NATIONAL PHOTONICS INITIATIVE

PHOTONICS: ENABLING AMERICAN INNOVATION, COMPETITION AND SECURITY

Recommendations by the National Photonics Initiative (NPI)

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EXECUTIVE SUMMARY

Look around you – your phone, computer, TV – all are modern-day technologies made possible largely by photonics.

Optics and photonics – the science and application of light – enable many of today's technology advancements and is critical to next generation innovations across US economic sectors. Applications are far ranging from photonics-enabled technologies used to advance robotics, manufacturing, medical imaging, next-generation displays, defense applications, biometric security, discover gravitational waves and much more. Simply put, much of our modern-day world is enabled by optics and photonics.

The National Photonics Initiative (NPI) is a non-partisan alliance among US industry, academia and government founded to raise awareness of optics and photonics and its impact on our everyday lives. Since its establishment in May 2013, the NPI has worked closely with the administration and Congress to promote public-private partnerships that will spur commercialization of cutting-edge photonics research. The NPI has worked successfully with members of Congress across the aisle and with the congressional committees that have jurisdiction over defense and national security; health and medicine; science and technology innovation; and education and the workforce. Through NPI, the optics and photonics community has engaged a range of federal agencies, including the US Department of Defense (DOD), US Department of Energy (DOE), US Department of Commerce, National Institutes of Health (NIH) and the US Food and Drug Administration (FDA).

In just over three years, the NPI has successfully demonstrated the value of optics and photonics technologies across economic sectors and contributed to national initiatives in health and medicine, defense and advanced manufacturing, and information technology, including the following:

- **Bridging the private and public sector gap to map ambitious US neuroscience technology goals.** The NPI created a multidisciplinary industry consortium and brought together leaders in industry, academia and government to develop a public-private optics and photonics technology road map in support of the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative;

- **Identifying the opportunity and advocating strongly for US advanced manufacturing in photonics.** The NPI helped to frame and establish a new DOD-led Integrated Photonics Institute for Manufacturing Innovation – now named "AIM Photonics" – awarded to a New York-based consortium;

- **Defining key technologies for the future of high performance computing (HPC).** The NPI identified critical optics and photonics benefits in next generation HPC architectures for the administration; and

- **Leading private sector experts to press for technology solutions that combat the most aggressive cancers and leveraging US private and public investments to benefit the greatest number of patients.** The NPI created a task force of leading patient advocacy groups, industry associations, hospitals, universities and thought leaders to develop a white paper and cancer technology road map to accelerate progress in cancer diagnosis and achieve the goals of the Cancer Moonshot.

The work is not yet done and the NPI is committed to working with the next administration and the 115th Congress to achieve breakthroughs in research commercialization and technology transfer to improve our nation's competitiveness. Although historically there had been a fair amount of photonics research and development (R&D) performed in the US, the current US share of the global photonics industry is only 17 percent – behind Japan and with increasing competition from Europe, South Korea, Taiwan and China. Concerted efforts around the following recommendations will dramatically improve the translation of federal research results into innovative commercial applications for the benefit of the nation's economy, security, health and competitiveness. To achieve national economic and security objectives in optics and photonics, the NPI makes the following recommendations to the federal government:

- **Establish pathways for the US photonics industry and federal government to collaborate on future technology goals.** Provide opportunities for the federal government to leverage state-of-the-industry advancements by working with industry groups on high-value technology road maps to achieve next generation technology goals.

- **Work with the US private sector to accelerate photonics research, technology development and commercialization.** Explore opportunities to accelerate technology development and ensure a well-trained workforce through internships and other collaborative work arrangements.

- **Work with states and the federal government to increase US technical training in optics and photonics to fill workforce demands.** Explore opportunities to ensure essential optics and photonics hands-on learning and create a robust education-to-workforce pipeline.

- **Inventory photonics-related R&D and solicit joint industry projects.** Provide opportunities for the private sector and federal government to work more collaboratively by surveying photonics projects underway within federal agencies and making these projects public.

- **Enable photonics-developed applications across federal agency missions and programs.** Ensure optics and photonics research and technologies can be applied toward multiple purposes by having federal agencies share information on their respective programs.

This white paper highlights where joint strategic efforts in key photonics-enabled industries will continue to grow our nation's economy and generate high-paying jobs in American communities. The following provides NPI priorities for 2017 and an overview of five core, global industries that rely on technological advances in photonics and an appropriately experienced workforce: health care and medicine, advanced manufacturing, communications and IT, energy, and defense and national security. Additionally, this white paper highlights the need for US investment in quantum science and technology as an area of enormous opportunity especially in next generation fields of computation and simulation, advanced sensors and communications - each enabled by optical sciences and technologies, and impacting all sectors of the US economy. With reach to top experts in both academia and industry, and across all fields from defense to medicine, the NPI will continue to serve as a trusted resource to the federal government as it explores the optimal paths forward.

NPI PRIORITIES FOR 2017

Education and Workforce Development

The NPI has generated a host of recommendations across many economic and scientific sectors, but a sound educational pipeline is critical for the long-term success of all these initiatives. For example, hands-on problem solving has made the US globally dominant in technology commercialization throughout our history. The NPI supports initiatives aimed at invigorating technical education through hands-on learning opportunities for students. This will help fill a present gap in hands-on learning and 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.

While maintaining US technological leadership can be accomplished in the near-term through targeted public and private investment in infrastructure and research, the greatest challenge is our nation's ability to sustain a well-trained workforce into future generations. The current demand for hands-on learning at the community college and undergraduate levels to meet industry needs will increase dramatically with the application of optics and photonics technologies in next generation products and services across economic sectors. The NPI sees a tremendous opportunity to invigorate technical education in the US by investing in programs that provide hands-on experiences for students pursuing post-secondary degrees and certificates.

Health Care and Medicine

Today, photonics permeates numerous aspects of health care and medicine. In the clinical laboratory, blood is routinely analyzed with laser-based instruments to assess immune cells and metabolites, and biopsy tissues are inspected with optically active reagents to detect molecular markers of disease. In the diagnostic imaging clinic, positron emission tomography (PET) provides whole body mapping of cancer sites and provides brain images to determine the presence of amyloid plaques as early signs of Alzheimer's disease. Photonics technologies are also essential to practice modern surgery and for the advances in gene sequencing. Consider the pulse oximeter used to provide continuous monitoring during anesthesia; the lasers used in corrective eye vision surgeries; and, the optical endoscopes and robotics used in minimally invasive surgeries that speed recovery and reduce risk of infection. Simply put, it is hard to imagine modern health care and medicine without photonics.

The emerging field of "biophotonics" represents a $34 billion global market that is expected to reach $91 billion by 2024. Biophotonics combines photonics principles, engineering and technology relevant for solving critical problems in the fields of medicine, biology and biotechnology. Unique in their unprecedented sensitivity and accuracy for rapid, "point-of-care" diagnostics and therapeutics, biophotonics-enabled health care and advanced medicine tools allow for efficient deployment with reduced time between diagnosis and more precise treatments. Because of the need for enhanced technologies for efficient health care delivery and medical advances, the NPI has focused its policy efforts on two critical areas of national importance – brain imaging and early detection of the most aggressive cancers.

On September 30, 2014, the NPI launched the Photonics Industry Neuroscience Group alongside officials from the White House Office of Science and Technology Policy (OSTP). The multidisciplinary consortium – comprised of top US industry leaders in optics and photonics, including Accumetra, LLC; Agilent; Applied Scientific Instrumentation; Coherent; Hamamatsu; Inscopix, Inc.; Spectra-Physics; and THORLABS – is working to advance biophotonics technologies to help revolutionize our

understanding of the human brain, and committed upwards of $30 million in existing and future R&D spending over the next three years to advance optics and photonics technology in support of the goals of the BRAIN Initiative. Basic neuroscience research is needed to inform us of solutions to some of our most pressing health care needs, including dementia, mental illness, autism, and neurodegenerative/neuroinflammatory diseases such as Parkinson's and Alzheimer's diseases that significantly impact our aging population. The NPI hosted numerous collaborative and successful meetings and published a technology road map and recommendations for private and public investment.

Separately, the NPI mobilized thought leaders from industry, academia and patient organizations to publish a white paper and technology road map on June 29, 2016 that identifies the most promising existing and new technologies for increased and concerted private and public investment to achieve the goals of the National Cancer Moonshot: accelerate the early detection of cancer and save lives. The white paper details a commitment made by the scientific community, leading medical technology industry, over 350 hospitals and major patient advocacy groups across the nation to leverage the more than $3 billion annual private investments in cancer research toward early detection technologies of the most aggressive cancers. The white paper recommends the expansion of support for clinical studies employing existing noninvasive, and minimally invasive, imaging technologies and companion molecular tests for early detection of cancer; coordinated public and private investments to expand funding for the development of new noninvasive quantitative imaging approaches for early detection and guided treatment of cancer where these technologies are needed; and, resources to develop a network for an information technology (IT) medical infrastructure available to US health care providers and consumers. The NPI is committed to continuing to engage with a broad array of stakeholders who can define and exploit opportunities that will significantly impact efforts to advance cancer detection and save lives.

Brain imaging and the early detection of cancer are just two areas of health and medicine strongly supported by biophotonics. While the US remains the world leader in biophotonics, medical devices and companion diagnostics, significant investments in European, Asian and Australian photonics-driven R&D and clinical translation threaten to eclipse US leadership. To maintain our nation's leadership, we require a diversely trained workforce that remains contemporary to rapidly evolving photonics technologies. Biophotonics training across engineering, chemistry, physics, mathematics, computer science, biology, biochemistry and medicine is essential and translational programs need to be driven by clinicians, diversely trained technologists, and information specialists who can facilitate the clinical adoption of photonics to substantially impact health care delivery at reduced costs. Collaboration of industry, academia, health care providers and payees, and federal agencies such as the National Institute of Standards and Technology (NIST), FDA and the Centers for Medicare and Medicaid Services (CMS) to facilitate post-market evidence collection will spur clinical adoption of impactful biophotonic technologies.

Advanced Manufacturing

For more than 100 years, manufacturing has been a driver of the US economy. During this time, the changes in manufacturing processes have been dramatic, and photonics is playing a prominent role in advanced manufacturing.

Products manufactured domestically, as well as the processes used to manufacture these products, now heavily utilize photonics to image, fabricate, treat, mark and measure. Communications, energy, health and defense are among the growing markets that are benefiting from the continuously improving capabilities in photonics manufacturing. Over the past 20 years, improvements in US

photonics capabilities have been steep and are expected to continue over the next decade. This will enable the US to sustain its leadership position in industrial and commercial markets while maintaining national security through production of mission-critical technologies.

Of the tools available in the advanced manufacturing toolbox, lasers are among the most important, widely used and versatile. Advanced and accurate welding, cutting, surface treatment, marking and measurement are enabled through the use of high-power lasers. The use of high-power lasers in manufacturing has enabled the United States to produce cost competitive, high-quality products, particularly in the automotive industry. It is essential to US manufacturing competitiveness that we not only continue to use high-powered lasers in our manufacturing operations but that we also build the capability to design and fabricate these lasers. Establishing competence in the design and fabrication of high-power lasers not only serves the US industrial need, but also offers the opportunity for commercial/defense "dual use," thus enabling commercial capability to be leveraged into defense and national security programs.

In 2012, the US government committed $1 billion to build a network of manufacturing institutes (i.e., the National Network for Manufacturing Innovation [NNMI]) – now known as "Manufacturing USA" – dedicated to advancing US manufacturing in areas determined to be of national importance. In 2014, DOD announced a competition for an integrated photonics institute and in 2015, awarded what is now AIM Photonics to a New York-based consortium.

With more than a $110 million federal investment and $500 million in non-federal funds, AIM Photonics will "create a national institute supporting the end-to-end integrated photonics manufacturing ecosystem in the US by expanding upon the highly successful public-private partnership model with open-access to world-class shared-use resources and capabilities." AIM Photonics is developing advanced manufacturing capabilities to support industry and defense applications in datacom/telecom, analog radio-frequency, sensors technologies and array technologies. The consistent goal across these applications is to increase performance while at the same time decrease cost and power consumption. The targeted market for this manufacturing capability is expected to be >$100 billion by 2025. It will not be possible for the US to accomplish these objectives without substantial growth in our skilled workforce. AIM Photonics is taking the lead in developing the integrated photonics workforce by collaboratively working with community colleges and universities to inspire, attract and retain students through career transitions to the photonics integrated circuits (PIC) industry. The NPI and its founding scientific societies will work to ensure the success of AIM Photonics.

Optics and photonics in advanced manufacturing does not end here. High performance computing (HPC) for example, is critical for many essential applications, including stockpile stewardship, i.e., managing nuclear weapons in the absence of nuclear testing; industrial competitiveness, e.g., designing better combustion systems and more aerodynamic trucks/cars/aircraft; big data analytics, e.g., discovering trends and features in massive amounts of data; intelligence community, e.g., cyber security and cryptanalyses; and, public welfare, e.g., weather forecasting, earthquake simulation, reservoir modeling and climate monitoring.

In 2015, the NPI convened a small industry advisory group of top photonics experts in communications and IT to identify the benefits of developing HPC with photonics. Recommendations include using photonics as the primary physical-layer communication to provide massive and flexible bandwidth needs to both scale existing workloads and address emerging workloads such as cybersecurity, fraud detection and big data analysis. The NPI participated alongside agency officials in the National Strategic Computing Initiative to show how optics and photonics interconnects are

critical to addressing next generation high-performance computing goals and regaining US leadership in this field. The NPI believes that there is a rare and significant opportunity today to harness current and future innovations in optical interconnect components and infrastructure that could transform HPC in this nation – and advance national security and economic competitiveness objectives in the United States. The NPI recommends that the US private and public sectors work collaboratively to establish and invest in a strategic advanced network system architecture and software center and demonstrate high-bandwidth, low-latency HPC network systems, and the NPI will continue to pursue collaborations to address inter-node communication in terms of latency and power as well as cost.

Energy

Photonics is a critically important technology in increasing the efficiency and safety of both energy production and consumption. Global demand for new energy sources represents a significant growth opportunity for US manufacturers and producers. US companies will need continued R&D investments and structural support to lead the world into a clean, secure, efficient energy future. The Chinese government, for example, has designated solar power and LED lighting as critical industries, providing tens of billions of dollars in the form of loans, land and R&D funding to directly support Chinese companies in this field. Strategic efforts to identify key industrial challenges and create appropriate federal funding support targeting these challenges are needed. Such efforts could highly benefit from industry-academic-government councils providing the necessary guidance in order to properly define strategic federal actions.

Optics and photonics enable our ability to harness, monitor and produce energy. The oil and gas industry, for example, 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 in half by 2030, an annual energy savings of $30 billion and a reduction of emissions equivalent to 40 million cars.

The rapid growth of renewable energy sources and solid-state LED lighting technologies has forced many existing workers to seek retraining to remain knowledgeable about new technologies. Importantly, the solar industry has reported significant difficulty in finding qualified workers in a recent census, highlighting the increasing need for workforce training at all levels. Robust photonics training and educational programs targeted to manufacturer needs in the energy sector are critically needed to ensure the US workforce will have the necessary skills in the future to compete with the global market.

The establishment of programs that support joint R&D programs among academia, industry and national laboratories have been shown to have a high return on investment. Such programs not only produce valuable results directly, they also provide the opportunity for graduates from US universities to gain experience in topics relevant to our industry. Establishment of similar collaborative programs in energy will ensure the nation remains at the forefront of technical innovation in photonics technologies for energy while creating a strong pipeline of experienced individuals in the workforce. Additionally, the formation of advisory councils populated by experienced industrial and academic individuals could prove valuable in advising key federal funding agencies of critical needs and fostering strategic high-impact investments that will ensure these needs are addressed effectively.

Communications and Information Technology

The vast majority of data we receive today from cell phones, cable TV, the Internet, radio and print is encoded, disseminated and received using lasers, fiber optics and optical detectors. Simply put, photonics is the key enabling technology behind the IT and telecom industry, with a $4.7 trillion global market accounting for more than 6 percent of the total world GDP. Over the past 30 years, innovations in optical communication systems have dramatically increased performance and reduced costs. The sharply lower costs drove, and were driven by, exponential increases in telecom traffic: North American telecommunication capacity grew 100 times over the last decade alone. Demand for more bandwidth is expected to continue, fed by new applications.

The increase in Internet traffic has been nothing short of astounding. This remarkable growth has been possible due to the existence of several key optical technologies: the erbium-doped fiber amplifier, increasingly powerful forward error correction, dense wavelength division multiplexing technologies, and coherent transmission. Given that Internet traffic continues to grow at a compounded annual rate of ~50 percent, new disruptive optical fiber transmission technologies will be needed over the coming several years to meet Internet growth. Possible disruptive technologies that have been discussed include: advanced higher order coding schemes, space division multiplexing, and ultra-broadband optical amplifiers.

Despite past impressive technical advances, companies are aggressively seeking innovative new solutions to meet the continuing growth in demand. Without improvements to address the critical pain points of cost, power consumption and data rate, demand will outstrip capacity, which may lead to higher costs and could even constrain the greater US and global economy.

Integrated photonic circuits will likely be a critical competitive differentiator for applications ranging from telecommunications networks to data center links to computer and on-processor interconnects. Leadership will help in national security and in advancing our Internet-based economy. The establishment of AIM Photonics is a crucial step in this direction.

Additionally, optics and photonics will play a critical role in future advances for HPC. US leadership in this area of national security importance is being aggressively challenged by many nations, especially China. However, it is widely recognized that optics can potentially provide significant improvement in higher capacity and lower power consumption for many types of interconnections within and between computer boards. Beyond interconnections, optical signal processing using classical and quantum optics holds a longer-term promise of even greater advances in speed and security.

The US wants to remain a global leader in information technologies (IT) and data center technologies. Leadership in this sector will drive numerous service and manufacturing jobs and launch high-value spin-off technologies. Europe, Japan and China have recently made significant R&D investments in telecommunications. Meanwhile, the US effort has less government support – and the support is less strategic and less centralized. Moreover, as compared to yesteryear, US R&D in this field is fragmented with a reduction in industrial research laboratories from which many past optical communications successes were built. The result is a lack of concentrated R&D funding necessary to drive the next stages of optical communications innovation.

For decades, domestic networks were largely operated by national monopolies using equipment that was designed and manufactured by themselves or domestic vendors. In recent years, the competitive landscape for communications equipment changed greatly, with equipment vendors and their

component suppliers more globalized than before. Only two of the top 10 network equipment companies are now located in the US. If this trend continues, there might not be any US domestic vendors for many types of networking equipment deemed critical to US operations and national security. It is possible that an adversary could withhold equipment or parts or insert sophisticated "back doors" into the networking equipment for eavesdropping or sabotage.

Defense and National Security

When US soldiers step onto the battlefield, their safety and ability to efficiently carry out their mission is critically enabled by optics and photonics. Soldiers carry night vision goggles to see in the dark; they use laser range finders and target designators to direct weapons precisely and minimize collateral damage; they determine the location of hostile forces using high-resolution images acquired from pilotless, unmanned systems; and they utilize high-speed, secure, optical communications to receive intelligence and data from control centers sometimes thousands of miles away. Indeed, US superiority in intelligence, surveillance and reconnaissance (ISR) as well as high-power laser capability will continue to be determined by photonic technologies.

While defense needs are unique, the advanced technologies developed to meet those needs can be leveraged to drive new generations of high-tech commercial applications: faster and more powerful computers and mobile devices; advanced medical imaging, diagnostics and treatments; enhanced environmental sensing; and lightweight and portable sources of renewable energy. Coordinated investment and associated technology development in remote sensing, advanced lasers and cybersecurity will help ensure future military and economic security.

High-power lasers are crucial for US national defense, and the fundamental technologies include: creation of the high-power laser beam, beam profile control, and target acquisition, tracking and pointing. Laser weapons using high-power solid-state lasers have made orders-of-magnitude improvement over the past 15 years in terms of output power, and such lasers offer ultra-precise targeting, low cost per use, and a nearly unlimited magazine. In increasingly common situations, laser weapons are the only practical method of countering new threats.

Lower-power lasers are already employed extensively in the form of illuminators and rangefinders, and they are used to gather intelligence and reconnaissance. Wavelength-agile, compact, rugged and affordable infrared laser systems are needed to provide protection against heat-seeking missiles. Indeed, speed-of-light high-power laser weapons may offer the only affordable, effective defense against ballistic missiles, cruise missiles, swarming small craft and unmanned aerial vehicle (UAV) threats.

Unfortunately, the US manufacturing base in high-power lasers is losing its competitive advantage. US funding for high-power laser programs has declined over the last decade, just as technology is on the cusp of practical implementation. At the same time, foreign competition has expanded rapidly – particularly in China and Russia. Unlike other countries, the US does not have a coordinated strategy to ensure a strong manufacturing base in high-power lasers. Increased support for technology and manufacturing will ensure cost-effective domestic supply of critical components required for high-power lasers.

Sensors are another key defense and national security technology. The US has: (i) passive wide area imagers (e.g., the 1.84 gigapixel visible imager ARGUS), which allows troops to view an area greater than eight miles with high resolution, and (ii) active sensors (e.g., HALOE) currently use laser sources to provide 3D imaging and mapping over wide areas day or night.

Small, inexpensive sensors mounted on robotic vehicles or in UAV's are increasingly needed on the battlefield to provide real-time imagery and intelligence. The US should work to increase the deployment of such ubiquitous, inexpensive, low-power photonic sensors that are connected to a secure network to provide real-time updates and actionable information.

Finally, cyber security and information gathering is vital to military superiority and national security. The US must ensure that our forces have the highest bandwidth and most secure wired and free space communications systems.

Quantum Science and Technology

A global quantum revolution is currently underway, and optical sciences and technologies will play in a large role in the US initiative to advance quantum science and technology (QST). This revolution is driven by recent discoveries in the new area of quantum information science, which is based on the recognition that the subtler aspects of quantum physics such as quantum superposition and entanglement are far from being merely intriguing curiosities and can be transitioned into valuable, real-world technologies. Quantum science and technology will revolutionize many aspects of our lives, including improved security and privacy in digital communications systems that connect our world; enhanced navigation in demanding environments; advanced sensors for geological resource exploration; and, superior computational capabilities for complex simulations and modeling of new pharmaceutical drugs and solar-energy-harvesting materials. Quantum information science will continue to yield some of the deepest insights into the fundamental workings of the universe, including the behaviors of black holes, complex network systems (such as living systems), and individual atoms and molecules that will form the basis of new electronics and other emerging technologies.

In the United States, the quantum revolution is commanding attention at the highest levels but missing from the top-level policy discussions is the recognition of the importance of optical sciences and technologies in QST. The promise of QST rests on new and unique capabilities in three core areas: 1) computation and simulation; 2) advanced sensors; and 3) communications. In all of these areas, optical sciences and technologies play key roles. Working together, the three aspects of QST may ultimately comprise a globally distributed network. Optical quantum communications systems will be the means by which a Quantum Internet will carry quantum information between distant locations, enabling distributed quantum sensing and distributed quantum computing.

QST will open new scientific, technological, and economic avenues to bettering and advancing society. R&D in optical science continues to develop new enabling technologies for a wide range of basic studies and applications in quantum science. The furthering of such supporting technologies is crucial for the success of QST. Support for such enabling technologies has a two-way benefit, as these commercial products will drive the development of quantum technologies, and the developing quantum arena will provide market space for these products.

About the National Photonics Initiative (NPI)

In 1998 the National Research Council issued a landmark report, "*Harnessing Light, Optical Science and Engineering for the 21st Century,*" which presented a comprehensive view of the potential impact of optics and photonics on health care, manufacturing, defense, communication, energy and many other industries. Since the report's release, many countries have significantly increased their national commitments to the optics and photonics industry. For example, Germany has committed nearly €1 billion ($1.3 billion in USD) to photonics R&D over 10 years; China began funding several programs targeting photonics supply chains; and the European Commission, as part of its new Horizon 2020 program, has directed >$2 billion USD to photonics-related R&D over the next seven years, and has designated photonics as one of only five key enabling technologies for future prosperity.

Historically, the US has been a leader in photonics research and development (R&D) but the current US share of the global photonics industry is only 17 percent – behind Japan and with increasing competition from Europe, South Korea, Taiwan and China. Global competition is putting at risk our nation's leadership position, which is causing a substantial loss of global market share to overseas competitors as well as thoughts of US jobs.

In 2012, the US National Academies published a follow-on report entitled *"Optics and Photonics: Essential Technologies for Our Nation,"* making the case for a national initiative to increase collaboration and coordination among US industry, government and academia to identify and further advance areas of photonics critical to regaining US competitiveness and maintaining national security.

Established in May 2013, the NPI is led by top scientific societies including the American Physical Society (APS), the IEEE Photonics Society (IPS), the Laser Institute of America (LIA), The Optical Society (OSA) and SPIE, the International Society for Optics and Photonics (SPIE). Through its scientific societies, the NPI represents optics and photonics companies and researchers across the United States. The NPI has focused its efforts on identifying areas where US public and private interests intersect, and where joint collaboration can achieve breakthroughs in research commercialization and technology innovation.

For more information on the NPI, please visit www.lightourfuture.org.