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Advanced Notice

Canadian Health Technologies for Space Exploration

1. Purpose and Nature of this Advanced Notice (AN)

Public Services and Procurement Canada (PSPC), on behalf of the Canadian Space Agency (CSA), and the Government of Canada wishes to inform the Canadian space and biomedical sectors of its intention to issue Requests for Proposals (RFPs) for space health technology challenges and socio-economic studies. These activities form part of the CSA's effort to define potential opportunities for Canadian participation in future international Human Spaceflight (HSF) missions into deep space.

A list of potential challenges and studies planned for September 2018 is provided in Annex A.

The objectives of this AN are the following:

- To inform the Canadian space and biomedical sectors of the posting date scheduled for the potential RFPs;
- To inform the Canadian space and biomedical sectors of preliminary areas of investment being considered by the CSA.

This AN is neither a call for tender nor an RFP. No agreement or contract will be entered into based on this AN. The issuance of this AN is not to be considered in any way a commitment by the Government of Canada, nor as authority to potential Respondents to undertake any work that could be charged to Canada. This AN is not to be considered as a commitment to issue a subsequent solicitation or award contract(s) for the work described herein.

2. Context

The international space exploration community is in the process of developing plans for the next steps in human space exploration beyond low-Earth orbit (LEO), including missions to lunar vicinity, the lunar surface, and, later, missions to Mars. As part of this planning process, space agencies are exploring technology areas that could contribute to the success of these missions. The health and well-being of space crews is of critical importance in the achievement of long-duration space missions and a key area of interest for all the international partners, as they plan the next steps in space exploration beyond the International Space Station (ISS). Due to greater physical distances and mission durations as well as communication delays, future deep space human spaceflight missions will require the development of medical systems and support technologies enabled by artificial intelligence (AI) that provide the crew with enhanced medical autonomy.

In the fall of 2017, the CSA, in partnership with the National Research Council of Canada Industrial Research Assistance Program (NRC IRAP), organized regional information sessions and a

national forum to engage stakeholders in a discussion on space health and areas of Canadian expertise and capabilities. It also sought advice from a group of experts on the potential Canadian healthcare and biomedical roles for deep space missions. Together, these activities revealed a strong interest from non-space biomedical players to engage in space-related work and identified synergies between space and terrestrial healthcare needs and technology trends.

Through the upcoming RFPs, the CSA will be looking at options for Canadian roles in deep space autonomous healthcare and technology contributions in areas of Canadian strength, including medical informatics, AI, big data analytics, life sciences and biomedical research. The CSA is also interested in assessing the potential to translate investments in deep space healthcare into new knowledge and capabilities that leverage digital technologies to empower innovation, value creation and improve the quality of life for Canadians.

This initiative will be implemented in collaboration with NRC IRAP. By partnering, the CSA would leverage the NRC IRAP's knowledge of Canadian SMEs in the health sector, and NRC IRAP clients would gain access to space development opportunities and the associated visibility and prestige. This collaboration between NRC IRAP and CSA will include engagement activities, coordination in funding of health research and technology development as well as advisory services.

3. Potential Work Scope and associated RFPs

The CSA intends to proceed with two space health technology challenges and contracts for socio-economic studies. Details on these topics are also presented in Annex A.

Space Health Technology Challenges

Two RFPs will be designed around problem statements associated with desired outcomes for deep space astronaut healthcare. Through these challenges, CSA intends to facilitate the early development, testing and validation of prototypes, and in collaboration with NRC IRAP, prepare a pathway to commercialization. This is an opportunity to support the growth of Canadian companies through contracts to support early stage, pre-commercial research and development, late stage prototypes, and to accelerate commercialization.

The CSA has identified the following preliminary areas of investment based on the fall 2017 stakeholder engagement activities:

- Decision support systems (the potential RFP will be managed by PSPC)
- Diagnostic Tools, Radiation Protection and Medical Training and Simulation (the potential RFP will be managed by PSPC)

Socio-economic benefits studies

In addition to the challenges, the CSA intends to fund socio-economic studies (the potential RFPs will be managed by CSA).

4. Schedule

For guidance, publication of the RFPs for the space health technology challenges and the socio-economic studies on the Government's electronic tendering service is planned for September 2018. It is worth noting that several factors may influence this date, and even lead to cancellation of such a publication.

5. Important Notes

This AN is intended to provide lead time to potential Respondents to prepare for RFPs described in Annex A. Questions should be withheld until the specific RFPs are issued through the Government electronic tendering service.

Canada asks potential Respondents to visit Buyandsell.gc.ca regularly for news on these processes.

Annex A

1. Upcoming RFPs for Space Health Technology Challenges and Socio-economic Benefits Studies

1.1 Technology Concept Studies and Prototyping of Health Technologies for Deep Space Missions – Decision Support Systems (managed by PSPC)

As part of the autonomous crew healthcare system for deep space missions, a space medicine decision support system (DSS) is aimed at supporting the on-orbit Crew Medical Officer (CMO) in the development of a diagnosis and relevant treatment plan(s), as well as the continuous health monitoring and early onset detection and prediction of disease states. This DSS could be an AI-enabled system which could interface with health-related databases (which would include medical and non-medical real-time and periodic data acquisition) as well as crewmembers health history. The DSS could also access a medical knowledge base containing established clinical guidelines and best practices. Advances in medical and AI technologies will enable continuous monitoring, ongoing tracking of health indicators, and early disease warning through the development of a variety of techniques and tools such as DNA sequencing, diagnostic biomarkers, genomics, miniaturized and portable bioimaging, bio-MEMS, etc. In addition, by tracking medical reserves and treatment plans, the space medicine DSS could also assist in the management of medical consumables, offering treatment options depending on the availability or predicted future need of the consumables.

This initiative will include two phases:

- The first phase will consist of the development of a technology concept study of a solution to address the need for healthcare support, i.e. clinical decision support, for future deep space missions;
- The second phase will consist of the development of a prototype. The prototype, to be delivered to CSA, will be intended to be used on the ground, in laboratory settings, to test the core functionalities and assess the possibilities of an eventual integration with other subsystems developed by the CSA and its partners.

An evaluation and selection process will be implemented at the end of the first phase to identify which projects will be funded to continue with the second phase of the contract. Details of this process will be presented in the RFP.

Under this RFP, the CSA is looking for a variety of solutions. Proposed solutions could target various aspects of astronauts' health, based on the risks and needs for deep space missions. Potential solutions could include (and are in no way limited to):

- A solution that can analyze health related data and provide a differential diagnosis for a set of medical conditions;
- A solution addressing one or more health concerns. For example, this could be a solution that autonomously:
 - Assesses cognitive health;
 - Predicts early on-set of medical conditions;
 - Provides trends and the associated potential health outcomes;
 - Identifies the state of "fit-for-duty";

- Assesses sleep, fitness or nutrition; or
- Evaluates the health state of a crewmember and detects transitions away from a baseline;
- Etc.

1.2 Technology Concept Studies in the Fields of Medical Diagnostic Tools, Radiation Protection and Medical Training and Simulation for Deep Space Missions (managed by PSPC)

To assist the CMO in providing medical support to crews on future long-duration exploration missions beyond LEO and improve our understanding of the effects of spaceflight on the human body, advanced medical technologies that suit the spaceflight environment (e.g. lightweight, compact, mobile, reliable, non- or minimally invasive, user-friendly, plug-and-play, rugged etc.) will be required.

This initiative will consist of only one phase. It will result in the development and delivery of technology concept studies for solutions that will address one or more health risks and needs. Note that successful small and medium enterprises may be eligible for NRC IRAP support for subsequent prototyping work. Technology areas of interest for this request for proposals are diagnostic tools, radiation protection and simulation and training. The CSA is looking for innovative solutions, including those that leverage advances in AI and automation, from the Canadian community.

- Medical Diagnostic tools: Medical diagnostic tools or devices measure or produce data of an individual, which can be used for health assessments, and to substantiate or rule out a particular diagnosis. Diagnostic tools are a subset of the larger “medical devices” category which cover a wider range of health or medical instruments used in the treatment, mitigation, diagnosis or prevention of a disease or abnormal physical condition. Diagnostic tools consist themselves of a number of sub-categories including bioanalytical, biomonitoring and imaging devices. The ultimate goal is to develop non-(or minimally) invasive medical devices and techniques for the purposes of astronauts health monitoring, and increasing the prospects for prevention, earlier diagnosis and improved treatment.
- Radiation Protection: Missions beyond LEO, to the Moon, Mars and beyond, will expose astronauts to increased levels of radiation, which is foreseen to cause significant health damage to the crewmembers if not appropriately protected. In addition to the materials and technologies used to shield the space vehicle, other solutions will be required to monitor, predict and protect the crewmembers from the harmful radiation exposure.
- Medical Training and Simulation: Crew training involves the acquisition and evaluation of a comprehensive range of knowledge and skills required to achieve space mission success. Training related to medical duties in space may come in the form of simulation exercises that can be used both before and during space missions. In general, simulation allows deliberate practice, exposure to new concepts and procedures, and the ability to evaluate systems and equipment without the risk of harm. Simulations that deliver training may come in the form of simple devices, complex models and/or computerized platforms.

Training programs and simulation technologies for deep space missions should aim to facilitate and provide skills maintenance and acquisition in flight, and also to provide psychosocial support, and behavioral and performance assessment. For example, this can include advances in augmented and artificial reality.

For this RFP, potential Respondents will be invited to propose ideas specific to one or pertaining to a wider aspect of astronaut health. For example, the proposed solution could either:

- Target a single health condition, or category of health conditions.
- Consist of a broader concept
 - e.g. Predict radiation effects on cardiovascular health, assess multiple parameters of mental health, introduce a novel imaging tool, provide a simulation platform, etc.

1.3 Socio-economic benefits studies (managed by CSA)

The CSA will contract out a series of studies to identify affinities between space and terrestrial needs and how deep space healthcare solutions can have terrestrial benefits and contribute to Canada's economic growth. This will include studies on the:

- Assessment of challenges to healthcare delivery for northern and remote communities, aging and sedentary populations and operational environments (e.g. military, industrial settings, remote research stations) and analysis of how these challenges could be overcome by deep space healthcare solutions, including cost savings and other benefits (e.g. improved access to specialists and equipment, reduced time away from home and community, improved timeliness, quality and continuity of care);
- Identification of priority areas for technology development based on their potential to be used in future deep space exploration missions (e.g. industrial capability and technology readiness) and potential to result in important socio-economic benefits (e.g. potential improvements to terrestrial health outcomes, commercial returns and spin-off potential, export potential). The studies in this category will focus on the point-of-care health diagnostics market and the clinical decision support market.