NATO PARLIAMENTARY ASSEMBLY

SCIENCE AND TECHNOLOGY COMMITTEE (STC)

ENHANCING NATO S&T COOPERATION WITH ASIAN PARTNERS

Preliminary Draft General Report

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

NATO has continuously expanded cooperation with countries that lie outside the geographical scope of the Alliance. Through a series of programmes and initiatives, NATO engages bilaterally with Partner nations which are not part of its regional partnership frameworks but share the Alliance's values and interests. The draft report stresses that cooperation in the area of Science and Technology (S&T) is part and parcel of NATO's relations with Partner nations. The rapporteur also notes that Japan and ROK are world leaders in, inter alia, several EDT sectors and science and technology powerhouses more broadly.

The preliminary draft report identifies comparative S&T advantages of NATO's Asian partners, particularly of Japan and the Republic of Korea (ROK) in key dual-use technologies. Therefore, in recognition of the changing security and technological environments, the Alliance is deepening S&T ties with its Partner nations in Asia-Pacific.

However, though S&T cooperation deepens relations with Partner nations, cooperation in this area is an underexplored pillar of NATO relationships with its Asian Partner nations, the rapporteur concludes.

The rapporteur welcomes the recent decision of the NATO Science and Technology Board to include Japan as a STO-EOP nation. She recognises that deepening and expanding cooperation in the S&T realm will depend on the degree to which Partner nations make use of NATO's vast network of scientific and technological expertise. In view of maintaining the technological edge in a stepwise approach, the STB might consider inviting other nations to consider becoming a STO-EOP nation.

I. INTRODUCTION

1. ***"As we look to 2030, we need to work even more closely with like-minded countries. Like Australia, Japan, New Zealand, South Korea. To defend the global rules and institutions that have kept us safe for decades. To set norms and standards. In space and in cyber space. On new technologies and global arms control. And ultimately, to stand up for a world built on freedom and democracy."*** (NATO Secretary General Jens Stoltenberg, "NATO 2030", June 8 2020)

2. In recent decades, the Asia-Pacific region has emerged as the strategic centre of gravity in the international system. Asia-Pacific nations have long acted as an engine of the global economy, and their economic prowess now drives a further strategic trend: the region's emergence as a global hub for science and technology (S&T) innovation. Asia-Pacific nations such as China, Japan, and the Republic of Korea (ROK) increasingly lead in the development of several Emerging and Disruptive Technologies (EDT), many of which are dual-use and expected to revolutionise military capabilities.

3. The Asia-Pacific is also emerging as a potential security concern to the NATO Alliance and its Partners in the region, Japan and ROK. The rise of China is a central driver of these concerns. Fuelled by its growing economic clout, China's technological and military capabilities have grown dramatically in the past decade, as has its willingness to employ those capabilities towards an aggressive foreign policy. As such, China simultaneously subverts the rules-based international order and undermines the local Asian security order – especially the maritime security order in the East and South China Seas. While Allies enjoy important economic ties with China, the NATO Alliance has concerns regarding its regional and global ambitions. Meanwhile, North Korea's aggressive stance against ROK and Japan and the continued expansion of its illegal nuclear weapons programme further underline the strategic importance of the Asia-Pacific to NATO.

4. In response to these challenges, NATO has sought to deepen ties with its Partners in the Asia-Pacific – especially Japan and ROK. Since Japan and ROK are global technological leaders in their own right, each possessing comparative technological advantages in the development of EDTs, the Alliance has been especially eager to invite these Partners to join a variety of bilateral and multilateral programmes that offer structured exchanges of defence-related knowledge, expertise, and standards between NATO officials and their Partner nation counterparts.

5. This short report aims to provide an overview of NATO's developing S&T cooperation with its Asian Partner nations Japan and the ROK. The draft report sheds light on the mutual benefits of this cooperation, identifies the defence-related comparative S&T advantages which might make this cooperation robust, and concludes by suggesting that all parties should deepen their cooperation to tap into these potential benefits. The draft report will be updated for the 2021 Autumn Session of the NATO PA.

II. SECURITY IN A CHANGING TECHNOLOGICAL ENVIRONMENT

6. Science and Technology and security are deeply intertwined. Throughout history, armed forces equipped with the more advanced technologies and the deeper understanding of their application in military operations, usually enjoyed victory on the battlefield, while those that failed to keep pace were often defeated. In the early modern period, for example, the English Navy defeated the much larger Spanish Armada, relying on advanced naval technology which gave their ships more firepower while maintaining manoeuvrability. During World War II, British innovations in radar technology also played a decisive role in the Allies' victory (Harford, 2017).

7. For over seventy years now, NATO has relied on its member states' technological superiority to deter and defend against adversaries. During the Cold War, NATO first deterred the Warsaw Pact

by relying on its advantages in nuclear weapons technology, before developing advanced conventional military technologies like stealth, precision-guided munitions, and space-based ISR capabilities (Breedlove and Kosal, 2019).

8. Emerging and Disruptive Technologies (EDTs) will have far-reaching implications for security and for NATO's technological edge. NATO's Science and Technology Organization (STO) has identified eight EDTs which are likely to have a salient effect on tomorrow's security landscape. Technologies such as Big Data and Advanced Analytics (BDAA), Artificial Intelligence (AI), Hypersonic Weapons, and Space Technology, are primarily disruptive in nature, in that they are projected to have a widespread impact in the next decade or even earlier (indeed, hypersonic weaponry and AI are already used by some militaries). By contrast, technologies such as Quantum Computing, Biotechnology, Additive Manufacturing (3D Printing) and Novel Materials Use are still emerging in character, meaning that their impact remains unclear (NATO STO, 2020).

9. Today, NATO's technological edge is at risk of being eroded – due primarily to ongoing shifts in the global technological environment within which EDTs are developed and diffused. During the Cold War, research and development (R&D) was driven by government funded projects. Organisations like the Defense Advanced Research Project Agency (DARPA) led the development of military technologies which gave the Alliance an advantage on the battlefield. The development and diffusion of these advanced military technologies could be tightly controlled. Moreover, some of these technologies found widespread applications in commercial settings. These so-called "dual-use" technologies include the precursor to the Internet, GPS, and synthetic rubber (Frohlich et al., 2019). Since the end of the Cold War, however, this relationship has been reversed. Today, private sector efforts surpass government-funded projects, and private sector technologies are increasingly adapted to military use. Private firms now spend more on R&D than national governments and integrate new technologies into public use more quickly. As a result, emerging and disruptive technologies (EDT) are today being developed more rapidly and proliferated more widely than ever before.

10. This new technological environment offers advantages to states that challenge the rules-based international order and non-state actors, enabling them to access previously unattainable capabilities (DARPA, 2019). For example, North Korea has utilised advanced offensive cyber capabilities to engage in activities ranging from international financial theft to offsets for its conventional military weaknesses (DuBois, 2020). Another example is the ongoing revolution in the use of drone technology by state and non-state actors. This phenomenon ranges from Daesh's use of drones in Iraq and Syria for ISR purposes to Iran's use of drones in a kinetic attack on Saudi oil production facilities (Soufan Center, 2018).

11. More importantly, this new environment offers advantages to NATO's strategic competitors, Russia and China. As new technologies emerge, both competitors are looking to grasp potential opportunities to leapfrog NATO's technological edge. Both nations are developing national overarching strategies to tap into their innovation systems and exploit their scientific and technological investments. They have also deepened cooperation with one another on S&T matters in recent years. This includes the establishment of bilateral dialogues and exchanges, the development of industrial S&T "parks" and innovation hubs, and the expansion of cooperation between the two nations' respective academic communities (Bendett and Kania, 2019).

12. More specifically, **China** is racing to develop key EDTs via a national technology strategy of Military-Civil Fusion (MCF). MCF actively blurs the line between the civilian and military technology sectors, making Chinese private sector innovations and resources available to the Chinese military establishment at the latter's request. This takes place via a set of legal frameworks, funding mechanisms, and public-private partnerships. Through MCF, China hopes to emerge as an economic superpower and a military superpower simultaneously. China is particularly interested in the development of AI, which it sees as key to its quest to become a "world-class military by 2049."

Other interests (amongst many others) include 5G technology, drones and robotics, and biotechnology.

13. Meanwhile, **Russia** lacks the economic capacity to match the Allies and China in terms of R&D investments, so it is instead keeping pace by relying on the high quality of its individual scientists to develop asymmetric uses for EDTs. For example, experts say Russia is implementing a national AI strategy in the hopes of being a world-class but nonetheless "niche" AI power by 2030, one that excels at particular military applications of AI like autonomous weapons systems and offensive cyber warfare (Markotkin and Chernenko, 2020). Beyond AI, Russia is arguably the global leader in the development and deployment of hypersonic weapon systems. Russia is the first country to deploy a hypersonic "boost-glide" vehicle – the *Avangard* – and is currently developing several other hypersonic systems for deployment in the coming decade (Davis, 2020).

14. In response to this changing technological environment, **NATO** is taking steps itself to further improve its S&T capabilities. Allies have bolstered their national innovation pipelines internally, while NATO is actively leveraging the combined S&T efforts of member and partner nations (Alleslev, 2020). Relevant NATO entities include the NATO Science & Technology Organization (STO), the Defence Investment division including Command Control Communication, NATO Communications and Information Agency, the Emerging Security Challenges division, the International Military Staff including Allied Command Transformation (ACT), Centres of Excellence such as the NATO Cooperative Cyber Defence Centre of Excellence (CCDCOE), and NATO "start-ups" which exist within the Alliance structure as a kind of "in-house" private sector (Brasseur et al., 2020).

15. The centrepiece of NATO S&T collaborative cooperation is undoubtedly the STO's collaborative network. The network brings together over 6,000 scientists and their respective organisations to jointly address S&T, including EDTs towards national and NATO defence and security purposes. The strength of the STO network lies in its multidomain approach, bringing together private sector, academic, and government scientists to work on security-related projects. The network not only researches new technologies, but also identifies the technologies that will be key to NATO's future security needs, to support national and NATO military commanders to integrate these technologies into their forces (NATO, 2020a).

III. SCIENCE AND TECHNOLOGY IN ASIA

16. In recognition of the changing security and technological environments, NATO is deepening ties with its Partner nations in Asia-Pacific, including in the Science and Technology (S&T) field. Japan and ROK are world leaders in, inter alia, several EDT sectors and science and technology powerhouses more broadly. NATO's STO has impressive S&T capabilities, based, among other things, on its vast network. Mutual exchanges with these nations benefit both sides and allow all parties to better orchestrate and accelerate the innovation process moving into the future.

17. This section highlights the comparative S&T advantages these Partners possess regarding EDTs and reflects on their broader technological vision for the future. It identifies key dual-use technologies that are under development and highlights explicitly military projects being pursued in Japan and ROK. This section also examines Singapore; although not a NATO Partner, Singapore is a global innovation leader, holds excellent relations with NATO, and has welcomed official visits by NATO PA and other NATO bodies in recent years.

A. JAPAN

18. Japan's technology vision is encapsulated in the government's "Society 5.0" initiative. Society 5.0 seeks to fully automate, digitalize, and integrate Japanese infrastructure to mitigate the negative effects of Japan's ageing citizenry, its declining population, and potentially shrinking economy (Minnevich, 2019). Japan aims to employ robots to alleviate physical tasks for the elderly, to automate services to offset the economic effects of a shrinking labour force, and to utilise AI to boost growth (Schneider et al., 2018; Lufkin, 2020).

JAPAN – QUICK FACTS

World Intellectual Property Organization (WIPO) Ranking: 16th (2021)
International Federation for Robotics (IFR) Ranking: 3rd (364 robots per 10,000 employees)
Bloomberg Innovation Index Ranking: 12th in 2021
OECD R&D expenditure total: USD 172.6 billion
OECD R&D expenditure as % of GDP: 3.24% (2019)
OECD R&D expenditure global ranking (% of GDP): 5th

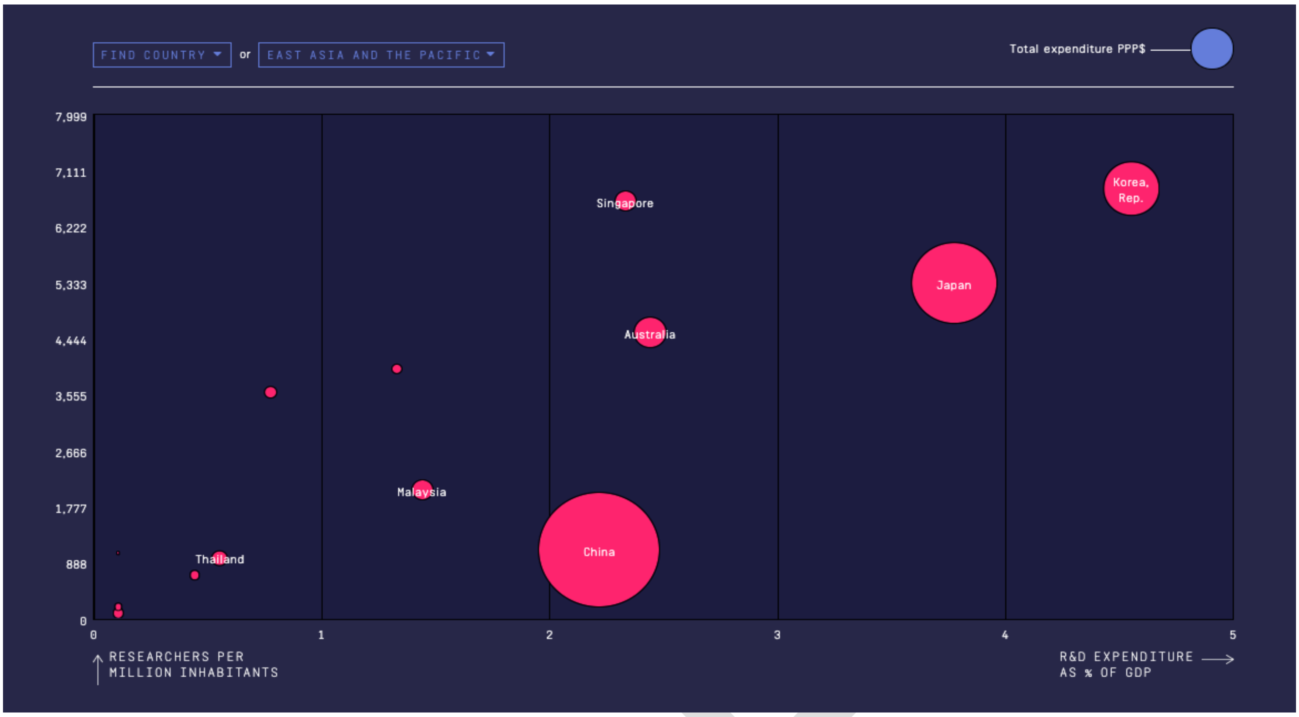
19. To that end, Japan is the "predominant robot manufacturing country" and enjoys one of the highest densities of "robots per worker" in the world; in 2020 alone, Japan produced about half of the world's robots, and the implementation of robotics-based solutions is widespread in Japanese industry and society (IFR, 2021). Japan's leadership in robotics also gives it a head-start in automation. Japanese firms lead the world in automating warehouses and parcel delivery and are actively deploying automated systems in brick-and-mortar retailers, health clinics, and restaurants (Hennessy Funds, 2021; Rich, 2020). Japanese automobile companies like Honda are likewise setting the pace for the development of autonomous vehicles (Till, 2020).

20. Japan is also a global leader in the adoption of AI in both private and business settings. Tokyo has established a USD 4 billion fund sponsoring AI innovation in private companies, while the Japanese are amongst the most eager to implement experimental AI solutions in their corporate networks (Tsuji, 2018). Moreover, Japanese government agencies are amongst the most advanced in the world in terms of installing AI programmes for public use (Oxford Insights, 2021).

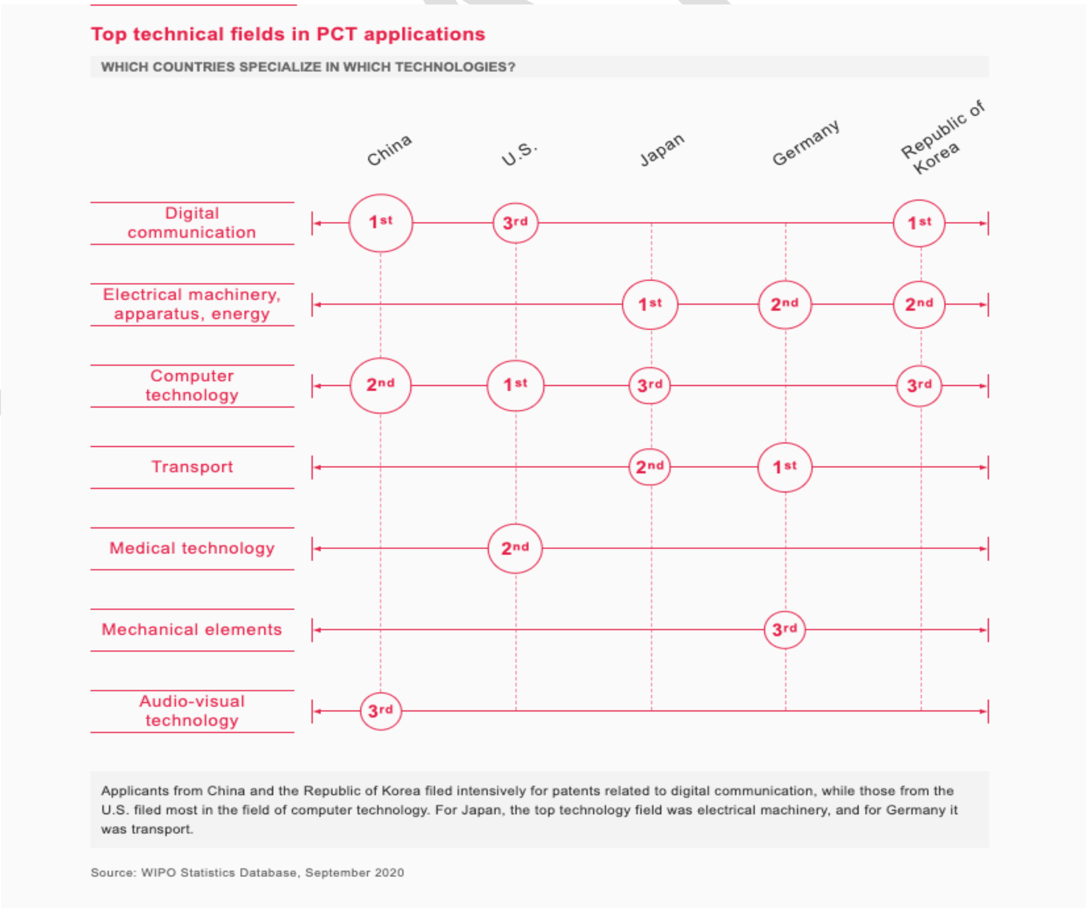
21. In parallel with its civilian technology strategy, Japan is expanding its indigenous defence technology capabilities. To promote the development and integration of high-end technology into the national armed forces, the Japanese Ministry of Defence established the Acquisition, Technology & Logistics Agency (ATLA) in October 2015. ATLA is heavily involved in the development and testing of new Japanese military platforms; ATLA's budget increased from approximately USD 1.6 billion in fiscal year 2020 to about USD 2.1 billion in 2021.

22. Projects include the cutting-edge sixth generation X-2 stealth fighter jet. Under development by Mitsubishi, the X-2 is seen as a "technological testbed" that has encouraged innovations in a number of key aerial technologies. This includes dual-use technologies like advanced materials, array radars, and afterburning turbofan engines (Yeo, 2018; Yeo, 2020a; Uesaka, 2016). Through the X-2 programme, Japan will likely emerge alongside the United States, China, and Russia as a leader in military aviation technologies – especially stealth aviation.

23. Japan has utilised its advantages in robotics to also emerge as a leader in space technologies. In 2013, the Japan became the first nation to send a robotic astronaut to the International Space Station, while the Japanese Aerospace Exploration Agency (JAXA) has been experimenting with space robots that may potentially be used to collect space debris. Beyond robotics, Japan has also set up its Quasi-Zenith Satellite System (GZSS), essentially a complementary system to US GPS systems. (Vijayakumar, 2020).



(Source: UNESCO Institute for Statistics, 2021)



B. THE REPUBLIC OF KOREA

24. The Republic of Korea's economic and technological growth has been nothing short of remarkable. Led by large Korean business conglomerates called chaebol, Korea has emerged as a global leader in multiple technology sectors. Chaebol like Samsung, LG, and Hyundai are household names in information and communication technology (ICT), consumer electronics, and automobiles.

THE REPUBLIC OF KOREA – QUICK FACTS

WIPO Rankings: 10th (2021)
IFR Ranking: 2nd (868 robots per 10,000 employees)
Bloomberg Innovation Index Ranking: 1st in 2021
OECD R&D expenditure total: USD 100 billion
OECD R&D expenditure as % of GDP: 4.64% (2019)
OECD R&D expenditure global ranking (% of GDP): 2nd

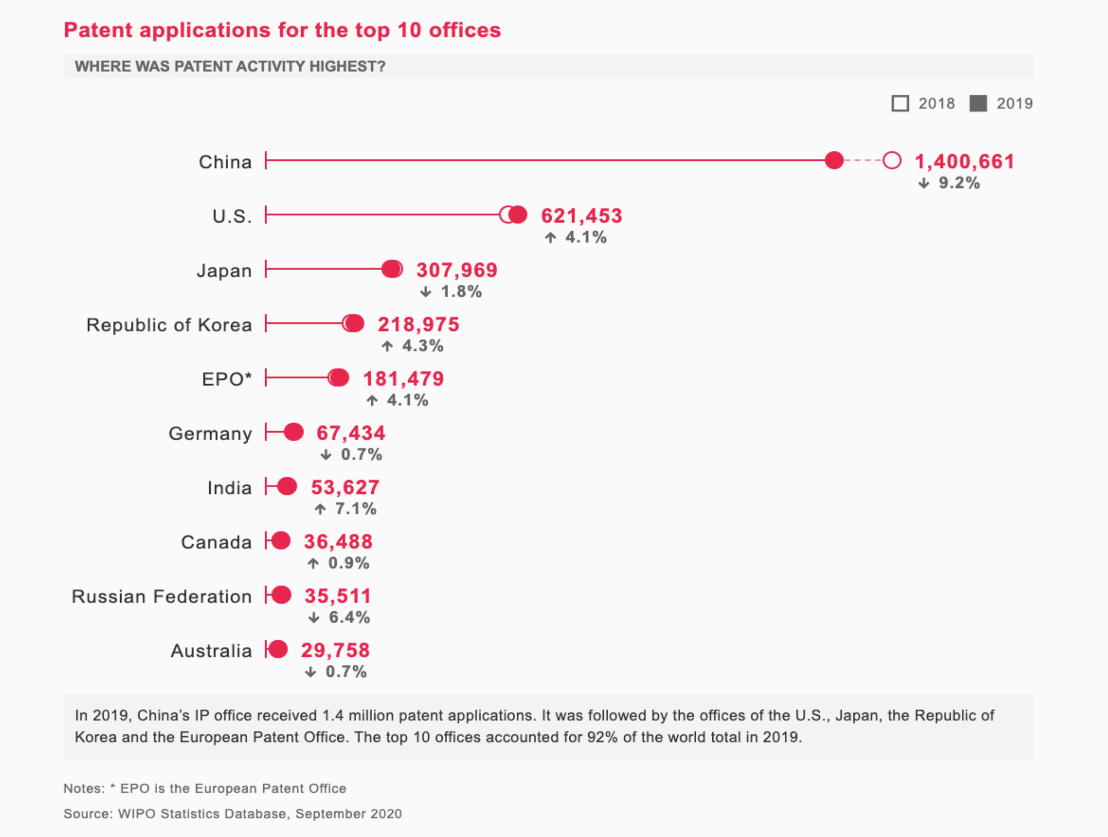
25. Under their leadership, Korea is the world's dominant ICT developer and innovator. As part of their stake in ICT, Korean chaebol are leading players in 5G technology. Samsung is already the largest smartphone producer in the world, is second only to Chinese telecommunications giant Huawei in terms of 5G patents filed, and became the first company to roll out a national 5G service (White, 2020; Kim, 2019). Moreover, Korea will likely be the first country to stand up a truly robust national 5G infrastructure – with 85 cities under coverage by the end of 2021 (Woo-Hyun, 2021).

26. Korea's 5G prowess is closely linked to its dominance in the global semiconductor economy. Semiconductors, or "chips," are a central component to all advanced electronics manufacturing and, due to the limited number of advanced semiconductor production centres, are seen as a strategic technological "chokepoint" in the global economy (FP Analytics, 2021). Samsung is only one of two manufacturers that produces the most cutting-edge chips (under 10 nanometres in size) and is considered a global leader in chip foundry facilities and technologies (Lee and Kleinhans, 2020). Beyond Samsung, over 20,000 semiconductor-related SMEs in Korea round out the most advanced chip-making economy in the world (Deloitte Insights, 2020).

27. An edge in chip manufacturing will also benefit Korea's AI industry. AI relies on large quantities of data to be effective; storing and processing this data requires advanced memory chips. Already, Samsung and Korean firm SK Hynix are the first and third largest memory chipmakers in the world, respectively, and both are expanding their production of specially designed "AI chips" (Liao, 2020). To encourage their progress, the Korean government has launched a National Strategy for Artificial Intelligence, employing thousands of Korean researchers to develop up to 50 AI-focused semiconductor models in the next decade (Yonhap, 2020).

28. Korea is also a leading defence innovator in conventional military technologies. Over the past decade, the government in Seoul has reformed the Korean defence industry, rendering it a global player on par with NATO defence manufacturers. Seoul is finding eager buyers for its conventional military technology abroad, and several Korean defence systems like the Hanwha K9 Thunder self-propelled howitzer and the T-50 light combat aircraft have been selected for service by NATO nations, including Norway, Estonia, Turkey, and Poland (Yeo, 2020b).

29. The Republic of Korea has also been actively developing an indigenous fight jet capability through the KF-X multirole fighter programme. As fighter jets are highly complex military platforms that require expertise in a number of diverse research areas, the development of an indigenous military aviation industry encourages innovation and technological growth in key dual use technologies. Korea, of course, already leads in several of these, including sensors development, advanced semiconductor production, automation, and potentially AI and other advanced computing systems. Through the KF-X programme, Korea will likely enhance its capabilities in terms of integrating and applying EDTs to existing military platforms (Newdick, 2020).



C. SINGAPORE

30. Singapore is not currently a NATO Partner nation and does not maintain official bilateral cooperation with NATO. That said, Singaporean officials are in frequent, informal contact with NATO officials and work closely with NATO and NATO member states on issues such as counterpiracy, maritime security, and counternarcotic operations in Afghanistan (NATO, 2017). The NATO PA Science and Technology Committee also led a delegation of NATO Parliamentarians on an official visit to Singapore in 2019, where there was a highly productive exchange of ideas with Singaporean officials. Members were impressed by Singapore's S&T vision and its broader achievements, and both sides were hopeful for future cooperation with the city state (NATO Parliamentary Assembly, 2019).

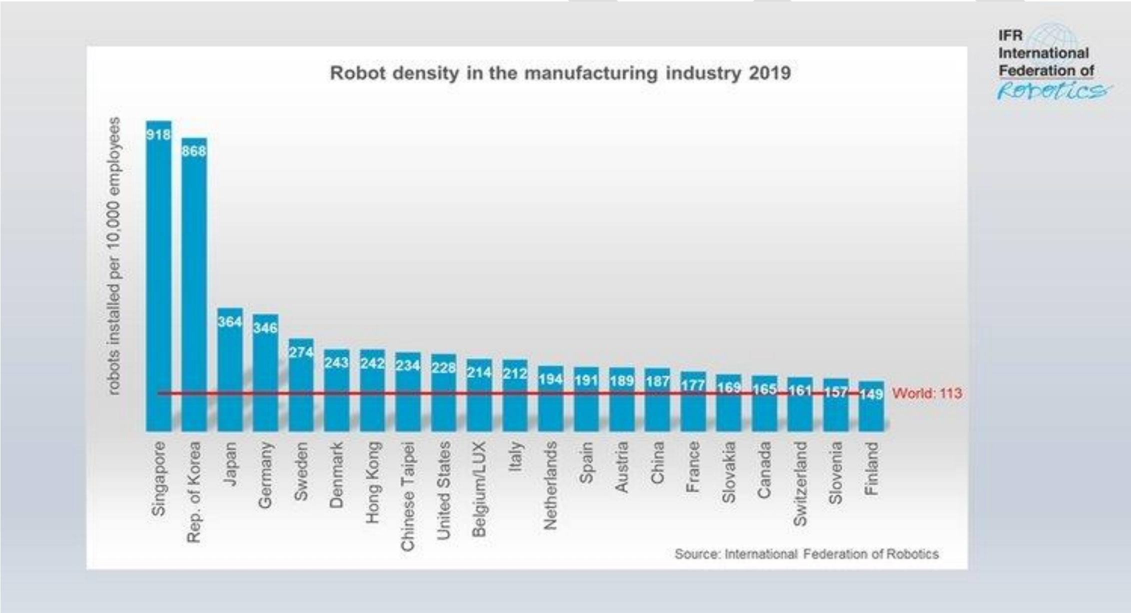
SINGAPORE – QUICK FACTS

WIPO Ranking: 8th
IFR Ranking: 1st (918 units per 10,000 employees)
Bloomberg Innovation Index Ranking: 2nd
OECD R&D expenditure total: USD 9.89 billion
OECD R&D expenditure as % of GDP: 1.84%
OECD R&D expenditure global ranking (% of GDP): 19th

31. As a small city-state with no natural resources, Singapore punches well above its weight in the S&T landscape. Singaporean leaders are aware that human capital is their chief comparative advantage and have promoted education and individual well-being to maximise this asset. The clearest demonstration of Singapore's S&T prowess is the means through which it promotes innovation itself. Since the 1990s, Singapore has launched successive Research Innovation and Enterprise (RIE) plans, which provide R&D funds and guidance to Singaporean universities and private firms. The most recent RIE2025 will dedicate a record USD 25 billion over the next five years to invest in key technology sectors like AI (Tan, 2020).

32. The RIE2025 is a key mechanism through which Singapore is pushing its broader Smart Nation Initiative begun in 2017, wherein the city government looks to promote a digitalised and technologically advanced Singapore. Today, as a result of these efforts, Singapore has a vibrant start-up culture and an international attractive pull as a S&T hub. Key investment areas in Singapore's Smart Nation Initiative are AI and cybersecurity defences. When the NATO PA STC Committee conducted a mission trip to Singapore in 2019, NATO PA parliamentarians and officers were impressed with Singapore's efforts to foster a pool of high-quality AI researchers and cyber security experts. Members were also informed of Singapore's two-phase AI Roadmap, wherein the government is investing heavily in digital infrastructure development, the construction of dedicated AI and cyber institutions, and the organisation of urban start-up clusters (NATO Parliamentary Assembly, 2019).

33. Finally, the Singaporean Ministry of Defence and the Defence Science and Technology Agency (DSTA) have also been eager to utilise technological solutions to security problems, especially as they relate to manpower shortages, lack of strategic depth, and urban warfare challenges (Budden and Murray, 2019). To that end, Singaporean defence leaders are fully committed to obtaining technological solutions to their security needs, which includes research on weapons automation, the reduction of ISR operators' workloads, and general technology to improve individual soldier performance (NATO Parliamentary Assembly, 2019).



IV. NATO S&T COOPERATION WITH PARTNER NATIONS

34. NATO Partnerships are guided by two principles: the principle of inclusiveness, which relates to non-discrimination and an assurance that all Partners are offered the same basis for cooperation, and the principle of self-differentiation, or the right of Partner nations to decide for themselves the extent and intensity of cooperation with NATO. All Partners have equal access to NATO's partnership activities, and each Partnership is tailored so as to respect the Partner's sovereignty, interests, and requirements.

35. The Individual Partnership and Cooperation Programme (IPCP) provides a strategic framework through which many Partner nations could participate in NATO activities – including workshops, joint trainings and exercises, capability development, and political consultations (Wiklund, 2019). The IPCP system is bolstered by other, more demanding bilateral documents like

the Individual Partnership Action Plan (IPAP), which focuses more on domestic reforms, and the Annual National Programme (ANP), which engages the Partner on comprehensive internal security and political reforms (NATO, 2016).

36. To better structure exchanges with Partner nations, cooperation also occurs through broader, multilateral frameworks. These include NATO's Science for Peace and Security (SPS) programme, which promotes research, innovation, and knowledge exchanges, as well as the Partnership Interoperability Initiative (PII), an Initiative launched at the 2014 Wales Summit that improves NATO-Partner nations' technological and procedural cohesion and familiarity (NATO, 2021a; NATO, 2020b). Within the PII, NATO has also established the Enhanced Opportunities Partners (EOP) programme for select Partner nations, which offers closer, more tailored access to NATO structures and processes.

37. More importantly, Partnership status with NATO grants Partner nations access to the NATO STO. This includes access to main Sessions held by the STO's main policy body, the Science and Technology Board (STB), access to the researchers in the STO's collaborative network, and the STO's various internal programs.

38. Inclusion in the STO network, particularly as an EOP Partner, offers critical benefits to Partner nations. As NATO member states and NATO Partner nations each possess comparative S&T advantages, the STO offers a network through which these actors can securely exchange their expertise (Author interview with representatives of the Swedish Ministry of Defence). Cooperation in the STO network can also promote standardization of methods and processes between the Alliance and selected partner nations within the Euro-Atlantic region. This can improve the interoperability and integration of each side's military platforms (Author interview with representatives of the Swedish Ministry of Defence). It is important to note that the whole of the network is greater than the sum of its individual parts, as the overall proficiency of the network allows each participant to overcome S&T deficiencies. This is especially important for smaller countries which lack the economic capacity to engage in multiple technology sectors, but nonetheless possess niche technological specialisations (Author interview with representatives of the Swedish Ministry of Defence).

39. Cooperation in the STO network deepens relations with NATO member nations and partner nations. This is also the case for NATO's relations with Global Partners, even though their individual level of cooperation is not as comprehensive as that of selected partners in the Euro-Atlantic region. However, as cutting-edge technologies are rapidly evolving, it is difficult to acquire all necessary technologies through national Research and Development activities. Partner nations therefore recognise the need to strengthen technological cooperation with other countries and with international organisations including the STO. Finally, and perhaps most simply, network access reduces simple human barriers to cooperation, including travel schedules and time management (Author interview with representatives of the Swedish Ministry of Defence; Author Interview with Dr Shigenori Mishima, Deputy Commissioner and Chief Defense Scientist, ATLA; Author Interview with Dr Hokazono, Senior Advisor for Institute of Future Engineering, former Deputy Commissioner & Chief Defense Scientist of ATLA)

40. More broadly, cooperation within the STO network allows both NATO member states and Partner nations to establish which EDTs will be crucial for future defence and security needs. This, of course, is important for all parties in terms of keeping pace in key technology sectors, but it also plays an important role in the planning and future direction of NATO's Partner nations (MoD Sweden). Science and technology cooperation with NATO will contribute to the early acquisition of important technologies and to ensuring technological superiority as well as the strengthening of the partnership between Partner nations and NATO, as partners sharing fundamental values and responsibilities for global security challenges. (Author Interview, Dr. Shigenori Mishima, Deputy Commissioner and Chief Defense Scientist, ATLA).; (Author Interview with Dr. Hokazono,

Senior Advisor for Institute of Future Engineering, former Deputy Commissioner & Chief Defense Scientist of ATLA).

41. Finally, participation in the NATO STO network is an essential mechanism through which NATO and Partner scientists and researchers can build personal relationships with one another. Since organisations and institutions are built on individuals, and the world of S&T research is relatively small and insular, the development of shared personal bonds between scientists benefits not only the individual projects on which these scientists are working together, but also the broader inter-organisational ties and familiarity which are crucial to effective cooperation at the macro-level (Author interview with representatives of the Swedish Ministry of Defence; Author Interview with Dr Shigenori Mishima, Deputy Commissioner and Chief Defence Scientist, ATLA; Author Interview with Dr Hirokazu Hokazono, Senior Advisor for Institute of Future Engineering, former Deputy Commissioner & Chief Defence Scientist of ATLA).

A. NATO'S PARTNERSHIP WITH JAPAN

42. Japan is NATO's longest-standing partner nation outside of the Euro-Atlantic region. Cooperation between the two sides began in the early 1990s, when Japan offered important assistance to NATO in the latter's efforts to stabilize the Balkan region. Cooperation then evolved further during NATO's missions in Afghanistan, wherein Japan provided (and continues to provide) strong financial support to the International Security Assistance Force (ISAF). Cooperation between Japan and NATO has since accelerated in the past decade. In 2013, Japan signed a joint political declaration with NATO, which was then bolstered with the signing of an IPCP in 2014 (most recently renewed in 2020). Likewise, Japan is an active participant in both the SPS Programme and the PII, and was approved as an EOP member by the STB in February 2021. Finally, Japan has also established a Mission to NATO in 2018, operating through Japan's Embassy to Belgium.

43. Despite this strong political relationship, however, Japan's cooperation with NATO in military S&T in particular has been relatively limited. This is largely due to historical reasons and Japan's domestic political preferences regarding external military cooperation in general. With the exception of its special bilateral relationship with the United States, Japan banned the transfer of military equipment and technology until 2014, in accordance with the "Three Principles on Arms Exports." In 2014, however, Japan adopted a new export control policy which enables Japan to identify and develop cooperative S&T opportunities with NATO (Author Interview, Dr. Hirokazu Hokazono, Senior Advisor for the Institute of Future Engineering; former Deputy Commissioner & Chief Defense Scientist of ATLA).

44. In this context, the Japanese Ministry of Defence established official dialogue channels with NATO and NATO member states to explore S&T cooperation opportunities on defence-related programmes. Japanese scientists actively participate in the Science for Peace and Security (SPS) Programme, wherein they engage in several areas of joint activities. These include developing technologies to enhance border and port security as well as infrared detection. In addition to SPS programmes, Japan pursues bilateral projects with individual NATO Allies. Cooperation has been especially close with scientists from the United Kingdom and France. For example, Japan does research together with the United Kingdom on resilience to chemical and biological agents, a new air-to-air missile and a next-generation radiofrequency-sensor. Another joint programme is with France on autonomous mine detection systems. (Author Interview, Dr. Hirokazu Hokazono, Senior Advisor for the Institute of Future Engineering; former Deputy Commissioner & Chief Defense Scientist of ATLA). Within the STO, Japan has recently been active in several of STO's activities.

45. Furthermore, NATO-Japan S&T cooperation has also been fruitful in the realm of cyber defences. Both sides have worked together to enhance resiliency to cyberattacks, and in October 2019 NATO was invited to Japan for cyber defence staff talks. During these talks, NATO officials

first assessed current cyber threats and policy developments with their Japanese counterparts, before engaging with academia and industry. A key focus was the need to jointly foster a norms-based, predictable, and secure cyberspace (NATO, 2019). In December 2019, Japan also actively participated in NATO's cybersecurity war games, progressing from its previous status of observer country (Miki, 2019). Finally, Japan has also sent an expert to work at NATO's Cooperative Cyber Defence Centre of Excellence (CCDCOE).

46. One area of future collaboration with Japan could be maritime security and maritime related technologies. China has engaged in aggressive behaviour in the South and East China Seas, with Beijing utilising ever more sophisticated means to destabilise the region (including the use of undersea autonomous drones to probe other countries' sovereign waters) (Sutton, 2021).

B. NATO'S PARTNERSHIP WITH THE REPUBLIC OF KOREA

47. NATO's relationship with the Republic of Korea is less intense than its relationship with Japan, but has nonetheless been very fruitful and productive. ROK began its relationship with NATO in 2005 and has been an important partner to NATO in Afghanistan, working closely with ISAF in the region from 2010 to 2013. The partnership reached a new level with the signing of an IPCP in 2012, which was most recently renewed in November 2017. Likewise, Korea is a participant in both the SPS Programme and the PII. Although not a member of the EOP programme, ROK has expressed a desire to work more closely with NATO on questions of military interoperability – especially exchanges of civilian and military personnel, joint trainings and exercises, and cooperation in standardisation and logistics (NATO, 2021b).

48. Practical security cooperation between NATO and Korea has concentrated on a variety of areas but has likewise remained limited. The SPS Programme is a central vehicle for cooperation between Korea and NATO. Korea participates in several Multi-Year Projects (MYP) within the SPS framework, which are longer-term cooperative ventures on key EDTs that Korean scientists engage in with scientists from NATO member states. These MYPs have tackled complex questions on EDTs like robotics, nanotechnology, and automation more broadly. Other areas of cooperation also include cyber defence, counterterrorism, civil preparedness, and disaster relief (NATO, 2021c).

49. One important area of collaboration is the non-proliferation of WMD and WMD delivery systems. North Korea's aggressive testing of nuclear systems as well as its wanton assassination of a North Korea citizen using a nerve agent at an airport in Malaysia has raised concerns in the region of CBRN threats. To that end, scientists from the Republic of Korea and NATO have cooperated to develop cutting edge sensor systems which can detect CBRN residues and emissions (NATO, 2021c). Within the STO, the Republic of Korea has been active in the Modelling and Simulation Group.

50. Overall, however, cooperation with the Republic of Korea can be significantly deepened in areas of mutual interest. One clear area that ROK may be interested in would be the inclusion of more interoperability programmes – if such a move were amenable to both sides. Since NATO member countries purchase conventional military technology from ROK's defence industry, any effort to improve standardization between ROK technologies and NATO would be of benefit to ROK's defence industry and would also improve NATO's own internal cohesion and integration.

V. PRELIMINARY CONCLUSIONS

51. S&T cooperation is a relevant, yet – in the view of your rapporteur – underexplored pillar of NATO's relationships with its Asian Partner nations. This pillar is naturally useful for the collective defence and security of both NATO and the Partner nations themselves – especially as it relates to capability development and interoperability. Indeed, S&T cooperation also generates synergies in

military and dual-use technology development, and reduces duplication and other inefficiencies. Since NATO's Asian Partner nations are second to none in several technology sectors, while the NATO STO has an extensive S&T network and is the world's largest collaborative research forum in the field of defence and security, cooperation between these two sides would be of the highest quality.

52. NATO's Asian Partner nations, as well as Singapore, have been involved in STO events on the strategic and planning level as well as in STO's Collaborative Programme of Work (CPoW) and in the Programme of Work of the STO's CMRE. Their participation has been on a focussed scale – due, among other reasons, to geographical distance and related logistical issues. As online videoconferences and teleworking become more widespread in the aftermath of the COVID-19 crisis, however, prospects for deeper and more comprehensive cooperation in the STO framework appear promising.

53. The recent decision of the NATO Science and Technology Board to include Japan as a STO-EOP nation is therefore a welcome and – in the view of your rapporteur – logical development. Deepening and expanding cooperation in the S&T realm obviously depends also on the degree to which Partner nations make use of NATO's vast network of scientific and technological expertise. The inclusion of Japan as a STO-EOP nation will deepen and expand cooperation between Japan and NATO. In view of maintaining the technological edge in a stepwise approach, the STB might consider inviting other nations to consider becoming a STO-EOP nation.

54. S&T cooperation with Partner nations currently appears to be particularly pertinent in the cyber domain. Cyber has become crucially important for national security, but also for increasing resilience. As both NATO Allies and their Asian Partner nations heavily depend on the freedom of the seas, closer cooperation in maritime technology seems equally compelling. More generally, closer cooperation between NATO and Asian Partner nations can, over time, lead to the development of a comprehensive technological policy dialogue concerning EDTs, both from a military and economic security perspective. For example, cooperation in these areas can help to advance global standards in the cyber and space domains. Other areas of interest could include operational concepts, training, technological standards, and ethics and safety of technology use.

55. Furthermore, NATO and Asian Partner nations can share best practices regarding new ways to leverage the creativity of their national S&T institutions and to expand the limited pool of expertise in disruptive technologies. Encouraging women to engage in defence-related S&T should receive higher priority. This will bring the benefit of expanding the intellectual base in S&T, and innovation more broadly. NATO and Asian Partner nations could share best practices on how to promote the participation of women in defence-related research of EDTs. Encouraging the participation of women is likely to bring new ideas and perspectives to research, development and implementation.

56. In addition, NATO could engage in structured political consultations with Asian Partner nations on topics which reflect shared areas of interest, such as intellectual property protection, enhanced export controls of sensitive technologies, screenings of investments, and restrictions against S&T/innovation collaboration with problematic institutions associated with adversarial nations.

57. The NATO PA can also help promote S&T cooperation with Asian Partner nations on the parliamentary level by raising awareness of the opportunities and challenges of S&T. This could be achieved by exploring efforts of NATO Partner nations on resilience during future visits, and more generally by putting S&T issues more prominently on the agenda of NATO PA visits to the region.

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