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# LIDAR and Laser - how vulnerable is the RAN to the emergence of light spectrum weapons and sensors?

By CPOEWSM Paul Freestone

## Introduction

As children of the 20th century, many of us marvelled at books, comics and TV shows featuring 'laser' weapons. It was pure fantasy and sci-fi at its best. But it is fantasy and fiction no more.

Whilst Light Illumination Direction and Ranging (LIDAR) technology has been in use in various military applications since the 1960s (laser guided free fall bombs for example), the recent, rapid advances in computer processing and memory has allowed LIDAR to evolve into a complex, precision instrument capable of incredibly accurate terrain mapping whereby hundreds of square kilometres of jungle can be mapped minus its foliage in a matter of hours. One does not have to draw too much of a long bow to apply this technology to the maritime environment, particularly ASW.

Not only does LIDAR possess the technology to remove sea clutter and reveal the periscope and masts of a dived submarine at PD with incredible fidelity, it also has the potential ability to penetrate the sea surface and detect a dived submarine at depth. This capability, when applied in the maritime warfare domain, has the potential to totally change submarine warfare - from both the submarine and prosecuting forces perspective, and have a similar effect on maritime surface warfare as a new category of both sensors and weapons in the visible light component of the electro-magnetic spectrum.

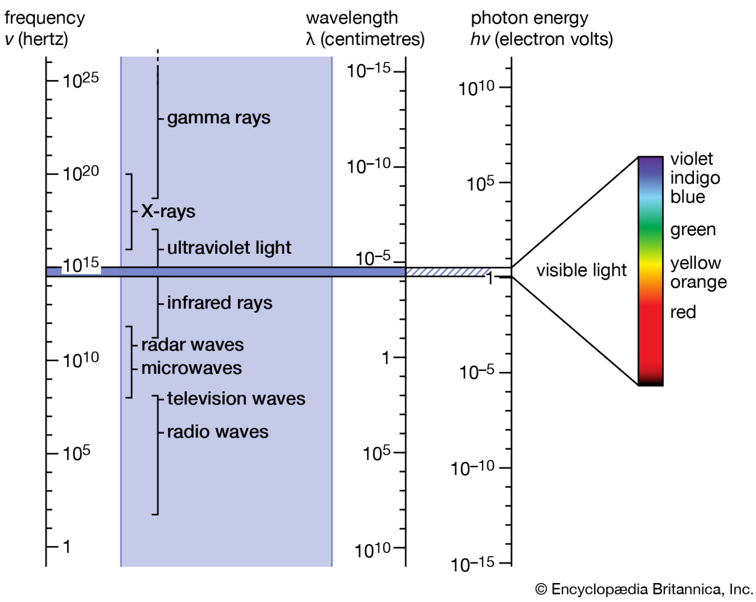


*Figure 1: The Electro-Magnetic Spectrum.*

## What is LIDAR?

LIDAR is the light spectrum equivalent of Radar. It uses the same principles that allow radar to use a broad spectrum of radio frequencies – from High Frequency (HF - 3-30 MHz) to Super High Frequency (SHF - 3-30 GHz) to transmit pulsed or continuous wave energy into the atmosphere. The frequency and modulation characteristics greatly depend on the intended function of the radar. LIDAR, however, operates in a comparatively speaking very narrow band in the light portion of the Electro-Magnetic Spectrum, between 500 and 1600 nanometres (187.3 THz - 599.6 THz). Combined with modern processing and memory in today's computer systems, it is capable of astonishing resolution and the ability to remove any unwanted content such as plant life (see image below) from the imagery it can provide. It is now also capable of being fused with other sensors, such as radar, to provide the customer with almost photographic resolution of the target.

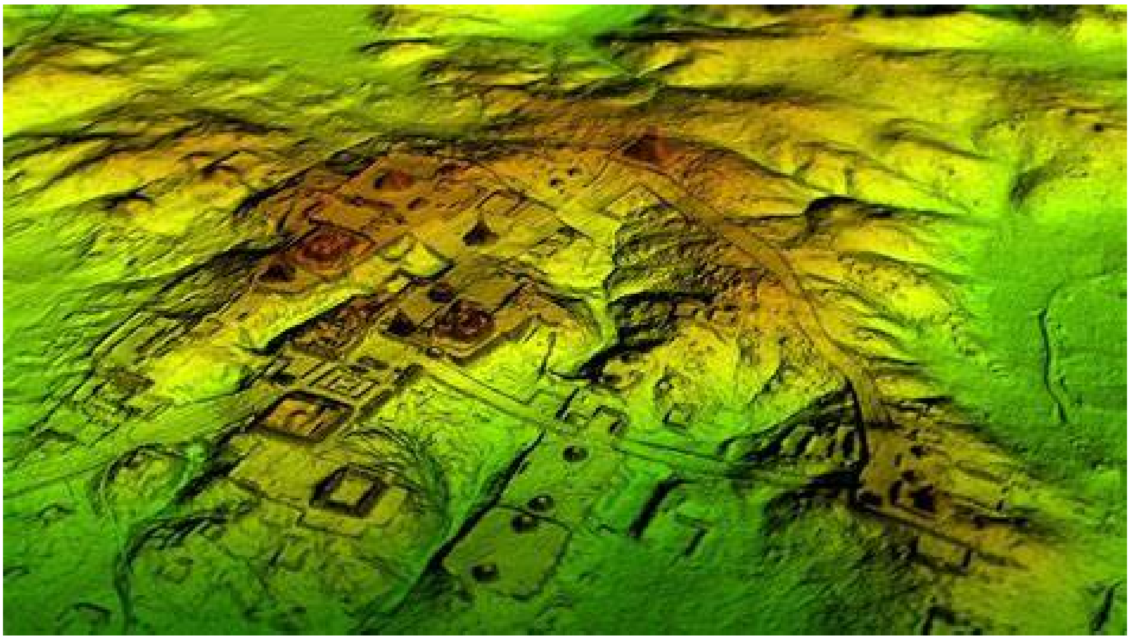

*Figure 2: Ancient Mayan city in jungle terrain discovered by LIDAR. (Image: nationalgeographic.com)*

### Past RAN vulnerability to new emitter technology

The race between emitter and target has been an ongoing technological battle since World War 2, when emerging Allied airborne and shipborne radar technology battled the German U-boat fleets in the Atlantic which were utilising the first submarine fitted EW systems. Radar technology, combined with other intelligence sources, played a large role in the decimation and defeat of the U-Boats from late 1943 to 1945. Since then, the technology advanced slowly but surely during the Cold War, after which a variety of technological advances occurred.

The emergence of rapidly advancing computer technology through the 1990s saw complex modulation types such as Frequency Modulation on Pulse (FMOP), Phase Modulation on Pulse (PMOP), very low power applications via Low Probability of Intercept (LPI) and the re-introduction of older technology such as Frequency Modulated Continuous Wave (FMCW). Radars utilising all of these advanced characteristics, often seen in one emitter, provided ASW assets with a formidable anti-submarine capability and narrowed the advantage dived submarines had against surface forces.

### Have we learnt from the mistakes of the past?

By the mid-1990s, the RAN's ships and submarines were fitted with 1980s (or older) technology EW systems, most of which had little to no ability to detect and identify the then current technology emitters, thus the tactical advantage usually provided by 'Range Advantage' of ESM versus Radar was vastly reduced, and in some cased reversed in favour of radar. It took many years until the RAN had the equipment, operators and doctrine to once again restore tactical ES advantage.

Command teams, especially in deployed submarines, relied on the experience and initiative of its EW operators to maintain the tactical advantage whilst utilising obsolete equipment. In todays' military and political climate in our operating areas, the RAN cannot allow itself to once again be overtaken by advanced technology.

### Current status

Any emitters or activity in the light spectrum are currently undetectable by RAN EW systems. Despite there being a plethora of both classified and open source information regarding this spectrum and its employment in both civilian and military roles, the RAN currently has no ability to detect, analyse, record and report LIDAR or Laser emitters.

We know LIDAR and Laser exist, we know that these systems are use but there is much we don't know about light spectrum emitters in our current areas of operations as we have no means of observing the spectrum. Are we now revisiting the contentious times of the mid-1990s to the late 2000s, when our opponents had the latest technology and we struggling to retain the tactical advantage with our obsolete ES systems?

### Why my concern?

Writing this as an EW sailor with over 30 years' experience, my biggest concern for current and future submarine and warship operations both now and into the future is our vulnerability against modern LIDAR and Laser emitters, both civilian and military. A warship operating in littoral waters might not be too concerned about civilian/paramilitary coast watch aircraft and ships using state of the art LIDAR systems for coastal mapping, maritime surveillance or even underwater surveys, a dived submarine operating in those very same waters would want to know about such activity.

Whilst LIDAR does have what could only be described as amazing resolution and accuracy above water - which is of course a problem for any submarine operating at periscope depth, its ability to penetrate the oceans' surface reportedly down to depths of 160 metres implies that a submarine operating deep and presumably believing it is under no threat of detection at the time, could very well have been detected by a LIDAR system and have absolutely no indication that it has been detected and potentially about to be prosecuted.

Submariners have a great dislike of being 'bounced', this technology has the potential of changing the entire paradigm of ASW by adding another category of means of detection alongside radar and acoustics - light. Please refer to Dr John Birkelands thesis, which was commissioned by the Royal Norwegian Navy, at the top of the reference list for more information about LIDAR and ASW. Additionally, Dr Dennis Delic from DST Group has recently written a study for the RAAF regarding LIDAR technology and ASW.

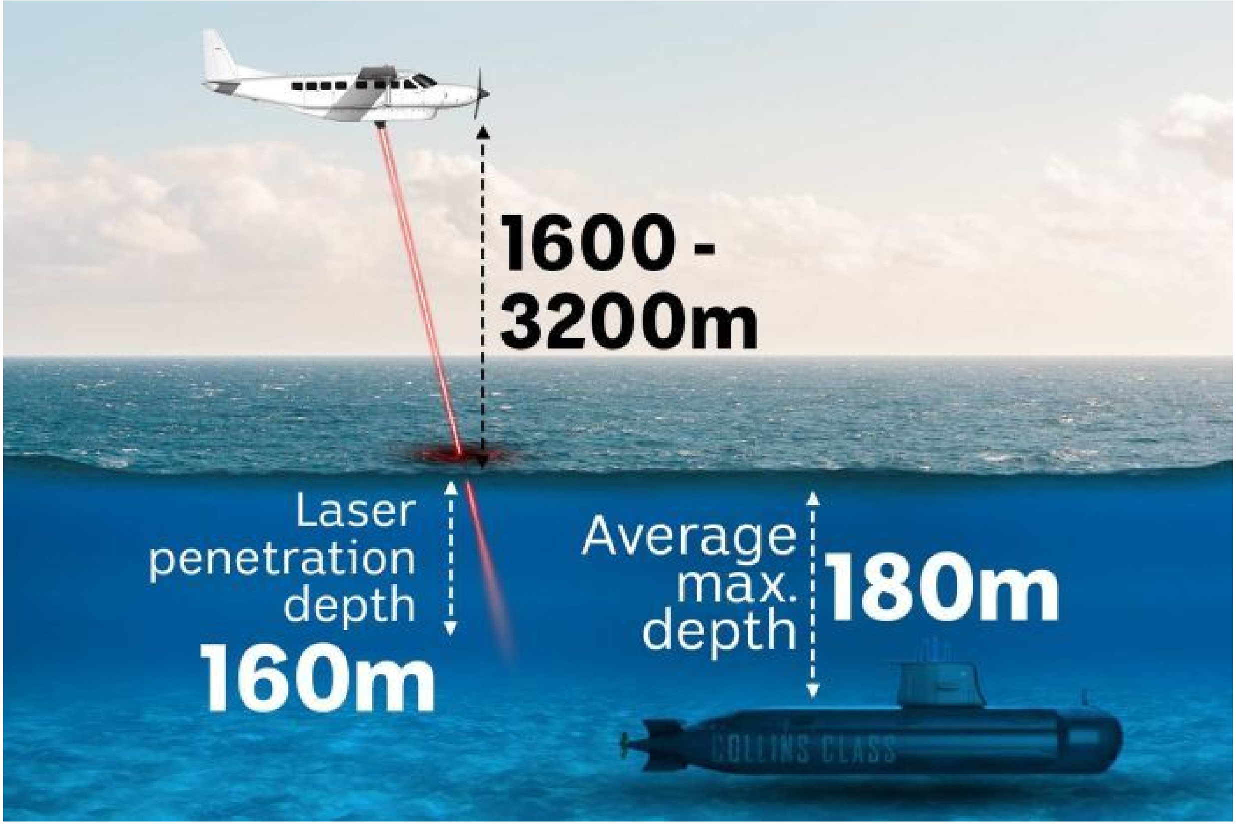


*Figure 3: Laser depth in range of Australia's operational submarines. (Image: ABC News from Jarrod Fankhauser)*

## The emergence of Laser weapons

The last five years has seen the emergence of Laser weapon systems, particularly in use by China and the USA. The US AN/SEQ-3 has been trialled on two ships in recent years and reportedly could enter service as early as next year, designated as the 'Helios' (High Energy Laser and Integrated Optical-dazzler with Surveillance) system.

China has a strong interest in both LIDAR and Laser, and if one searches more guarded resources it is clear that China is currently using light spectrum sensors and weapons. One can watch video of the USN's AN/SEQ-3 trials on the internet and see the capability and potential of a relatively low powered (15-50kW) laser in a maritime warfare context.

From an EW perspective, once again we find ourselves in the position of a new weapon system on the verge of becoming operational, and no first hand means of detecting it and countering it. Directed Energy Weapons, using microwave RF or Laser, are the new frontier in modern warfare. How hard are we looking at it, both from a countermeasures point of view, and indeed from acquiring it and using it for ourselves?

## Conclusion

The purpose of this article to arouse interest amongst the Maritime Warfare Community. I have deliberately kept this article brief and to the point, and encourage you all to think about this potential threat and how we might go about both utilising and combating this technology.

## References and suggested reading


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## About the author

CPO Freestone joined the RAN in 1986 as a Radio Operator Electronic Warfare (ROEW) sailor. He has served on-board HMA Ships *Brisbane*, *Perth*, *Stuart* and *Swan*; and HMA Submarines *Orion*, *Collins*, *Farncomb*, *Waller* (twice) and *Dechaineux*. CPO Freestone has served three postings as an EW instructor at the Submarine Training and Systems Centre and two postings as the Manager of RANTEWSS Det West. CPO Freestone has also undertaken EW training in the USA and is currently studying a Master of War Studies at UNSW.