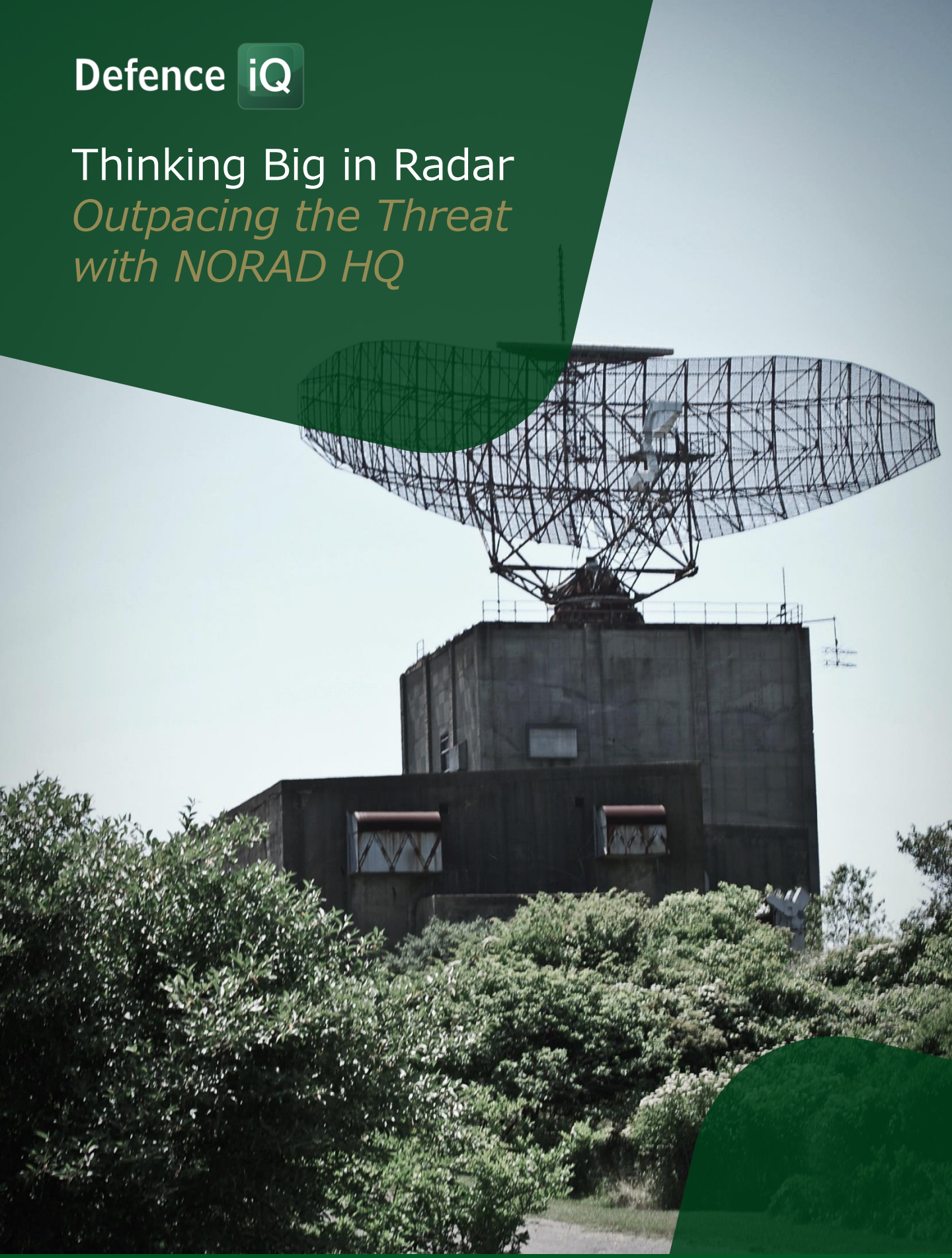
Defence iQ

Thinking Big in Radar

Outpacing the Threat with NORAD HQ



IN ASSOCIATION WITH MILITARY RADAR

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The customers in question? The world’s militaries. **Brian Lihani** is the Chief of the Radar Warning Branch at NORAD HQ. NORAD (North American Aerospace Defense Command) is a binational and combined organization co-led by the United States and Canada. The NORAD Agreement establishes three primary missions for NORAD. They are Aerospace Warning, Aerospace Control, and Maritime Warning for North America. NORAD is devoted to preserving air sovereignty, protecting national aerospace and conducting aerospace and maritime warning.

The defence of North American airspace and any contested territory is a tightrope act. The variety of radar countermeasures and the development of electronic warfare can quickly lead to capability gaps, plus widen the risk of infiltration.

During our interview with Mr. Lihani, phrases and descriptors such as “system-of-systems” and “outpacing the threat” were often mentioned and are key to understanding the urgency and importance of patrolling the skies.

Considering the enormous task that NORAD continues to face, system-of-systems is an apt way to describe the integration of new platforms into NORAD’s radar infrastructure.

The pragmatic choices of radar equipment – alongside NORAD’s lengthy requirements – reflects the underlying philosophy of system-of-systems and threat-centric strategies.

It is possible to strike a productive and communicative relationship between industry and militaries by thinking big in radar.

Continue to full interview ✈

"Keeping up with world events and getting critical information is essential for success. As one of our previous commanders stated, "we need to outpace the threat" and this couldn't be more factual. Think outside the box and think like a threat. Be one step ahead. The threat will continue to develop new products to try and 'outsmart' the US and our allies. We need to make sure we are ahead in that area."

The specific threat is not named by Mr. Lihani. In the case of a large-territorial operation like NORAD, adversarial threats in the air can include land-to-air based missiles and aircraft.

In 2017, several Western news outlets reported an uptick in Russian military aircraft activity. Activity spiked in 2014 with 10 intercepts but has since leveled. One of the most prominent examples were the four intercepts conducted in April 17-20, 2017. NORAD intercepted Russian aircraft inside the ADIZ (Air Defense Identification Zone) off of Alaska. Another Russian intercept occurred in May 2017, detecting Russian TU-95 Bear Bombers escorted by SU-25s. This was the first time since 2015 that such a formation has been observed. The US military has stressed to the public that flights of this nature are routine and are not cause for alarm.

While these instances were detectable and NORAD has the means to identify them, radar evading technologies are still being pursued. Lihani mentions a particular challenge that is precisely known to deploy such countermeasures,

"Next generation fighters are a challenge and NORAD is always evaluating what needs to be 'seen' to protect North America. Radar developers are continuously researching the best ways to see and identify the new generation of fighters."

This has been the case with add-on technologies being placed on Russian and Chinese next generation fighters. The new (fifth) generation fighters boast advanced stealth capabilities, making them a challenge for traditional radio systems to detect.

Outpacing the threat's stealth detection entails keeping abreast of the frontiers of radar research. It is thus becomes essential to monitor which technology potential adversaries are exploring.

In 2017, Beijing state media broadcasted that China is developing photonics-based radar – aka "quantum radar" – for military applications. Reports claimed that this new radar type would have the ability to penetrate through current stealth capabilities.

Quantum radar emits a stream of coupled-photons instead of radio waves. Sensors then analyze instances of photon entanglement. Quantum radar is supposedly undetectable and un-jammable. But photon decoherence would still limit quantum radar's reported 100km range.

Russian state-media also reported on photonics radar development. Russia's ROFAR system (radio-optical phased array antennae) was announced to be undergoing testing. Russia intends to place it onto the next generation fighter, the Sukhoi PAK-FA. ROFAR is to be ready for testing in 2018.

The marriage of stealth and stealth detecting technologies on multiple next generation fighter models could prove extremely challenging for radar detection.

With increasing amounts of research being spent on new and novel ways to counter and confuse radar detection and processing, it makes sense for technology to expand and meet (or in this case, "outpace") the threat.

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Over-the-Horizon but not Out of Reach: OTH Radar

In addition to stealth aircraft, UAVs and low-altitude flying aircraft are also a challenge for military radar. In uncertain times, going back to older technologies for inspiration is one option. Over-the-Horizon Radar (OTHR) is one such technology.

Due to the curvature of the earth, airborne threats can hide from traditional radar. Radar microwaves are typically transmitted at straight angles, creating blind spots that can be exploited by adversaries flying low and capitalising on rough terrain. This is known as terrain hugging.

To combat against terrain hugging OTHR uses an area of the sky known as the ionosphere to refract micorwaves so that the radar can 'see' these blindspots. OTHR comes in either backscatter or surfacewave variants and can cover thousands of kilometers. This range made them the traditional choice for early warnings of missile launch detection.

"The continuing advancements in OTHR are very exciting. If the operational system does what is expected it could be a major benefit to the air defense of North America."

Countries which have either vast amounts of territory to monitor or sit alongside adversaries, are the primary operators. OTHR has been used extensively in Russia since the Cold War and is still a mainstay in its defensive radar infrastructure. It is also expanding.

Rossisskaya Gazeta reported that six new OTHR radar installations will operate in the Russian Arctic. The Tianbo Radar installed in 2017 and the OTH-B backscatter radar monitoring South China Sea, are two known Chinese OTHR. Eastern Powers have stayed the course with OTHR, while OTHR is experiencing a resurgence in the West.

Among allies, Australia is one of the most recent to use OTHR with its Jindalee Over-The-Horizon Radar Network (JORN), completed in 2000 . France has used OTHR since the 1990s through its NOSTRADAMUS project and officially launched the maritime-based STRADIVARIUS OTHR project in 2009. OTHR is also used in the UK, Japan, Italy and by US services, but not presently by NORAD.

Existing OTHR such as JORN and NOSTRADAMUS are able to detect missile launches, as well as stealth aircraft that were previously impervious to microwave radar. If JORN and NOSTRADAMUS's successes are any indication, OTHR would be a wise investment for NORAD. JORN's operational life is expected to extend to beyond 2024.

"Over-the-Horizon-Radar has been a part of the NORAD's (and US Northern Command's) wish list for years. A proven and highly effective system, OTHR could be a part of our 'super radar' should it work out."

Even if an OTHR solution for NORAD is unable to be fully enmeshed into the Super Radar system, it does not mean that OTHR would be completely out of the picture. Mr. Lihani closes the topic of a future OTHR in the US with this operational caveat:

"But, more likely, it will be a stand alone system that feeds into the NORAD air defense system."

Super Radar, Legacy Platforms

While NORAD still searches for its preferred OTHR, they are ready to see what a Super Radar System can offer. Featuring prominently on the agenda of the Military Radar Conference held in London, we asked Mr. Lihani what Super Radar actually means.

"The 'Super Radar' (not an official term, by the way) has the potential to subsume up to 793 existing radar systems, including all 342 ASR-8, ASR-9, ASR-11, GPN, TDWR, NEXRAD, ARSR-4, CARSR, and collocated ATCBI cooperative 343 beacon systems."

The proposed composition of the Super Radar include s air-traffic control radar, weather tracking radar, and 3D solid state long-range radar. They will be synchronized and work alongside infrared-tracking satellites and fighter aircraft in NORAD's ever-expanding arsenal of airspace and missile defenses.

The radar bands being subsumed include low-attenuating S-Band radars for near and far weather observation, L-band low frequency radars, digital next generation terminal air traffic control and specialised doppler radar.

Each radar can fill in the others' gaps. For instance, L-band radars are optimal for rough detection and reducing radar clutter coming from stealth craft at long ranges. L-band radar, which is more weather robust, can be optimised by exchanging information with S-band radar. S-band radars are effective at short range but are sensitive to weather conditions.

All radar groups will still simultaneously maintain their primary purpose.

Lihani summarised Super Radar's operational goal:

"This system must support simultaneous characterisation of weather phenomena as well as track all aircraft within the terminal, en-route, and border airspace. Bottom-line, it will be able to track aircraft and provide weather critical data at the same time."

It is still a perennial challenge for the world's armed forces to balance new and legacy systems. We asked Lihani how NORAD's legacy systems will be integrated into this ambitious project,

"Many legacy systems are still very capable and just need 'tweaking' to upgrade their capabilities. Legacy systems are always evaluated to determine if they can be incorporated in a system-of-systems. If they can be modified to 'fit in' to new multi-system radar then the legacy system will be kept; if it can't 'fit in' then it could be replaced with a new system or turned off completely."

System-of-systems engineering holds two defining characteristics. The first is that all managerial elements of a component are independent. The second is that all components are also operationally dependent. These characteristics enable NORAD to achieve operational flexibility while maintaining a wide capacity to act.

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> *"Outpacing the threat is always something that NORAD attempts to do. The current launches by potential adversaries increases the urgency to make sure we can defend North America"*

NORAD is no stranger to the system-of-systems dynamic experience. Their BMEWS (Ballistic Missile Early Warning System) built in the 1960s, was replaced by SSPARS (Solid State Phased Array System) in 2001 while also incorporating PAVE PAWS (Precision Acquisition Vehicle Entry Phased Array Warning System). PAVE PAWS, having originated in the 1970s, would later replace the previous radars in Alaska and expand to cover the US's Southeastern flank.

NORAD's PAVE PAWS may soon join BMEWS in the annals of history. PAVE PAWS is currently being replaced and absorbed into the SSPARS on Beale and Cape Cod.

The shift change and later incorporation of varied technologies are expected in system-of-systems. As an organisation with a large geographic responsibility, it is essential for NORAD to cover all its bases.

Conclusion

Between developing super radar and simultaneously reassessing legacy systems, outpacing the threat continues to be the principal target for NORAD.

With every radar solution put forward, acceptance into the wider network is not automatic. Each component must demonstrate persistent relevance. The evolution of NORAD may appear Darwinian at first but the ultimate advantage for any independent unit in a system-of -systems model is its ability to pool resources into a more complex framework,. The sum will become greater than its parts.

As threats experiment with more evasive radar countermeasures at all ends of the spectrum, bigger becomes better. In the race of offense vs. defence, NORAD looks to be gaining on the threat, whatever and wherever it may be. Lihani leaves us with these parting words:

"Outpacing the threat is always something that NORAD attempts to do. The current launches by potential adversaries increases the urgency to make sure we can defend North America. Our co-command, US Northern Command, works closely with NORAD to ensure North America is defended as best as possible." ✪

Brian Lihani, will be speaking at the Military Radar Conference in London in August 22-24 2017.

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Military Radar 2017 will identify the critical improvements to radar functionality. Key to the programme will be an update on progress towards cognitive radar, together with the risks and benefits of adopting multi-system technologies. Managing SWaP challenges is another focus for capability development, reflective of the need to mount radar on ever-smaller airborne platforms.

Join a panel of experts at the 15th annual Military Radar summit, as they establish a critical path for applying advanced radar technology to deliver improved threat detection. Take part in the only summit commited not just to realising the latest research, but to understanding the growing threat of Electronic Warfare.

Top Reasons to Attend

*Hear directly from HQ NORAD about the operational requirements of a multi-system radar

*Develop adaptive and autonomous systems that are rigorous enough to meet the minimal fail rates required by military operators, and continue to work towards the application of a truly cognitive radar system

* Discover the critical advances in ELINT and Electronic Warfare, and analyse how advances in MIMO radar can be used to safeguard your capabilities against jamming and stealth technologies

* Establish an effective procurement strategy by exploring the latest innovations in radar technology and reasearch.....and more!

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