

SINGAPORE DEFENCE TECHNOLOGY SUMMIT

27-29 June 2018

Impact of the 4th Industrial Revolution
on Defence and Security







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Coordinating Minister for National Security, Singapore

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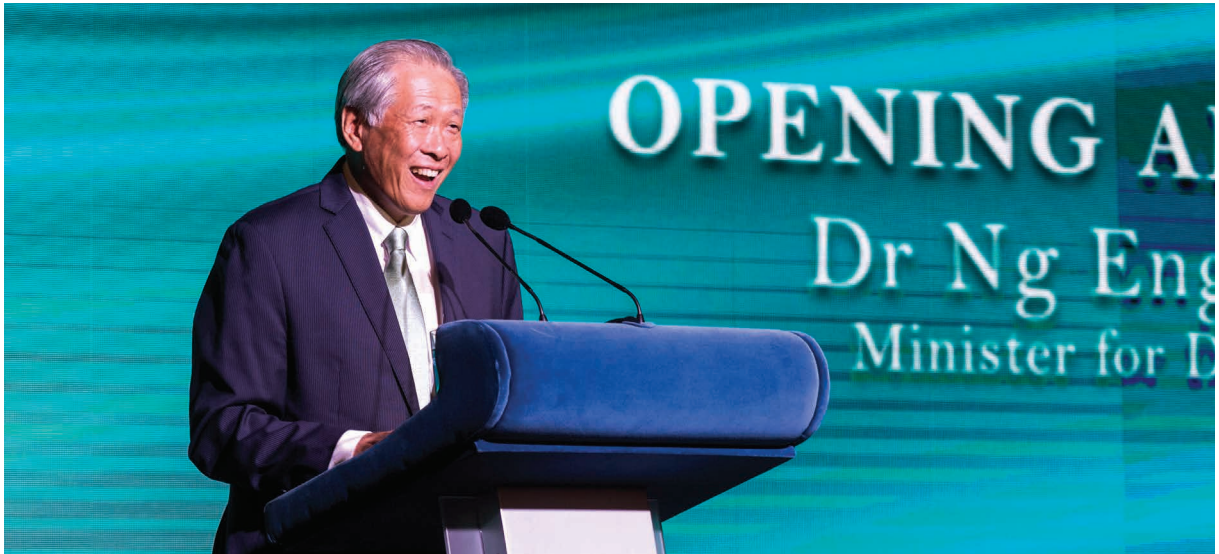
“New sensing and data analysis tools allow us to achieve near comprehensive awareness. Remote, precise and rapid response capabilities allow us to deal more effectively with conventional or traditional threats in the physical world. . . . On the home front, we are able to protect our borders better, seek out and detect potential threats before they develop into actual attacks. . . . The question is, are these adequate to deal with these new situations and technologies? . . . Another major change is that commercial technologies are now often advancing more rapidly than specialised solutions for defence and security. . . . Many of these commercial technologies and products can be adapted to meet defence and security needs.”

Addressing New Vulnerabilities

“Technologies which help us address gaps in our security and defence capabilities can themselves create new vulnerabilities. . . . While the defence and security community is keenly aware of these new vulnerabilities, the reality, often, is that governments and commercial operators struggle to find solutions. . . . Our conventional modes of regulation and protective measures will need to be geared up to deal with the speed, anonymity and scale of such new threats. . . . Governments, industry and academia need to share strategies and knowledge. And we must start the conversation now to address the governance and ethical concerns related to the use of these technologies.”

Forming New Partnerships

“As economies become more integrated and connected digitally, governments, companies and academia need to form partnerships to better address issues that cut across sectors and national boundaries. The more interconnected we are, and the more we rely on key nodes and critical information infrastructure, the higher the concentration risks. These can result in not just a local disruption, but potentially a system-wide global one. . . . We also need to work together to establish new codes of practice and norms for technologies that are becoming ready for deployment, but where there are no international standards.”



Excerpts

“Why have leading lights of this generation of inventors, innovators, scientists and engineers not behave as their predecessors did, but chose instead to meet, discuss and compare notes? Let me just share three possible reasons. First, the pace of knowledge discovered or new applications developed has been rising at a phenomenal pace. . . . Second, new knowledge, which many of you here have discovered or pioneered, is already leading the world into terra incognita. . . . Third, this Summit allows, I use this word very generally, ‘Techies’ around the world to socialise, if not commiserate. . . . Whatever the motivations, we have assembled here in this meeting distinguished men and women who, through their ideas, inventions and leadership decisions, will shape tomorrow’s World, hopefully for the better.”

“Today, huge investments into technology are made by both Government and Industry. . . . With private sector involvement and a multipolar world for technology start-ups, the pace of discovery and application thereof, will likely quicken, with shorter development cycles. . . . Governments will increasingly look to commercial companies for solutions too. . . . These changes spell good news for the private sector but there are also risks and dilemmas to confront at this meeting. How do we ensure that new technologies do not undermine our collective security? . . . Can and how do we attain the golden mean between sharing and privacy? . . . These are tough questions and moral dilemmas to address, with often no easy or cost-free answers.”

“I believe that Singapore can play a useful role in this region and even globally as a place where progressive minds meet, where ideas flourish, and new paths are forged. . . . If we can play that small role to advance the cause of peace and enable progress in humanity, then Singapore ought to do it and do it well. I hope that this Tech Summit can play a role in helping all countries deal with the many blessings as well as challenges that technological disruptions will bring in their wake.”

Impetus of the
Tech Summit

Moral Dilemmas
Arising from New
Technologies

Singapore’s Role
in Advancing
Peace



(From left)

Moderator: **Dr Kathleen HICKS**, Senior Vice President, Henry A. Kissinger Chair; Director, International Security Program, Center for Strategic and International Studies, USA

Speakers: **BG(Ret) Dr Daniel GOLD**, Head, Directorate of Defense Research and Development, Israel
IGA Caroline LAURENT, Director, Strategy Directorate, Directorate-General for Armaments, France
Mr Jan-Olof LIND, Director General and President, Swedish Defence Research Agency, Sweden
Dr Brian PIERCE, Director, Information Innovation Office, Defense Advanced Research Projects Agency, USA
Mr QUEK Gim Pew, Chief Defence Scientist and Future Systems and Technology Architect, Ministry of Defence, Singapore

In a hyper-connected world where information, ideas and people are travelling faster than ever before and technology becomes more easily accessible, the nature of defence and security threats, and the distribution of power will change, both geographically and from state to non-state actors. The speakers shared approaches by their governments to address challenges posed by the rapidly evolving threat environment.

Technology Development and Ethics

Regarding the extent to which ethical considerations should shape technology development, BG(Ret) Dr Gold opined that technology development was meant to create options for policymakers, and should hence not be constrained upfront by ethical considerations. IGA Laurent and Mr Lind, however, spoke of the strong concerns in France and Sweden towards justifying the ethical use of technologies before development. Dr Pierce noted that the US had started exploring how to manage ethical concerns for emerging Fourth Industrial Revolution (4th IR) technologies, while Mr Quek shared that Singapore would observe very strict rules of engagement.

Leveraging and Adopting Technologies

While the speakers concurred on the need to leverage commercial technologies, they advised caution in selecting the right technologies and assessing their suitability for the military environment. Systems thinking could be applied to determine the appropriate approach to integrate such technologies in military systems. In parallel, the defence and security sector could adapt commercial technology development approaches, such as agile development, to better harness such technologies.

Biological Threats

Another topic of discussion was the mitigation measures against threats posed by the ability to engineer bacteria and viruses for biological warfare. Dr Pierce highlighted the Defense Advanced Research Projects Agency's Safe Genes program, which aimed to protect the US military against accidental or intentional misuse of genome editing technologies. IGA Laurent pointed out that the area's less classified nature could also offer more collaboration opportunities for countries.



(From left)

Moderator: **Dr Anthony TETHER**, Former Director, Defense Advanced Research Projects Agency, USA

Speakers: **Mr Jeroen CAPPAERT**, Co-Founder and Co-Chief Technology Officer, Spire Global, USA

Prof Hugh DURRANT-WHYTE, Chief Scientific Adviser, Ministry of Defence, UK

Dr HONG Won-Pyo, President and Chief Executive Officer, Samsung SDS, South Korea

Prof Richard KITNEY, Professor of BioMedical Systems, Department of Bioengineering, Imperial College, UK

Prof TANG Xiao'ou, Founder, SenseTime, People's Republic of China

Noting that the current 4th IR built upon the third to leverage the increasing influence of the digital world on every aspect of our lives, Dr Tether invited the speakers to share their views of the technology paramount in driving the 4th IR. Prof Tang highlighted artificial intelligence (AI), which allowed machines to perform specific tasks more efficiently than humans. Prof Kitney spoke about synthetic biology, which enabled the designing and engineering of biological-based parts and the re-designing of existing natural biological systems. Dr Hong suggested blockchain, which realised information exchange by many different entities in a transparent manner whilst protecting data integrity. Mr Cappaert stated the commoditisation of space access and space technologies, which allowed widespread outreach to remote and under-instrumented areas. Prof Durrant-Whyte mentioned material science, which opened up a new realm of developing materials with unique properties.

Data: “Crude Oil” of the 4th IR

Prof Tang highlighted that increased access to large amounts of data was a key enabler of many technology developments, resulting in a paradigm shift from using models or algorithms to churn out data, to using data to derive models and algorithms

in technology developments. Dr Hong agreed, giving the example of how Samsung utilised data analytics and AI to improve efficiency in its semiconductor factory. Prof Durrant-Whyte, however, observed that many problems that man were interested to solve inevitably had very little data. He postulated that the real problem was one of small data, rather than big data. Adding on, Mr Cappaert pointed out that data also required filtering and cleaning in order to be useful.

The Future of Work: Utopia or Pandora’s box

Noting that disruptions caused by the 4th IR could result in the loss of jobs, Dr Tether mused that the future of work could turn out to be either a utopia or Pandora’s box. Prof Durrant-Whyte expressed his concern that technology advancements were “hollowing out the middle”. Instead of removing “blue-collar” jobs, AI was taking away the jobs of accountants, lawyers and paralegals – jobs that man was educating the young for, and would result in a polarised society. Prof Tang, however, opined that AI was actually replacing jobs which were repetitive and uninteresting. This would free up significant resources from “low-end” jobs, such as farmers and drivers, to be channelled towards other industries.



(From left)

Moderator: **Prof LOW Teck Seng**, Chief Executive Officer, National Research Foundation, Singapore

Speakers: **Dr Jean-Luc BEYLAT**, Chairman, Business Cluster for Systematic Paris-Region, France

Mr Antoine BOUVIER, Chief Executive Officer, MBDA, France

Vice ADM Arie Jan DE WAARD, National Armament Director and Director, Defence Materiel Organisation, The Netherlands

Dr Chris KIRCHHOFF, Visiting Technologist, Harvard University and Former Partner, Defense Innovation Unit Experimental, USA

Prof Alberto SANGIOVANNI-VINCENTELLI, The Edgar L. and Harold H. Buttner Chair, Department of EECS, University of California, Berkeley, USA

For defence and security agencies, collaboration is a key enabler, both to leverage myriad innovations and diverse sources and to tackle common security challenges. The speakers highlighted several collaboration models for consideration, including the Campus for Research Excellence and Technological Enterprise (CREATE) in Singapore, the Systematic Paris-Region in France, and the Defense Innovation Unit Experimental in the US. In addition, they drew attention to the establishment of an innovation cell within the Netherlands' Defence Materiel Organisation.

No Innovation without Collaboration

Prof Sangiovanni-Vincentelli highlighted five conditions required for innovation to flourish: a common goal and shared vision; co-location; mutual respect and strong personal bonds; the use of the same technology language; and government research funding and mentorship by venture capitalists.

Managing Security Risks

To manage the risks introduced by extensive collaboration, Dr Beylat suggested adapting from mechanisms used in the open-source community.

Vice ADM de Waard recommended protecting core defence domains, while opening the fringes to non-traditional sources. Dr Kirchhoff noted that the security community should rationalise opportunities vis-à-vis associated risks from collaborations. Mr Bouvier suggested reviewing security frameworks and agreements. Prof Sangiovanni-Vincentelli felt that countermeasures could be put in place to ensure traceability and deter unauthorised manipulation of technologies. However, a balance should be struck between onerous regulations and market accessibility.

Fielding Innovation

Defence ministries need to work with small and medium enterprises to quickly field innovative technologies. Dr Kirchhoff recommended pairing technologies from start-ups with the traditional systems integrator to speed up the implementation cycle. Vice ADM de Waard opined using smart procurement to circumvent long acquisition cycles. Dr Beylat suggested that defence ministries should continue investing in the ecosystem to facilitate growth in start-ups, while large companies could acquire innovations from start-ups to accelerate their R&D capabilities.

Breakout Session 1: Realising the Potential of Autonomous Systems



(Clockwise from top right)

Moderator: **Mr John MARKOFF**, Pulitzer Prize Winner, Author of *Machines of Loving Grace*, USA

Speakers: **Dr Nicolas CHAPADOS**, Co-Founder and Chief Science Officer, Element AI, Canada
MG(Ret) Robert LATIFF, Consultant and Author of *Future War: Preparing for the New Global Battlefield*, USA
Dr Robert SADOWSKI, Army Chief Roboticist, US Army Tank Automotive Research, Development and Engineering Center, USA

Autonomous systems powered by AI are set to play an increasing role in defence and security as they reduce manpower, expedite decision making and take over dangerous tasks. The speakers shared their views on watch areas for realising the potential of autonomous systems. Dr Chapados highlighted standards for safe and ethical autonomous systems, such as the principles of the Institute of Electrical and Electronics Engineers' "Ethically Aligned Design" and the three principles for creating safer AI by Stuart Russell, and expressed concern about adversarial attacks. Using the US Army's experience in developing and integrating robotic systems, Dr Sadowski illustrated challenges in deploying such systems in the military domain. MG(Ret) Latiff raised concerns on whether sufficient consideration was being given to the ethical use of these systems.

Building Trust in Autonomous Systems

Dr Sadowski noted that autonomy in man-machine teaming could be strengthened by building in explainable AI with runtime safety, behaviour and mission assurance over dynamic mission profiles. Physical experimentation with soldier feedback and exercises for soldiers to train with autonomous

systems would further build trust for humans working alongside autonomous machines.

Building the Ecosystem

Dr Sadowski acknowledged the need for close partnerships between the military, government, academia, industry and innovators, to adapt commercial-off-the-shelf solutions to military-off-the-shelf. A common development environment and an open and scalable architecture could help build up the ecosystem.

Ethics in Autonomy

MG(Ret) Latiff pointed out that discussion on the ethical use of autonomy lagged behind technology developments in this area, and highlighted that deeper moral issues pertaining to human rights warranted further deliberation. Instead of focusing on lethal applications, there could be more non-lethal applications of AI. Dr Chapados shared that while there were many efforts in developing AI capabilities for autonomous systems in Canada, the country supported a full ban of Lethal Autonomous Weapon Systems (LAWS). However, Dr Sadowski cautioned that there was a need to be mindful that enemies would have access to LAWS and to be prepared with countermeasures.



(Clockwise from top left)

Moderator: **Mr CHEONG Chee Hoo**, Chief Executive Officer, DSO National Laboratories, Singapore

Speakers: **Prof Anthony FINKELSTEIN**, Chief Scientific Adviser for National Security, UK
Dr Kira RADINSKY, Chief Scientist and Director of Data Science, eBay, Israel
Prof Neil ROBERTSON, Founding Chief Technology Officer, AnyVision; Professor of Research for Image and Vision Systems and Director of Research for Data Science and Scalable Computing, Queen's University of Belfast, UK
Dr WU Shuang, Scientist, Head of Research in Singapore and Silicon Valley, YITU Technology, People's Republic of China

Mr Cheong noted that terrorism was an evolving problem that had become highly sophisticated. The speakers discussed their views on how technologies could be applied to analyse data on human activity and aid counter-terrorism efforts.

Defining the Problem Statement

The hunt for terrorists was both a big data and small data problem. Prof Finkelstein postulated a long-tail distribution for a potential terrorist threat, with only a small number of individuals presenting very high risk. Dr Wu said that there was a need to understand the costs of errors at each search stage, to ensure that should mistakes occur, these would be at a reasonable and acceptable "cost". In response, Prof Robertson opined that it was easier to find suspects in big data with the right data. Dr Radinsky observed that for organised crime and terrorism, it was easy to gain knowledge of the group through identifying the group leader.

Challenges in Applying 4th IR Technologies

The speakers concurred that 4th IR technologies were useful in sieving out anomalies, but there were limits as to their abilities. At the same time, the democratisation of AI could allow terrorists to possess means to develop and deploy counter-

analytics analytics capabilities, making adversarial AI a viable threat. Prof Finkelstein opined that standard analytics methods would require a more granular understanding of terrorist psychology and methodologies to yield real results. Prof Robertson and Dr Radinsky concurred that an understanding of machine learning could enhance the ability to sieve out data anomalies and devise counter strategies.

Data Privacy

Prof Robertson noted that it was in the interest of technology companies to ensure data privacy to encourage widespread adoption. In contrast, Dr Radinsky highlighted that shared cancer screening data in Israel had helped to identify potential cancer patients. Prof Finkelstein shared that potential technologies to enable data mining while preserving data privacy were in the early stages of development. Dr Wu said that there would be trade-offs between privacy, security, personal convenience and efficiency, but these were not mutually exclusive. As such, governments should set good regulations to govern the use of personal data. Concurring, Prof Finkelstein added that it was important for governments to maintain their citizens' trust in them for national security.

Breakout Session 3: Forging a New Cyber Security Paradigm



(Anti-clockwise from top left)

Moderator: **Mr David KOH**, Deputy Secretary (Special Projects) and Defence Cyber Chief, Ministry of Defence; Chief Executive, Cyber Security Agency, Singapore

Speakers: **GEN(Ret) Keith ALEXANDER**, Founder and Chief Executive Officer, IronNet Cybersecurity, USA

Mr SRINIVASAN CR, Chief Digital Officer, Tata Communications, India

Prof Stuart MADNICK, John Norris Maguire Professor of Information Technologies, MIT Sloan School of Management and Professor of Engineering Systems, MIT School of Engineering; Founding Director of MIT's Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity, USA

Mr Hudi ZACK, Chief Executive Director, Technology Unit, Israel National Cyber Directorate, Israel



Mr Koh noted that with the inexorable move towards increased digitalisation, cybersecurity had permeated every aspect of our daily lives. Each of the speakers shared his viewpoint on the challenges and possible mitigation approaches towards forging a new cybersecurity paradigm.

Nature of Cyber Warfare

Cyber warfare was inherently asymmetric. While governments and organisations were bound by the need to use legitimate, usually limited, resources, hackers could operate unencumbered with stolen and potentially unlimited resources. GEN(Ret) Alexander pointed out that the lack of information sharing within sectors and with the government, as well as the increasingly stealthy nature of cyberattacks, were key reasons why industries and governments were woefully unprepared for cyberattacks. Mr Zack added that these were further exacerbated by the open and ubiquitous nature of the internet, and state-sponsored actors conducting more sophisticated and larger-scale attacks.

Responding to the Cyber Threat

Prof Madnick highlighted the importance of establishing a cyber-safe culture in organisations.

GEN(Ret) Alexander drew parallels with military training, and said that response abilities could be sharpened through relentless cyberattack drills and exercises. Mr Zack opined that understanding the motivations, intentions and modus operandi of potential attackers could further allow them to be deceived and confused. The speakers also noted that governments could lead the setting of standards for Internet-of-Things devices for device identification, anomaly detection and remote response, to manage challenges posed by the proliferation of such devices.

Nurturing Talent

Mr Srinivasan emphasised that it was paramount to nurture new talent in cybersecurity. Noting that cyberattacks often occurred at the cusp of various technologies, he opined that the education arena should emphasise cybersecurity and encourage the basic understanding of various technologies within cyberspace. The speakers concurred that cyber threats could be mitigated and managed through widespread information sharing and cooperation to maintain a sound understanding of the complex cybersecurity landscape. In addition, establishing coalitions with like-minded partners could enhance collaboration at the enterprise, national and international levels.



(From left)

Moderator: **Dr Linton WELLS II**, Former Acting Assistant Secretary of Defense and Department of Defense Chief Information Officer, USA

Speakers: **Mr Peter HO**, Senior Advisor, Centre for Strategic Futures, Prime Minister's Office, Singapore
Mr Frank KENDALL, Former Under Secretary of Defense (Acquisition, Technology and Logistics), USA
Mr Rafi MAOR, Former Chairman of Israel Aerospace Industries, Israel
Dr Thomas PHILBECK, Head of Science and Technology Studies, World Economic Forum, Switzerland

Dr Wells observed that the scope of the 4th IR was blurring the lines between different domains. The summary plenary brought together insights garnered over the plenary and breakout discussions on the 4th IR in the context of defence and security.

Impact of the 4th IR on Defence and Security

Mr Ho noted that while the 4th IR had ushered in a new reality of cyber war waged across borders, even low technology could be used in disruptive ways, especially when combined with imagination. Hence, defence and security organisations must change to adapt quickly and be imaginative to drive real innovation. Mr Kendall said that the 4th IR could not only boost productivity but also bring about a revolution in military affairs. He cautioned that technologies driving the 4th IR could be used for both good and ill. Mr Maor remarked that the debate surrounding the 4th IR was complex as it aimed to replace the human brain – not just its functions but also the intellectual and emotional aspects. Concurring, Dr Philbeck noted the symbiotic relationship between humans and technology, highlighting that people would shape

how 4th IR technologies could be used to construct a different way to relate to each other.

Balancing Defence Investments in the 4th IR

Mr Kendall opined that governments had an obligation to invest in and develop 4th IR technologies because potential adversaries would invest and use them in less ethical ways. Mr Ho suggested that defence investments for the 4th IR should budget for unforeseen technological disruptions by being flexible and building spare capacity into designs to cater for unforeseen circumstances. He added that it was critical to have a significant component on R&D in defence budgets, to allow for rapid response to changes in the environment. Dr Philbeck noted that technology might not always be the only solution, and instead recommended considering the broader societal perspective, and assess the need to reallocate budget to support relevant social, economic and education programmes.

Managing Technological Disruption

Mr Maor highlighted that those who bore the brunt of technological disruptions were often those who



did not understand the technologies. As such, Dr Philbeck said that it was essential for technologists to master the art of explaining things from a layman's perspective, to help the public better understand the 4th IR amidst media hype and sensationalisation. He added that businesses, policy-makers and citizens needed to speak a common language to communicate effectively in this new paradigm. Mr Ho suggested that pilots, such as setting aside a dedicated precinct to experiment with autonomous vehicles in Singapore's context, could offer a means to introduce people to new technologies.

Managing the Impact on Society

Mr Ho said that the 4th IR may lead to fragmentation within nations as people no longer associated themselves with nations and instead aligned themselves with ideologies that transcended borders, following the homogenisation of values. Dr Philbeck said that it was important to examine 4th IR developments further, not just from a direct defence and security perspective, but also in other indirect aspects such as industrialisation, the future of work and its impact on education.

There were also wider implications stemming from the developments in neuro-technology that would warrant deeper discussions.

Enabling a More Secure Global Environment

Dr Wells noted that a poll of the audience indicated that it was divided as to whether the overall social, political and technological trends of the 4th IR would make the global environment more secure or less secure by 2030. In contrast, the speakers were unanimous in their belief that it would become more secure. Mr Kendall highlighted that there was vast potential for 4th IR technologies to be used to achieve a world without the use of military force. Mr Maor noted that man would do what was needed to bring about a safer world as with his nature. Mr Ho concurred, expressing optimism that the younger generation, who were more comfortable with digital technologies, would use these to facilitate the search for security. Whilst in agreement, Dr Philbeck cautioned that the greater global security afforded by the 4th IR would come at a price, where man might have to address difficult questions, such as what it meant to be a citizen and if man was comfortable to live without anonymity.

Technology Showcase and Site Visits

To drive further dialogue and facilitate collaboration, a technology showcase which featured the innovative use of emerging technologies was organised as part of the Tech Summit. Over the three days, delegates and exhibitors discussed extensively about the Singapore technology ecosystem, and technologies in the areas of digitalisation and Internet-of-Things, robotics and automation, cybersecurity and quantum technology, as well as AI and data analytics.

The Tech Summit also provided first-hand insights into the exciting innovations and initiatives that are shaping Singapore's development through various site visits. These included CREATE, DSO National Laboratories, Littoral Mission Vessel, Port Operations Control Centre, Singtel's Future Now Innovation Centre, Smart Airbase of the Future, Singapore Technologies Engineering and Woodlands Checkpoint.



Engagements

Apart from the exchange of knowledge, the Tech Summit opened doors to new opportunities for greater collaboration and partnerships. More than 120 meetings, both within the defence and security sector as well as beyond, were arranged on the sidelines.

In addition, eight speakers met with Singapore Prime Minister Mr Lee Hsien Loong at the Istana, where they exchanged views on emerging trends and opportunities arising from rapid technological change.



Singapore's next-frontier defence innovations

Can Singapore become a leading innovator in the research, development and production of next-generation defence technologies?

Michael Raska

For Singapore, the rationale for pursuing military innovation has never been greater. As the gap in military technology in East Asia narrows with that of the West, and the character of regional security challenges becomes more complex, Singapore must search for its niche capabilities in military technology – such as by developing superior skills and knowledge, intelligence, information and technology – to better protect itself.

Moreover, Singapore faces demographic challenges and a shrinking military force, which requires developing and integrating defence systems in new ways to become more efficient and agile.

What are some of these next-frontier areas in the military-technology field? Examples are advanced technologies such as augmented reality, 3D printing, synthetic biology and Internet-of-Things that blur the lines between physical, cyber and biological domains.

The list of potentially disruptive military technologies is extensive and encompasses various domains.

These include the use of robotics, artificial intelligence and learning machines, as well as modular platforms with state-of-the-art sensors that improve target detection and tracking. Advanced materials with adaptive properties also have the potential to make military equipment lighter as well as more weather-resistant, while quantum technologies could enable the next generation of secure communications.

Much of the current debate portrays the next-frontier defence technologies as synonymous with a “discontinuous” or “disruptive” military innovation in the character and conduct of warfare.

Historically, however, most military innovations have arguably followed a distinctly less than revolutionary or transformational path, consisting of incremental, often near-continuous, improvements in existing technologies and capabilities.

Singapore's defence ecosystem has traditionally projected such an adaptive approach with the adoption of a gradual, phased, building-block approach in the research and development of niche defence technologies. Singapore's defence technologies have evolved in parallel with the increasing operational

requirements of the Singapore Armed Forces, while placing a premium on cost effectiveness and self-sufficiency.

The gradual approach to defence innovation has helped Singapore integrate diverse technologies.

For example, the latest Littoral Mission Vessel has integrated varying state-of-the-art navigation, command and control, surveillance, and combat systems.

But next-frontier defence innovation is driven by more than breakthroughs in technology, which in themselves do not guarantee successful innovation. To succeed in a dynamic competitive environment, Singapore's defence and technology base must be able to incorporate creative ideas from diverse sources.

It has to go beyond working on already proven technologies to betting on new concepts, moving from an incremental approach to a bolder one that supports riskier innovations.

Current efforts to forge closer collaboration with both local and global enterprises point towards that direction.

The Ministry of Defence (Mindef), for example, has been working with a number of local small and medium enterprises to boost Singapore's defence capabilities, with projects including a compact autonomous underwater vehicle capable of

autonomous detection of mine-like targets in shallow waters.

In February, Defence Science and Technology Agency (DSTA) and Boeing signed a collaboration agreement to co-develop and engage in research and experimentation in data analytics for the Singapore Air Force's fleet of aircraft. The idea is to use select algorithms and models for better diagnosis of problems, and to detect system failures early, thus reducing downtime for the aircraft.

At the same time, Singapore's Defence Technology Community seeks collaboration with commercial entities worldwide to gain access to novel ideas and solutions. In this regard, DSTA is hosting the inaugural Singapore Defence Technology Summit 2018 from today to Friday – a meeting of leading defence technology policymakers, defence scientists and security professionals from academia and think-tanks.

Going forward, the key challenge for Singapore's defence planners is to successfully prioritise, generate, and incorporate these emerging technologies in the country's future weapons systems and military operations.

According to Mindef, some ongoing projects include Unmanned Watch Towers designed by defence engineers and scientists from DSO National Laboratories to enhance 24/7 coastal surveillance capabilities while optimising manpower resources.

The Republic of Singapore Navy's Smart Base Access project is looking at using a combination of facial recognition and digital identification to streamline the base security screening process for potential savings in time, costs and manpower.

Another example would be the Army Battlefield Instrumentation Analytics

system that harnesses data analytics to provide commanders with focused training data from the field for more effective and efficient action reviews with their men.

These initiatives indicate that Singapore is taking multiple paths towards defence innovation – continuing with its gradualist approach of integrating existing systems, while accelerating efforts that may ultimately enable more “transformative” defence innovation.

• *Michael Raska is an assistant professor and coordinator of the Military Transformations Programme at the Institute of Defence and Strategic Studies, based at the S. Rajaratnam School of International Studies, Nanyang Technological University, Singapore.*



Conceived by DSTA and the Republic of Singapore Navy, the Littoral Mission Vessel is a 'uniquely Singaporean' defence innovation that has integrated varying advanced navigation, command and control, surveillance, and combat systems.

Testimonials



“I am very glad to be invited to the Singapore Defence Technology Summit. It is not the question of if, but how we should incorporate innovation within our defence organisations. All the new developments which are happening – if you are talking about artificial intelligence, cyber, digitalisation, nanotechnology – all these things will affect humanity. And, that is why Tech Summit 2018 is so important – to have the dialogue with all the different nations and nationalities gathered here in Singapore.”

Vice ADM Arie Jan DE WAARD, *National Armament Director and Director, Defence Materiel Organisation, The Netherlands*

“I am very pleased to have been invited as a speaker in this inaugural Singapore Defence Technology Summit. This summit was a great opportunity to meet technology experts in various fields. It also allowed me to share on SenseTime technologies and solutions, and my personal beliefs in how AI can benefit mankind and society in the most positive ways.”

Prof TANG Xiao’ou, *Founder, SenseTime, People’s Republic of China*

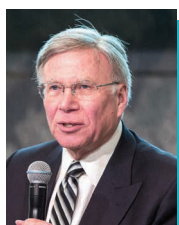


“[The Tech Summit] brought in a lot of different expertise and organisations, which is really reflecting different perspectives from different industries and different levels of interest. I found this summit to be very valuable because many speakers are now talking about the convergence between the technology innovation from the enterprise and also the need for innovations in the defence industry.”

Dr HONG Won-Pyo, *President and Chief Executive Officer, Samsung SDS, South Korea*

“I think that the whole idea of organising this Tech Summit is important as we all realise we are going through enormous changes in technology that are affecting private sectors as well as the military. And being able to pull together people from around the world to try to talk about what are the big developments going on, as well as the challenges they propose is important. The fact that Singapore has taken on the leadership role in organising this is something I am glad to see happen and I think this will be an important event to continue into the future.”

Prof Stuart MADNICK, *John Norris Maguire Professor of Information Technologies, MIT Sloan School of Management and Professor of Engineering Systems, MIT School of Engineering; Founding Director of MIT’s Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity, USA*



“I was completely surprised by the level of participation – you have got international speakers and you have got locals... The exchange of knowledge was so open and free, so I think this is a great success of sharing what we are doing in Singapore with our counterparts from overseas, and what we are learning from our counterparts from overseas. I am completely engrossed by what has happened at this summit.”

Prof LUI Pao Chuen, *Advisor, National Research Foundation, Prime Minister’s Office, Singapore*

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