OptiPulse, Inc.
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High Tech Start-up Aims to Propel USA to a Sustained Lead in Communications Infrastructure

OVERVIEW: OptiPulse has created a new light source with a combination of features enabling effective FSOC links in space and on the ground. It's capabilities to form inexpensive high bandwidth secure wireless links enables rapid development of optical wireless meshed networks. OptiPulse's LightGrid™ VCSELA manufactured on a chip produces High Optical Power, High-Speed over Distance, with Low Divergence. The chip is inexpensive to manufacture and light weight. This new low CSWaP (Cost, Size, Weight, and Power) semiconductor-based photonics emitter developed and patented by OptiPulse enables efficient high optical power (Ws), fast single channel operation (25Gbps), and simple PAM capable multiplexing from a single chip. Simple wavelength multiplexing forming a single beam small formfactor module (0.2cm x 2cm x 2cm, with a low coherent light source with adjustable divergence would be the final product. Among many features ideal for Space, the OptiPulse technology enables non-mechanical beam steering and the semiconductor structure is inherently hardened.

PROBLEM: The appetite for DoD bandwidth is growing, and new communication infrastructures must be fast. The maturation of our adversaries' capabilities in Electronic Warfare presents crucial threats on several levels to a network that employs traditional Radio Frequency (RF) radiation for communications. Our adversaries are now capable of locating, intercepting, and disrupting those communications. Beyond disturbing the communications, locating the source makes the sender itself vulnerable to physical attack from remote locations. In military and space applications Multi-Domain Command and Control needs secure wireless links that auto-align, point, and self-heal with adaptive characteristics for high speed mobile operations.

Wireless Free Space Optical Communication FSOC as a discipline has evolved to coherent laser communications sending high speed data. These systems currently are aligned by using mechanically driven gimbals for beam steering. The lasers are expensive and typically bulky. Systems with mechanically driven beam steering are associated with large form factors and need higher power requirements for operation. Coherent propagation through the atmosphere limits reception by creating non uniform Bit Error Rate BER areas in the beam. This technology has low coherence reducing scintillation. The full functionality and benefit of FSOC has not been achieved with current optical light sources. An edge emitter, a VCSEL, or a fiber optic cable bundle have specific applications but none of them have the combination of capabilities and low CSWaP necessary for FSOC.

SOLUTION: OptiPulse offers a tiny photonics light source that produces enough power and speed to sustain earth to space high-speed links and satellite to satellite communication, tracking and sensing. The OptiPulse light source can form an optical wireless meshed network infrastructure supporting 4G, 5G or even 6G cell phone backhaul, LiFi to customers and edge computing servers distributed throughout communities, enabling cost-effective, rapid deployment high bandwidth connectivity. There is no other comparable technology in the world.

Design potential suggests Watts of power at >10s Gbps per channel with multiple multiplexing techniques to boost the bandwidth. Spatial multiplexing can multiply the heavily multiplexed beams forming bandwidths well over 100Gbps per/ spatial channel. Close, narrow VCSEL type single channel line widths sum optical power forming an incoherent light source in a narrow band of a few nms. Each chip can be a channel spectrally with pulse amplitude information possible on that channel. The characterization of these devices revealed unique operation capabilities enabled by the low capacitive waveguide's introduction of the high-speed signal into many lasers in parallel at the relative same time

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(ps jitter). Frequency response tests of a single device compared to a 105-element array shows no penalty in frequency response leading to the possibility to have hundreds of watts with high bandwidth in an inexpensive source.

The patented OptiPulse light-source is made in a compound semiconductor wafer scale process eliminating expensive micro optical elements all in a chip that costs $1 in production and can form a 10Gbps link over kilometers distance.

High power devices will have improved eye-safety performance over similar coherent sources. Wall-plug efficiencies are at 33% and can be improved. Back emitting structure enables efficient passive or active cooling. Microlens fabrication on exit side of wafer sums beams at an overlap point on the Z axis in front of the chip, or behind the chip (virtual overlap of beams). Overlap of beams have shown high power density uniformity and high speed BER uniformity forming an intensity profile that can be at a focal plane of the optical train. Result "projects" uniform beam into the far field.

Modification of the design can be developed and fabricated to produce high average power Gbps sources with the ability to pulse low duty cycle high peak power outputs by changing the high current source characteristics. A study of peak power vs. avg power with these devices could suggest a flexible LiDaR source for beacons and for long-distance Gbps communications links for space.

The typical beam quality of the lasers in the array produce an M2 value (the beam quality factor – describing how well a collimated beam may be focused to a small spot) of ~8 which works well to expand and collimate the optical beams to enable short to medium (10s to 1000s of meters) atmospheric link distances for communications supporting 4G, 5G, or 6G applications.

Other aperture and microlens selected variables can affect the divergence of the combined beam. Lasers arrayed with single mode characteristics (small apertures) could produce higher quality beams without adjustment of the cavity epitaxial design. The form factor best representative of the deployment model uses a pole that is set up at a location. The pole is taller than typical streetlamps. Regions can be quickly modeled for a mesh network, then manufactured for quick and optimal deployment. Poles are ordered with specific heights and components with angles for links set at the factory. When installed the unit's power on and auto connect the optical mesh network with its pole neighbors within a mile or more.

DEVELOPMENT STATUS: (Chip TRL6, FSOC System TRL4) Proof of concept devices are already operating and being tested in Albuquerque, New Mexico. With support of the National Science Foundation, advancements are being made to demonstrate a solid-state beam directing using 10Gbps capable arrayed light sources with enough optical power to reach multiple kilometers. Optical elements direct beams passively through photolithographic optical offsets. With current Department of Defense support, OptiPulse is developing the backhaul links with electro-optical and communications PCBs that can mechanically actively align with large angle directing of beams.

GO-TO-MARKET: OptiPulse seeks a shortened timeline to fund accelerated get-to market parallel efforts to develop the components and support rapid deployment. There is increased urgency to support our nation's space initiatives and security with low CSWaP technology. Funding is required for the following 1) to complete development and scale-up manufacture of product solution, 2) to establish partnership and/or licensing arrangements with qualified entities, and 3) test-beds within targeted cities and communities for optimizing deployment metrics and strategies.

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FUNDING PLAN - ACHEIVEMENTS AND NEXT STEPS:

- Reg D 506 (b) and 506 (c) filing completed: raised ~$3.6M
- Awarded NSF Phase I grant and DoD Phase II follow-on from completed Phase I grant.
- Completed PO with City of Albuquerque
- In Process - Reg CF through WeFunder.com portal to go live in several weeks (up to $1M)
- To Follow - Reg A+ filing after CF, continue access to public funding up to limit of $50M
- Revenue Potential – current investors / local partners seeking test devices
- In Parallel -OptiPulse is working on tranched VC raise of >$15M for rapid expansion

TEAM:

John Joseph, CEO/Founder of Optipulse, has written over 17 major concept issued patents, more pending, on VCSEL array architecture providing a unique light source capable of transmitting significant amounts of data (10Gbps), wireless and over distance. With his expertise in broadband and VCSEL technology, John has founded OptiPulse to use VCSEL technology to bring broadband to underserved communities throughout New Mexico and the United States.

Dr. Jim Lott, CTO/Co-Founder, is an epitaxial designer of world record speed, power, and efficiency semiconductor laser technologies, renowned for record breaking epitaxial wafer designs for high speed VCSELs. Most recently Dr. Lott was a professor and researcher at the Technische Universität Berlin, Berlin, Germany. Previously, Dr. Lott was with Intel Corporation's Materials Laboratory. He was a professor and deputy department head (1993-2006) at the Air Force Institute of Technology, Wright-Patterson AFB, OH while on active duty. He was a guest scientist (on sabbatical) at the NEC Optoelectronics Laboratory in Japan in 1995 and at Samsung Electronics in 1996. He was a Military Research Associate (guest researcher) at Sandia National Laboratories, Albuquerque, NM USA from 1988-1993. Retired military science/engineering officer.

Mathis Shinnick, COO/Co-Founder, has extensive experience in C Level Management in Start-ups, Mid-Market and Large Corporates living and working around the globe as CEO and Managing Director including: Chase's Aerospace and Defense business, a Merchant Banking business based in Hamburg, Germany, and as founder of numerous financial and corporate start-ups. Mathis is excellent at building and guiding teams through challenging business plans.

In addition to John Joseph and Mathis Shinnick, OptiPulse success is supported by an experienced Board of Directors and a talented team of scientists, engineers, and business specialists.