EXECUTIVE SUMMARY

China, which began research on industrial robots in 1972, promoted R&D on industrial robots with such applications as spraying, spot-welding, arc-welding, and transport robots from the era of the 7th Five-Year Plan (1986-1990). In March 1986, it announced the 863 program, a high-tech R&D program. This was a scheme of massive government support for robot-related R&D, and constituted a key source of funding for China's research into industrial and intelligent robots.

In the 1990s, R&D of welding robots was prioritized, and investment made in nine robot industrialization hubs and seven R&D hubs. At this time, China's leading robot manufacturers such as Shenyang Siasun, Harbin Boshi Automation, and Beijing Research Institute of Automation for Machinery Industry first appeared.

The 10th Five-Year Plan (2001-2005), which began in 2001, included hazardous assignment robots, counterterrorism ordnance disposal robots, and human-like and bionic robots. In addition, the 11th Five-Year Plan (2006-2010), which began in 2006, included key technologies for intelligent controls and human-robot interaction, and it emphasized robotics and automation technologies for industries including integrated circuits, ships, automobiles, light fabrics, household electrical appliances, and foodstuffs.

The 12th FYP (2011-2015) was labeled "for intelligent manufacturing," and demanded that Chinese manufacturing firms use (automate) more robots and integrate information technology.

The Guideline on Promoting the Development of the Industrial Robot Industry, announced in 2013, sets out the goals that China should achieve by 2020. These include: 1) developing three to five globally competitive robot manufacturers; 2) creating eight to ten industrial clusters for the industry; 3) achieving 45% of domestic market share for China's high-end robots and; 4) increasing the robot penetration rate to 100 per 10,000 people.

Also announced in May 2015, 'Made in China 2025' aimed to innovate the three-stage manufacturing industry for the next 30 years and included advanced numerically controlled machine tools and robots among the top 10 core industries.

In the 13th FYP (13th Five Year National Economic and Social Development Plan, 2016-2020), a manufacturing innovation strategy encompassing the convergence of the manufacturing industry and ICT was promoted, and the term 'artificial intelligence' appeared in use.

In 2016, the Robot Industry Development Plan (2016-2020) was announced, with the aims of completing the robot industry system, expanding industrial scale, strengthening technological innovation capacity, improving core parts production capacity, and improving application integration capacity. It designated 10 product and five core components. The 10 products were: 1) welding robots; 2) cleaning robots; 3) intelligent industrial robots; 4) human-machine cooperation robots; 5) two-armed robots; 6) heavy loads AGV; 7) fire-fighting rescue robots; 8) surgical robots; 9) intelligent public service robots and; 10) intelligent nursing robots. The five core components were: 1) high precision reducers; 2) high performance motors for robots; 3) high performance controllers; 4) sensors and; 5) terminal actuators.

In **Japan**, the national R&D program for robotics is planned and funded by the Economic Revitalization Policy and Science, Technology, and Innovation Policy.

In February 2015, the Japanese government announced the New Robot Strategy (The Headquarters for Japan's Economic Revitalization), based on the revised 2014 Japan Revitalization Strategy, as a key policy of the Abenomics Growth Strategy. After announcing this strategy, the robot-related budget for FY2016 stood at 273 million dollars (29.4 billion yen), an increase of 83% over the previous fiscal year. The budget for FY2019 is 351 million dollars (37.8 billion yen). The New Robot Strategy presented action plans in five sectors to pursue over the following five years (2016-2020), which were: Manufacturing; Service; Nursing and Medical; Infrastructure, Disaster Response, and Construction and; Agriculture, Forestry, Fishery, and Food Industry. The Robot Revolution & Industrial IoT Initiative (RRI) was established in May 2015, to execute these action plans. The government and the RRI provide a plan for sectoral robot-related R&D projects as well as cross-sectoral activities such as global standardization, regulatory reform, and robot awards and competitions. The robot-related R&D projects are planned in three stages: introduction and substantiation; development of technology applicable to market and; development of next-generation technology.

The Council for Science, Technology, and Innovation, under the leadership of the Prime Minister of Japan and the Minister of State for Science and Technology Policy, has promoted planning and coordination for comprehensive basic science, technology, and innovation policies, taking a bird's-eye view of Japan's entire science and technology landscape. In these circumstances, the council proposed three new policies: (1) strategic formulation of overall governmental science and technology budget; (2) the cross-ministerial Strategic Innovation Promotion Program (SIP); and (3) Impulsing Paradigm Change through Disruptive Technologies (ImPACT). ImPACT is the R&D program to promote high-risk and high-impact R&D that could result in disruptive change to industry and society. ImPACT was implemented from 2014 to 2018 and provided funds of 510 million dollars (55 billion yen). SIP is a program aimed at accomplishing a leading role in science, technology, and innovation beyond the framework of government ministries and traditional disciplines. SIP has identified R&D themes that will address the most important social problems. Each R&D theme is led by a program director who is responsible for guiding the projects from basic research through to practical application and commercialization, and then ultimately towards a clear exit strategy. The first period was carried out from 2014 to 2018 at a cost of 463 million dollars (50 billion yen), and the second period was started in 2018 with funding of 605 million dollars (65.2 billion yen) until 2022.

Such R&D programs will be showcased during the "World Robot Summit" to accelerate R&D and to introduce and diffuse robotics in the Japanese society. World Robot Summit features World Robot Challenge, where robots will compete with one another, and World Robot Expo, where the latest robot technologies will be exhibited. There are 4 categories in both events, industrial, service, disaster robotics and junior.

In July 2019, the "Conference to Promote Social Reformation through Robots" announced a report called "Changes in the Environment Surrounding Robots and Direction of Future Policy". This report analyzes the market trends of industrial robots, the increasing participation of new players, the appearance of new businesses utilizing robots, and the direction of each country's robot policy. Based on this analysis, the report presents the direction of future robot policy.

Since welding robots in car manufacturing was first introduced to **Korea** in 1978, an industry-academia collaboration began conducting independent robot-related R&D without government support. Subsequently, in 1987, the government started supporting the 'Common Core Technology Development Project' in the field of manufacturing robots and followed this up with an active R&D support policy. However, due to the IMF crisis, which began in 1997, government support and R&D almost stopped completely. Intelligent robots appeared in 2002, and the Ministry of Trade, Industry, and Energy (MOTIE), Ministry of Information and Communication, Ministry of Science and ICT (MSIT) and various ministries and agencies began to provide support for the robot business, meaning government support was scaled up and organized. In August 2003, the robot industry was selected as one of the top 10 'next generation growth engine industries'. During the six years from 2002 to 2007, the government led the development of technology and market creation by investing a total of 408.7 million dollars (486.5 billion won) , 353.0 million dollars (420.2 billion won) in R&D, 8.0 million dollars (9.5 billion won) in demand creation, and 62.8 million dollars (74.8 billion won) in foundation) for 1,259 projects. It then enacted a 'special robot law' in November 2007.

In March 2008, the 'Intelligent Robot Development and Supply Promotion Act' was enacted, and in accordance with Article 5 of the Act, the statutory plan, 'The First Intelligent Robot Basic Plan (2009-2013)' was announced in 2009. The core strategy of the plan was to select three product groups by the time of market formation and to focus promotion policies accordingly. The three product groups selected were: 1) Market Expansion (Manufacturing Robots); 2) New Market Creation (Education, Cleaning, Surveillance and Reconnaissance Robots) and; 3) Technology Leadership (Medical (Surgery), Traffic/Transportation, Silver, Housework, Wearables, Underwater/Aerospace, Biomimetic Robots). In the meantime, policy investments totaling 639.0 million dollars (760.7 billion won) (R&D 431.5 million dollars (513.7 billion won), 72.7%) were made, and the robot industry is assessed to have achieved substantial results in corporate sales growth while securing some key source technologies via continuous improvement-oriented R&D development that avoided simply emulating the past. In 2011, the robot team at the Ministry of Knowledge Economy was expanded to become the 'Robot Industry Division' and the robot market exceeded 1,680 million dollars (2 trillion won) by production standards that year.

'The Second Basic Plan for Intelligent Robots (2014-2018)' was announced in 2014. It promoted large-scale R&D projects in robot fields for specialized services such as 'Disaster Response Robots and Robot Health Town' and reinforced investments in core robot parts and services (Logistics Robots (AGV), Emotion Robots (Human Robot Interaction), which were relatively weak compared to technologies and products. The second plan did not limit the scope of robot industry to robot products, establishing 'Seven Robot Convergence Business Strategy Roadmap', in order to expand other manufacturing and service sectors of robot technology. It also plans to strategically utilize the robot supply business to create a new market for large-scale robots and strengthen global cooperation with countries possessing advanced robot technology and others. The seven key areas are: 1) manufacturing; 2) automobiles; 3) medical and rehabilitation; 4) culture; 5) defense; 6) education and; 7) marine. During the five-year period, the government's R&D-related budget was 91.9, 104.7, 108.0, 144.6 and 142.5 million dollars (109.45, 124.6, 128.6, 172.2 and 169.7 billion won) from 2014 to 2018 respectively.

With the vision of leaping into the world's top four robot industry by 2023, 'The 3rd Basic Plan for Intelligent Robots (2019 ~ 2023)' was announced in 2019. While the 1st and 2nd basic plans are centered primarily on the government-led support system, support areas, and growth foundation for the growth of the robot industry, The 3rd basic plan promotes systematic dissemination and diffusion through the selection and concentration of promising sectors as well as role assignment for the government and the private sector. The main tasks are as follows.

(1) Expanded dissemination for manufacturing robots with focus on the three largest manufacturing businesses – To supply 700,000 units manufacturing robots (accumulated) by 2023, develop standard models of robot utilization are to be developed for 108 processes by 2023, while first develop standard models for the three largest business types such as root, textile, food and beverage, etc.

(2) Concentrated cultivation of four largest service robot areas – such as care, wearable, medical care, logistics, etc. were selected. Technology development and dissemination are supported with leading by the concerned departments such as Ministry of Defense, Ministry of Agriculture, etc. for the ten largest niche market-type areas such as drone-bot, agriculture/exploration robot, etc. to develop robots in many different areas; National defense area (unmanned surface vehicles, wearable muscular strength-enhancing robots), agriculture area (smart farm robots for facility gardening, unmanned tractor, agricultural robot capable of control, harvesting operations), underwater/exploration area (underwater robot system capable of monitoring environmental changes, safety robots for the marine accidents, and underwater construction robots), and evacuation/safety area (search robots for a narrow space, remote mobile measuring device with sensors and detection device for drugs), etc.

(3) Reinforcement of Robot Industry Ecosystem - Support independence of the three key next-generation components (Intelligent controller, Autonomous mobile sensor, Smart gripper) and the 4 key software components (Robot SW platform, Gripping technology SW, Image information-processing SW, Human-robot interaction). Reinforce the support focus on demonstration and dissemination of decelerator, motor, motion controller, etc.

The Framework Programs (FPs) – abbreviated FP1 to FP7 with "FP8" named "Horizon 2020" – are the **European Union**'s main instrument for funding research and development activities. These multi-annual programs have been implemented since 1984. The framework programs up until Framework Program 6 (FP6) covered five-year periods. From Framework Program 7 (FP7) on, programs run for seven years.
In FP6 and FP7, carried out from 2002 to 2013, the robotics-related work program was still focused on technological research, but Horizon 2020 places emphasis on innovation and transfer of technology to the marketplace.

FP7 is the seventh Framework Program for Research and technological development scheme, which was carried out from 2007 to 2013. The European Commission (EC) financial contribution in FP7 was estimated to be around 55 billion dollars (50 billion euros) over seven years.
The robotics-related sections in FP7 focused on research related to the perception, understanding, action-cognitive, and intelligent enabling technologies. Upon completion, FP7 directly funded some 130 robotics-based projects involving around 500 organizations, with total grants of 596 million dollars (536 million euros). Other funding with elements related to robotics amounted to 189 million dollars (170 million euros).

Horizon 2020 is the eighth EU Framework Program, running from 2014 to 2020. The work programs in Horizon 2020 are set out in multi-annual programs, namely Work Program 2014-2015, Work Program 2016-2017 and Work Program 2018-2020. The Robotics Work Programs in Horizon 2020 are established based on the outcomes of the consultation and discussions in the SPARC program. In addition, the robotics projects funded by Horizon 2020 represent a wide variety of research and innovation themes from Information and Communication Technologies (ICT), Future and Emerging Technologies (FET), and Societal Challenges. Through this program, EC provides an estimated 779 million dollars (700 million euros) worth of funding for robotics research and innovation. The summary section covers the Horizon 2020 ICT Robotics Work Program related to manufacturing, commercial, healthcare, consumer, transportation, civil and agri-food, inspection, search and rescue robotics.

Under the ICT Work Program 2014-2015, Research Development and Innovation (R&D&I) projects aim to advance current robot capabilities in terms of robustness, flexibility, and autonomy, while operating in real-world environments for manufacturing, commercial, civil, and agriculture. The work programs have been providing total funding of 174 million dollars (157 million euros) for 36 projects.

The R&D&I projects in ICT Work Program 2016-2017, with estimated funding of 134 million dollars (121 million euros), focus on a wide variety of robotics and autonomous systems and capabilities, such as navigation, human-robot interaction, recognition, cognition, and handling to move research results into the marketplace.

ICT Work Program 2018-2020 is the final work program under Horizon 2020. Its main topics are related to digitization of industry through robotics, robotics applications in promising new areas, and robotics core technologies such as AI and cognition, cognitive mechatronics, socially cooperative human-robot interaction, and model-based design and configuration tools. For this program, a total of 173 million dollars (156 million euros) has been budgeted.

In **Germany** in 2006, the High-Tech Strategy was formulated to move the country forward on its way to becoming a worldwide innovation leader. The goal is for good ideas to be translated quickly into innovative products and services. Most of the framework of the High-Tech Strategy promotes partnership between companies, universities, and research institutions in order to bring together institutional research and entrepreneurial expertise.

The Industry 4.0 initiative, in which robot-related R&D plays an important role, is one part of the High-Tech Strategy of the German government to maintain Germany's status as a leading supplier of products and production location for digital equipment, processes, and products. As such, the German government launched a series of technology-centered research programs related to robot R&D.

Between 2009 and 2014, the "AUTONOMIK" program provided funding for robot-related R&D projects in the fields of manufacturing, logistics, and assembly. The technology program of AUTONOMIK focused on forward-looking approaches to advance the development and proof testing of smart tools and autonomous systems. Through this program, the German government has provided a total of 48 million dollars (44 million euros) in funding for 14 projects involving around 90 partners from industry and academia.

The outcomes of the AUTONOMIK program formed an important basis for the program entitled "AUTONOMIK für Industrie 4.0" that was designed to merge information and communication technologies with industrial production technologies. From 2013 to 2017, 16 projects qualified for support from the Federal Ministry, which backed the projects with funding in the order of 48 million dollars (44 million euros). These funded projects tried to address a range of technologically important issues including human-robot interaction, 3D technologies in industrial application, and cognitive features that enable systems to act independently.

Since 2016, the 55 million dollars (50 million euros) funded "PAiCE" program has been continuing the work as a follow-up program related to AUTONOMIK and "AUTONOMIK für Industrie 4.0" for the next five years. The technology program of "PAiCE" emphasizes the development of digital industry platforms as well as collaboration between companies using these platforms. In particular, the robotics-oriented projects are focusing on the creation of platforms for service robotics solutions in the various relevant application areas including service, logistics, and manufacturing fields.

The **Italian** government contributes to research funds that are managed by the EC, and Italian researchers successfully participate in the European HORIZON 2020 ICT, NMBP, and other programs that involve robotics. As part of the FP7 (2007-2013) program, 16.5% of funding for robotics projects was awarded to Italian institutions. Robot-related programs currently active in Italy include the following:

1. National Plans and Programs of the Italian Government
1.1. National Industry 4.0 Plan
   - An organic policy of public support for corporate adoption of 4.0 technologies via promotion of 4.0 technological solutions and stimulation of qualified investment demand.
1.2. National Research Council (CNR)
   - Robotics research aims to develop new robotic systems with decision-making autonomy in highly uncertain environments, also cooperating with other robots and humans
1.3. National Research Program (PNR)
   - Robotics is not specifically predefined in the program

2. Italian Technological Clusters
   - Networks of public and private subjects operating in the national territory in sectors such as industrial research, training, and technology transfer
   - ACMM- Marche Manufacturing Cluster Association on machine tools, robots, and machining

3. Competence Centers
   - Research and innovation centers integrated with universities and companies with high-level skills and facilities with respect to the essential dimensions of Industry 4.0
   - ARTES 4.0. Focus on Advanced Robotics and enabling digital Tech & Systems
   - Advanced Manufacturing CIM 4.0
   - MADE for Industry 4.0
   - BI-REX (Big Data Innovation & Research EXcellence)
   - SMACT for social networks, mobile platforms, and advanced analytics
   - MediTech for integration 4.0

4. Istituto Italiano Di Tecnologia
   - Sustainability and the environment, healthcare, the aging society

5. Robotic Olympics to encourage and support the educational potential of robotics with reference to STEM

In **Sweden**, there are currently two primary robot-related R&D programs; one is Robotdalen and the other is framework grants for research on smart systems.

Since 2003, VINNOVA (a Swedish governmental R&D agency) has supported Robotdalen. Robotdalen is one of Europe's leading robotics centers, where researchers, developers, manufacturers, and academics work together in the field of robotics with a commercial focus. Robodalen has a particular emphasis on industrial, logistics, service, and healthcare robotics. The approximate annual budget has varied from roughly 0.7 to 2.5 million dollars. There are five representative ongoing projects: robot suit HAL, FIREM (FIre REscue in Mines), STRADA for interactive remote rehabilitation for stroke patients, the cognitive retinal generator for assisting ophthalmic surgery, and the world's first hygiene robot, Poseidon.

Aside from Robotdalen, the Swedish Foundation for Strategic Research (SSF) funds science, engineering, and medicine via grants of up to 100 million dollars annually. Among the 32 currently active projects, one robotics research project is, especially in information-, communication and systems technology, being funded under the project title of "Smart Systems" including ICT, robotics, and AI with a budget of 30 million dollars over five years from 2016 until 2021. The goal of framework grants for research on smart systems is to improve the designs and functionalities of existing kinds of technological systems or to create entirely novel types. Smart systems may offer adaptive, predictive, and robust behaviors and capabilities even under hostile conditions. They could also provide compensation for uncertainty or variability in a range of contexts. Safety and security can be features of a target system, while flexibility and upgradeability are normal parts of the specification. The major research areas are Cyber Physical Systems, Integrated Systems, Systems of Systems, Automation, Autonomous Systems and Robots, and Artificial Intelligence-Based Information Systems.

US robot R&D programs were reviewed in key categories with "Space Robotics," "Military Autonomous Vehicles & Systems," and "Ubiquitous Collaborative Robots," which are managed by the US government.

As a space robot R&D program, the National Aeronautics and Space Administration (NASA) has been promoting its Mars Exploration Program (MEP). MEP is a long-term mission to explore the planet Mars, funded by NASA. Since it was formed in 1993, MEP has been employing diverse orbital spacecraft, landers, and Mars rovers to discover clues about the possibilities of life on Mars, as well as the planet's climate and natural resources. At the beginning of the 21st century, the missions were concentrated on the "Follow the Water" goal, including the Mars Odyssey (2001), Mars Exploration Rovers (2003), Mars Reconnaissance Orbiter (2005), and Mars Phoenix Lander (2007). Since then, the MEP has transitioned from the "Follow the Water" goal to a combination of characterizing the climate and geology of Mars with the Mars Science Laboratory's Curiosity Rover (2011) and Mars Atmosphere and Volatile Evolution (2013). Currently, MEP missions are placing more emphasis on seeking signs of life as well as preparing for human exploration of the planet by conducting the programs InSight Lander (2018) and Mars Rover (2020).

Since NASA announced the Mars rover program called "Mars 2020" on December 4, 2012, the rovers have taken journeys toward Mars with specific goals. In September 2013, NASA launched the Opportunity Rover for scientists/researchers to propose and develop instruments, including the Sample Caching System for storing Martian soil. The scientific instruments for the mission were selected in July 2014 after an open competition based on objectives set one year earlier. Recently, Mars 2020 has been under operation by MEP with a planned launch for July 17, 2020 and aims to touch down in Jezero crater on Mars on February 18, 2021. The rover in the Mars 2020 program is based on the design of the Curiosity Rover but with key scientific instruments embedded in order to explore a site considered likely to have been habitable. The MEP budget in 2017 was approximately 647 million dollars from the US government and separate sources, and NASA funded 408 million dollars for Mars Rover 2020 and 239 million dollars for other missions & data analysis. In 2019, MEP funding has been approximately 604.5 million dollars, with NASA allocating 348 million dollars for Mars 2020 and 253.5 million dollars for other missions & data analysis, respectively.

For military autonomous system R&D, the Department of Defense (DOD) has been managing a large number of programs related to developing unmanned military systems and robotic vehicles. Since the US Secretary of Defense's RDE Focus was released in 2010, "**Autonomy**" has become the Science & Technology (S&T) priority for the DOD. The DOD has published annual progress reports and plans associated with development of military autonomous vehicles and integration of the vehicles/systems of each department such as the Army, Navy, Air Force, etc. The autonomy technology development topics can be classified into Machine Perception, Reasoning and Intelligence (MPRI), Human/Autonomous System Interaction and Collaboration (HASIC), Scalable Teaming of Autonomous Systems (STAS), Test, Evaluation, Validation, and Verification (TEVV). Within these topics, seven core technologies have been identified: sensors/payloads, navigation/control, weapons, comms/data management, autonomy, propulsion/energy, and mobility. The largest investment has been made in integrated sensors and payloads followed by navigation and control systems. The DOD 2019 annual budget for developing autonomous systems is 9.6 billion dollars for the three main services (Navy, Army, Air Force) and the other agencies (DBDP, DARPA, DLA, DTIC, DTRA, MDA, OSD, SOCOM, TJS, WHS), which have detailed plans to develop unmanned systems and robotics.

For fundamental robot R&D, the National Robotics Initiative (NRI) was launched in 2011 and has advanced from NRI-1.0 to NRI-2.0, supported by the US Government. At the beginning, the goal of NRI-1.0 was to accelerate the development and use of robots in the United States via innovative robotics research and applications emphasizing the realization of such co-robots working in symbiotic relationships with human partners. Since NRI-2.0 was released in 2016, the main goals of NRI under the policy, "Ubiquity: Seamless Integration of Co-Robots" have focused on researching the fundamental science, technologies, and integrated systems needed to achieve a vision of ubiquitous collaborative robots assisting humans in every aspect of life. Moreover, in NRI-2.0, collaboration between academic, industry, non-profit, and other organizations is encouraged in order to accomplish better connections between fundamental science/engineering/technology development, deployment, and use. The current annual budget of NRI-2.0 is 35 million dollars. This funds Foundation (FND) and Integrative (INT) projects in multiple agencies of the federal government, including the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the U.S. Department of Agriculture (USDA), Department of Energy (DOE), and the U.S. Department of Defense (DOD).

In **Canada**, aerospace is the number one R&D player among all Canadian manufacturing industries. In 2018, the Canadian aerospace manufacturing industry invested 1.4 billion Canadian dollars in R&D, contributing close to a quarter of total manufacturing R&D in Canada and achieving over five times higher R&D intensity than the manufacturing average.[1)]

The only Canadian government-led large robot R&D program is Canadarm*, Canada's best-known contribution to robotics. A manipulator able to withstand the harsh radiation of space, it was first used by the crew of the NASA Space Shuttle Columbia in 1981. On subsequent missions, Canadarm2 and Dextre were used to construct and maintain the International Space Station. On February 28, 2019, the government promised 2.05 billion Canadian dollars in funding for this "third generation" Canadarm over 24 years.[2)]

The first Canadarm's technical name was The Shuttle Remote Manipulator System (SRMS). The project was launched in 1974. Spar, CAE, and DSMA Atcon formed the industrial team, with what was formerly the National Research Council of Canada (NRC) and currently the Canadian Space Agency (CSA) overseeing the project. The Government of Canada invested 108 million Canadian dollars in designing, building, and testing the first Canadarm flight hardware, which was given to NASA for the orbiter Columbia. It was deployed in 1981 and returned to earth in 2011.[3)]

The second Canadarm's technical name was The Space Station Remote Manipulator System. It was designed, built, and tested from 1986 to 2001 by MDA in Brampton, Ontario.[4)] On April 21, 1988, Canada announced a 1.2 billion Canadian dollar commitment over 15 years for the realization of the Mobile Service System (MSS) under the name of the Canadian Space Station Program.[5)] It included the Space Station Remote Manipulator System (SSRMS, Canadarm2), mounted on a Mobile Base System (MBS) and designed to handle large loads onboard the ISS, and the Special Purpose Dextrous Manipulator (SPDM, Dextre), a second robot designed to perform more delicate tasks. Canadarm2 was deployed on April 19, 2001 and MBS was deployed on June 5, 2002. A total of 1.4 billion Canadian dollars were invested in this up to 2002.[6)] The third and last component of MSS, Dextre, was developed from 2003 to 2007 and deployed on March 11, 2008 and 116 million Canadian dollars were invested.[7)]

The third Canadarm's letter of interest, "Lunar Gateway Robotics_Canadarm3" was announced on July 26, 2019. CSA proposed to include the following elements: 1) the eXploration Large Arm and its tools (XLA); 2) the eXploration Dexterous Arm (small arm or XDA); 3) various robotic interface fixtures, platforms, and receptacles and; 4) ground segment and robotic integration.[8)] To contribute an artificial intelligence-enabled robotic system to the United States-led Lunar Gateway, the government announced 209 million Canadian dollars in funding from 2019 to 2024 to develop Canadarm3 under a policy entitled "Canada Reaches for the Moon and Beyond" in the 2019 Canadian Budget.[9)] CSA announced a request for a proposal to develop XLA, XDA "Gateway External Robotics Interfaces (GERI) Large and Dexterous Arms Interfaces_Phase A" on April 26, 2019. It states that 2,727,000 Canadian dollars for XLA and 3,809,500 Canadian dollars for XDA will be allocated, and its expected completion date is on or before August 31, 2020.[10)]

Canadian Robots Canadarm2 and Dexter have led to the development of many technologies, such as neuroArm and IGAR. Now, with the improved Canadarm incorporating advanced artificial intelligence (AI) technologies, Canadarm3 is expected to open the door for new robotics technologies.