MANOHAR PARRIKAR INSTITUTE FOR DEFENCE STUDIES AND ANALYSES
मनोहर पर्रिकर रक्षा अध्ययन एवं विश्लेषण संस्थान

MP-IDSA
Issue Brief

Data on a Beam of Light: Li-Fi and India's Military Communications

Anamika Choudhary

August 25, 2026

Summary

Light Fidelity, or Li-Fi, an optical wireless technology, has opened new avenues for strengthening military communications in the contested electromagnetic spectrum. India's strengths include a mature communications architecture, a capable industry, a broad research base, standards, and a proven route from innovation to procurement. The opportunity is to align these behind a shared objective, with clear ownership across the services, DRDO, industry and the Department of Telecommunications.

Introduction

Light Fidelity, or Li-Fi, an optical wireless technology, has opened new avenues for strengthening military communications in the contested electromagnetic spectrum. A Delhi-based firm reported in March 2026 that it has secured a contract to deploy free-space optical links across Indian submarines.[1] The company is backed by three grants from the Ministry of Defence's Innovations for Defence Excellence (iDEX) programme.[2] An optical link needs no spectrum allocation or host-nation clearance, since light sits above 3,000 GHz, outside the International Telecommunication Union (ITU) Radio Regulations.[3] A link confined to an optical beam is also harder to locate, jam or intercept from outside it.

The brief seeks to understand LiFi adoption in the military domain. It argues that India needs to align its various building blocks, such as a Centre of Excellence (CoE) on Li-Fi,[4] a Defence Research and Development Organisation (DRDO) development line,[5] the IDEX pipeline, and a capable defence-electronics industry. Optical wireless, an instrument of spectrum survivability for fixed nodes, can complement the fibre backbones India has built.

The Spectrum as Contested Ground

Modern operations depend partly on control of the electromagnetic spectrum. Every emission can be detected, located and targeted, and a receiver holds a range advantage over the transmitter it listens to. A fixed headquarters carries several emitters; each of them becomes a detection opportunity.[6] Reducing that signature without losing connectivity is the problem that is addressed by optical wireless communication. Li-Fi and free-space optics are spectrum-survivability tools for nodes that cannot move. Emission control—managing one's own emissions to lower the probability of detection—is a recognised discipline.

The war in Ukraine has shown electronic warfare shaping targeting in real time. Operation Sindoor was fought across a sensor-rich environment in which India's air-

---

[1] **"Velmenni Secures Funding to Scale FSO and LiFi Tech"**, *SMEStreet*, New Delhi, 17 March 2026; **"Velmenni Secures Rs 30 Crore Pre-Series A Funding to Scale Light-Based Wireless Tech"**, *LiFi Tech News*, 18 March 2026.

[2] **"iDEX Details"**, Department of Defence Production, Ministry of Defence, Government of India.s

[3] **"Complementing Current Radio Frequency Delivery Mechanisms Using Optical Wireless Communication"**, Recommendation ITU-R SM.2152-0, International Telecommunication Union, Geneva, September 2022.

[4] **"About Us — Centre of Excellence on LiFi"**, Indraprastha Institute of Information Technology Delhi.

[5] **"Technology Development Fund (TDF)"**, Defence Research and Development Organisation, Ministry of Defence, Government of India.

[6] **"Electromagnetic Spectrum Operations is Everyone's Problem"**, *Empyrean Defense*, 17 May 2026.

defence and counter-drone systems performed significantly, with the Air Force Network serving as the backbone of the Integrated Air Command and Control System (IACCS).[7]The network delivers decision advantage and also concentrates emissions at command nodes. However, for survivability, protecting their signature is important.

Light as a Carrier

The concept of sending data via light dates back to Alexander Graham Bell, who transmitted speech via a sunbeam with his 1880 photophone. The effort was only defeated by unreliable sunlight and crude receivers.[8] The deficiencies of the photophone were overcome by light-emitting diodes (LEDs) and photodiodes—an LED can be switched millions of times a second, and a photodiode reads the flicker back into data. The main motive behind the concept is the scarcity of the radio spectrum, which is finite and congested, while the light band above it is a thousand times wider and unlicensed.[9]

Professor Harald Haas of the University of Edinburgh coined the term 'Li-Fi' and earned the label 'father of Li-Fi'.[10] He gave a Technology, Entertainment Design (TED) talk, 'Wireless Data from Every Bulb' in 2011, about streaming data from an ordinary LED. Two years before this TED talk, in 2009, Germany's Fraunhofer Institute demonstrated the feasibility of underlying visible light communication at 125 Mbit/s over a distance of five metres.[11]

Li-Fi needs near line of sight, with a range of about 10 metres.[12] The academic literature confirms line-of-sight dependency and optical attenuation as the binding limits for Li-Fi.[13] Free-Space Optics (FSO) is generally used for long-range applications and operates with a beam between two fixed points over distances of up

---

[7] **"India's Defence Leap: From Indigenous Production to Global Exports, Redefining National Security"**, Press Information Bureau, Government of India, 10 June 2025.

[8] **"Interview: Father of LiFi Brings Web Out of the Dark Ages"**, *The Scotsman*, 25 October 2016.

[9] Arun Agarwal, Chandan Mohanta and Gourav Misra, **"Li-Fi Technology: Principle, Future Scope, Challenges and Applications"**, *American Journal of Electrical and Electronic Engineering*, Vol. 10, No. 1, 23 January 2022.

[10] Harald Haas, **"Wireless Data from Every Light Bulb"**, TED Global 2011, cited in "About", LiFi Research and Development Centre, University of Edinburgh.

[11] J. Vucic, **"125 Mbit/s over 5m Wireless Distance by Use of OOK-Modulated Phosphorescent White LEDs"**, *IEEE Xplore*, September 2009.

[12] **"Study Paper on LiFi (Light Fidelity) & Its Applications"**, FN Division, Telecommunication Engineering Centre, Department of Telecommunications, Government of India; Deepak Halan, **"Militaries are Testing Li-Fi and It Could Change Warfare Forever"**, *Electronics For You*, 1 April 2026.

[13] **"Li-Fi Range Challenge: Improvement and Optimization"**, *Foundations*, Vol. 7, No. 1, MDPI, 4 February 2026.

to kilometres. This explains why the ITU groups it with Li-Fi under optical wireless communication (OWC).[14]

Li-Fi and Electronic Warfare

There are three aspects of electronic warfare and optical wireless communication.[15] The first is **electronic support**: intercepting and locating emissions. A link confined to a beam offers little to a distant receiver; the same is the concept behind the United States Army's 'zero-radio-frequency footprint' operations centre.[16] It is harder to intercept the beam from outside if it is not invisible: light leaks through windows, and a sensor inside the cone can detect it.

Second is **electronic attack**: an optical link cannot be jammed by a distant radio emitter, though a beam can be dazzled by bright light or degraded by smoke and dust. This means it requires an adversary to be close by only to cause a local effect. Third is **electronic protection**: the surest protection is not emitting on contested frequencies at all. Emission control is a form of passive electronic protection. The prudent design keeps a radio fallback, reverting automatically when the optical path is blocked.

Like any other technology, Li-Fi comes with its own merits. It offers far more bandwidth, no interference with radio equipment, a signal confined to the lit space, and operation where radio cannot go. Its demerits, however, include a limited reach of about 10 metres, a line-of-sight requirement, sensitivity to sunlight, and limited device support.[17] It cannot support manoeuvre. Hence, armoured columns, aircraft and ships will need radio. Laser-safety rules apply to any usable beam.[18]

Table 1. Comparative Assessment

Attribute	Radio (Wi-Fi, Tactical)	Li-Fi	Free-space Optics	Cable/Fibre
Throughput	Up to ~1 Gb/s	10 Mb/s–9.6 Gb/s	Multi-Gb/s	Very high

[14] **"Complementing Current Radio Frequency Delivery Mechanisms Using Optical Wireless Communication"**, Recommendation ITU-R SM.2152-0, International Telecommunication Union, Geneva, September 2022.

[15] **"Electromagnetic Spectrum Operations"**.

[16] Andrew Foreman, **"Free Space Optics (FSO) and Light Fidelity (LiFi) Communications: A Modern Day Transitional Crossroads"**, United States Army Europe and Africa, G6.

[17] **"Li-Fi vs Wi-Fi"**, Symmetry Electronics.

[18] **"Study Paper on LiFi (Light Fidelity) & Its Applications"**, no. 12.

Range	Tens of metres to km	~10 m indoors	Up to ~16 km	Any fixed distance
Detectable at range	Yes	Confined to lit area	Confined to beam	No
Remote jamming	Vulnerable	Not by radio means	Not by radio means	Not applicable
Mobility	Full	Within lit area	Fixed points	None
Regulatory need	Licensed	None	None	None
Best military role	Mobile forces	Interior of fixed nodes	Fixed point-to-point	Permanent backbone

Sources: IEEE 802.11bb-2023;[19] Recommendation ITU-R SM.2152-0;[20] Telecommunication Engineering Centre;[21] literature on Li-Fi limits;[22] US Army reporting[23].

Optical wireless is strongest where radio is weakest—the interior of fixed nodes and short links that must stay quiet—and weakest where radio is essential. Optical wireless is a cable replacement; it is not a mobile network and will not replace radio at the tactical edge. No single technology wins outright; the sound design is hybrid.

The Global Picture

The visible light band offers roughly 10,000 times the unlicensed bandwidth of the radio spectrum and is treated as a way to relieve congestion rather than replace

[19] **"IEEE Standard for Information Technology — Telecommunications and Information Exchange between Systems — Local and Metropolitan Area Networks — Specific Requirements, Part 11, Amendment 6: Light Communications"**, IEEE Std 802.11bb-2023, Institute of Electrical and Electronics Engineers, 2023.

[20] **"Complementing Current Radio Frequency Delivery Mechanisms Using Optical Wireless Communication"**, Recommendation ITU-R SM.2152-0, International Telecommunication Union, Geneva, September 2022.

[21] **"Study Paper on LiFi (Light Fidelity) & Its Applications"**, no. 12.

[22] **"Li-Fi Range Challenge: Improvement and Optimization"**, no. 13.

[23] Andrew Foreman, **"Free Space Optics (FSO) and Light Fidelity (LiFi) Communications: A Modern Day Transitional Crossroads"**, no. 16.

radio.[24] Its wide usage is in places where radio is congested—hospitals, aircraft cabins, factories, and underwater.[25] Signify (formerly Philips Lighting) sells Li-Fi under the Trulifi brand with a cryptographically certified product. pureLiFi, Oledcomm, Fraunhofer Heinrich Hertz Institute (HHI), Panasonic and Velmenni make up a fragmented field.[26] Market estimates cluster around US$ 1–1.5 billion in 2025.[27] The greater significance is 6G: with the radio spectrum saturated and connected devices expected to reach the tens of billions by 2030, standards bodies treat optical wireless as one of the bands that 6G will exploit. The ITU agreed on the IMT-2030 (6G) requirements in 2026.[28] Optical wireless is a component of the next mobile generation.

Chinese research groups have published the highest reported underwater optical data rates, including 170 Gbps in 2025.[29] Published laboratory rates are not fielded capability, and demonstrated ranges remain short, but this is the domain in which India's first optical wireless procurement—a submarine link—operates.

In October 2019, United States Army Europe units became the Department of Defense's first to use free-space optics and Li-Fi, streaming video between operations centres about 10 miles apart across the Rhine.[30] A 16-kilometre link held 95 per cent availability in rain and fog and needed no host-nation permission.[31] The command then committed US$ 4.2 million to Li-Fi access points for Exercise Defender-Europe 21, and procured the technology’s ‘next-generation optical wireless communication system’ by expanding the order in December 2021.[32] In June 2025, pureLiFi released

---

[24] Arun Agarwal, Chandan Mohanta and Gourav Misra, **“Li-Fi Technology: Principle, Future Scope, Challenges and Applications”**, *American Journal of Electrical and Electronic Engineering*, Vol. 10, No. 1, 2022.

[25] **“Li-Fi vs Wi-Fi”**, no. 17.

[26] **“Free Space Optics (FSO) and Visible Light Communication (VLC / Li-Fi) Market”**, *MarketsandMarkets*, 28 October 2024.

[27] **“Li-Fi Market Size, Share, Forecast & Analysis”**, Mordor Intelligence, 6 March 2026.

[28] Cheng-Xiang Wang et al., **“On the Road to 6G: Visions, Requirements, Key Technologies and Testbeds”**, Survey Paper, 2023, listing optical wireless among the 6G spectrum bands; **“IMT-2030: Technical Requirements for the 6G Future”**, International Telecommunication Union, 18 March 2026.

[29] Zhilan Lu et al., **“170 Gbps PDM Underwater Visible Light Communication Utilizing a Compact 5-Lambda Laser Transmitter and a Reciprocal Differential Receiver”**, *Photonics Research*, Vol. 13, No. 6, 2025, p. 1654.

[30] Stephen Perez, **“U.S. Army Europe Soldiers Test Li-Fi”**, Defense Visual Information Distribution Service, United States Army Europe and Africa, Lucius D. Clay Kaserne, Germany, 15 October 2019; **“Move Over Wi-Fi, Soldiers Become First in DoD to Use Li-Fi”**, *MilitarySpot*, 16 October 2019.

[31] Andrew Foreman, **“Free Space Optics (FSO) and Light Fidelity (LiFi) Communications: A Modern Day Transitional Crossroads”**, no. 16.

[32] **“pureLiFi Secures Multi-Million Dollar Deal with the US Army”**, *Technology Magazine*, 27 April 2021; Scott Reid, **“Edinburgh Tech Firm Behind Light-Based Wi-Fi Hails US Army Deal: Smart Cars and Smartphones on Horizon”**, *The Scotsman*, Edinburgh, 27 April 2021; Scott Reid, **“Edinburgh Tech Star PureLiFi Lands New Multi-Million-Dollar Deal With US Army”**, *The Scotsman*, 8 December 2021.

the Kitefin XE system for the national security community and beyond; the product line now draws investment from In-Q-Tel, the United States national security community's strategic investor.[33] Optical wireless holds a resilient position in the United States national security community.[34]

Li-Fi and India's Networked Force

India's reported naval procurement is free-space optics. When a submarine returns from patrol, it must transfer several terabytes of data to the command centre. Radio can be intercepted, so the crew lays over 200 metres of cable each time. Velmenni proposed doing it with light and demonstrated the link; the Ministry of Defence framed the grant as a means of strengthening secure naval communication.[35] Velmenni reported an Indian carrier-grade free-space optical link holding 99.999 per cent availability over 18 months in Odisha's tropical conditions.[36] This is the most valuable step, letting industry aim at a defined target for the Navy.

While the Army Static Switched Communications Network (ASCON) provides the Army's static backbone, the Air Force Network (AFNET), commissioned in 2010, carries the Integrated Air Command and Control System (IACCS). The tri-service Defence Communication Network (DCN) and Network For Spectrum extend secure fibre with satellite redundancy.[37] These were performed during Operation Sindoor. The lesson is that future military communications are hybrid—fibre, satellite, software-defined radio, tactical networks and optical wireless: Li-Fi and free-space optics slot in at the last of metres, feeding the backbones that already exist.

In an air-defence operations centre under drone surveillance, Li-Fi inside the bunker and free-space optics between structures keep interior work off the radio signature while the fallback remains available. In an aircraft mission-planning facility, a Li-Fi-lit room keeps large mission data inside the walls. In a submarine dockyard, a free-space optical link replaces the cable and the emission, as addressed by the Velmenni order.

---

[33] **"pureLiFi Unveils Kitefin XE, the Next Generation LiFi System Ready to Secure Communications for Defence and Beyond"**, *Business Wire*, 10 June 2025.

[34] **"PureLiFi Introduces Secure Li-Fi System Targeting Government, Defence Sector Clients"**, *Telecompaper*, 10 June 2025.

[35] **"Velmenni Secures Rs 30 Crore Pre-Series A Funding to Scale Light-Based Wireless Tech"**, *LiFi Tech News*, 18 March 2026; Ajai Shukla, **"Delhi-Based Velmenni Wins Grant to Develop Submarine Communication"**, *Business Standard*, 15 July 2024; Ajai Shukla, **"Delhi-Based Firm, Velmenni, Wins iDEX Grant to Develop Submarine Communications"**, *Broadsword*, 15 July 2024; **"Velmenni Li-Fi to Enhance Indian Navy Communication"**, *SMEStreet*, 1 July 2024.

[36] **"Velmenni Secures Funding to Scale FSO and LiFi Tech"**, *SMEStreet*, 17 March 2026.

[37] **"Network-Centric Warfare: Rethinking Defence Communications"**, *Voice&Data*, 5 April 2026.

The building blocks for an indigenous capability exist: a public-sector integrator, private optical expertise, a photonics base, and a research pipeline. Bharat Electronics Limited (BEL), the Ministry of Defence's flagship electronics enterprise, already builds military communications, electronic warfare, and electro-optics systems, and was featured in Operation Sindoor. Companies such as Tejas Networks build optical transmission products and are partnering with BEL on defence networks. Himachal Futuristic Communications and Sterlite Technologies have laid down the fibre for the Project NFS (Network For Spectrum).[38] Tata's electronics arm has an MoU with BEL to develop advanced indigenous electronics and semiconductor solutions.[39] The task is integration and a defined requirement, aligned with the Atmanirbhar Bharat drive.

Internationally, Li-Fi and free-space optics are mature—standardised, commercial, and fielded by the military—placing the core technology high on the technology-readiness level (TRL) scale. The Indian context is encouragingly accepting the technology and is maturing well; where it further needs to focus is on ruggedisation for smoke, dust, vibration and blackout.

A Phased Path

Optical wireless suits staged adoption. First, **requirement definition**: the Directorate General of Signals, or a tri-service equivalent, frames an emission-control standard for fixed installations, against which Li-Fi, free-space optics, and cable are assessed. Second, **pilot deployment** at a command post, shelter or dockyard, building on the naval link. Third, **operational evaluation**, including performance under Indian conditions and under smoke, dust and blackout. Fourth, **doctrine** placing optical wireless within electronic-protection practice. Fifth, **procurement** of ruggedised terminals, for which iDEX already offers a route under the Defence Acquisition Procedure 2020. Sixth, **joint integration** alongside ASCON, AFNET, the DCN and Network For Spectrum.[40]

The action can be expected with ownership. The Indian Army, through the Directorate General of Signals, can define the emission standard, with the Military College of Telecommunication Engineering developing doctrine. The Indian Navy can evaluate optical wireless for submarine and dockyard use and publish a requirement. The Indian Air Force can assess hardened shelters and air-defence

[38] **"Armed Forces Get a Dedicated OFC Network"**, Himachal Futuristic Communications Limited.

[39] **"Tata Electronics and Bharat Electronics Signed MoU to Advance India's Ambition for Self-Reliance in Electronics and Semiconductors"**, Tata Electronics, 6 June 2025.

[40] **"Network-Centric Warfare: Rethinking Defence Communications"**, no. 37.

direction centres. DRDO can lead ruggedised terminal development. BEL and industry can carry out indigenous manufacture. The Department of Telecommunications, through the Telecommunications Standards Development Society, India (TSDSI), can coordinate standards and carry India's requirements into the international ones. The CoE on LiFi, with a defence liaison, can direct part of its research towards emissions control.

The milestones set up are required to mark progress: a published emission-control specification with a named directorate; an indigenous, military-qualified terminal in evaluation; and a released availability figure for an Indian military optical link.

Conclusion

Optical wireless is a solution for reducing emissions from fixed nodes. It is a useful contribution to spectrum survivability. Its adoption does not change the character of war but is a meaningful instrument within a hybrid architecture. India has begun with its naval link. India’s strengths include a mature communications architecture, a capable industry, a broad research base, standards, and a proven route from innovation to procurement. The opportunity is to align these behind a shared objective, with clear ownership across the services, DRDO, industry and the Department of Telecommunications. Li-Fi and free-space optics are one element of India's transition to a resilient, networked and spectrum-aware force.

About the Author

Wg. Cdr. Anamika Choudhary (Retd.) is Research Fellow at the Manohar Parrikar Institute for Defence Studies and Analyses, New Delhi.

Manohar Parrikar Institute for Defence Studies and Analyses is a non-partisan, autonomous body dedicated to objective research and policy relevant studies on all aspects of defence and security. Its mission is to promote national and international security through the generation and dissemination of knowledge on defence and security-related issues.

Manohar Parrikar Institute for Defence Studies and Analyses
1, Development Enclave, Rao Tula Ram Marg
New Delhi 110 010 India
T +91-11-2671 7983 F +91-11-2615 4191
www.idsa.in
Twitter @IDSAIndia
www.facebook.com/ManoharParrikarInstituteforDefenceStudiesAnalyses