologies for a wide range of basic studies and applications in quantum science. Many quantum innovations rely on photonics-enabled technologies. Support for such enabling technologies has a two-way benefit: commercial products will drive the development of quantum technologies, and the developing quantum arena will provide market space for these products.