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Title - Sujet Development of enabling space technologies - Développement des technologies spatiales habilitantes	
Solicitation No. - N° de l'invitation 9F063-190729/A	**Amendment No. - N° modif.** 007
Client Reference No. - N° de référence du client 9F063-190729	**Date** 2020-12-08
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on - le 2021-01-05 Heure Normale du l'Est HNE

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PROJECT TITLE: Development of enabling space technologies

The purpose of this amendment is to answer questions received.

Questions and answers:

For Priority Technology 4: Mass and Volume Reduction for Planetary Exploration Instrument

Question 1:
Under "Targeted Missions" (p. A-84), the RFP states "For the purpose of this RFP Priority Technology, "near-term" is defined as launch before 2027." We have talked to senior officials at NASA and ESA who have confirmed that there are no opportunities for Canadian participation in any lander or rover-based missions to any inner solar system planetary body with a launch before 2027. All missions planned in this timeframe already have payloads confirmed. Using Mars as an example, ESA and NASA have an agreement for the Fetch Rover Mission, that prohibits any other payloads. This is the only mission to the surface of Mars currently being planned with a launch date before 2027. Hence, we would hope that the 2027 date be considered flexible for the purposes of this RFP.

Answer 1:
Despite what was indicated in Section 5 "Targeted Missions", sub-section "Understanding of Mission Objectives", the requirement is to provide a development plan consistent with a launch readiness in 2027". The intent was not to imply that the launch need to occur by 2027. Note that this sub-section also provides instructions to the bidder in the case a mission is not yet identified. Therefore the wording is revised as follows:

Delete:
Section 5 Targeted Missions, entirely.

Replace with: (underlined text is used to ease the identification of the changes)
The primary objective of this work is mass and volume reduction to advance readiness of a mature, low-cost planetary instrument concept targeting a near-term mission opportunity to generate science data to address Canadian planetary science priorities (RD-02).

For the purpose of this RFP Priority Technology, `near-term` implies that the development plan be consistent with a launch readiness in 2027, and, `low-cost` means a CSA investment up to $35M ROM Life Cycle Cost (LCC), excluding risk, taxes, and science data analysis grants. See section 6 of this SOW for further discussion of scope, and section 10 for further information on cost analysis. Cost estimates and technology readiness and risk analysis arising from this project will be an important factor for future planning.
The technology areas for this work include, but are not exclusive to, the Planetary Concepts developed as results of recent CSA-supported concept studies. Planetary instrument concepts that have been developed in Canada as a result of CSA science maturation studies, CSA science definition studies, CSA FAST grants or through other investments, are also eligible.
For the purpose of this work, the Bidder will address "Understanding the technology to fulfill mission objectives" (Criterion 1 of the STDP evaluation criteria) with evaluation elements defined as follows:

- **Understanding of mission objectives** – the Bidder should describe the target mission, demonstrate maturity of the concept, demonstrate "low cost", and provide a development plan consistent with a launch readiness in 2027, including:

- A description of the space mission opportunity that the Bidder is targeting, providing the mission opportunity title and partners. The date at which it is anticipated that CSA should commit to partners and the launch date should also be provided to the best of the Bidder`s knowledge, with

  a narrative describing the degree of certainty associated with the schedule for this opportunity. If the Bidder has not yet identified a mission opportunity, the Bidder may include a workpackage to explore partnership opportunities (see section 6.8 of this SOW);
- A description of the assumed mission accommodation, environmental and planetary protection requirements, with narrative that provides the basis of assumptions. Where no specific target mission is yet defined, these mission requirements must still be provided, with basis of assumptions.
- The objectives of the baseline science investigation to be undertaken by the planetary science instrument (see sections 7 and 8 of this SOW), showing alignment with Canadian Science Priorities (RD-02);
- A science traceability matrix for the baseline science investigation demonstrating an understanding of how the key functional and performance instrument requirements identified by the Bidder will deliver the identified science objectives (see section 7 of this SOW);
- A self-assessment of Science Readiness Level (SRL), demonstrating SRL of 3 or above at the start of this contract. The SRL scale to be used for this study is referenced in AD-05
- A cost-benefit analysis for the targeted mission, justifying the ROM cost to the Government of Canada in terms of the scientific, technological, and economic benefits of the targeted mission opportunity to Canada. The ROM cost to CSA must be aligned with the definition of `low cost` above; and,
- A mission development schedule that supports launch readiness in 2027.

- **Understanding of the technology and systems level design trade-offs** – the Bidder should present a clear, mature technical specification for the instrument against which significant mass and volume reduction is planned:

  - A clear specification for the flight instrument has been defined, flowed down from the science requirements, the science operations concept and target mission accommodation and environmental requirements;
  - The feasibility of the concept has been demonstrated experimentally using a breadboard built by the Bidder`s team members, which has produced data of sufficient quality to address the science objectives;
  - A review of the path to flight for the concept, including a TRRA of the concept identifying current Technology Readiness Level (see section 6.5 of this SOW). The Bidder must include in their bid a Technology Development Plan, a.k.a. Technology Roadmap, the required technology developments to meet targeted mission needs, and a plan and a timeline to reach TRL 5 (this study), TRL 6 and TRL 8. The Technology Roadmap must be provided in the format of the Technology Roadmap Worksheet (AD-04); and,
  - Specific technical objectives for the current work, including but not limited to a mass and volume reduction exercise (see section 6 and 8 of this SOW). Improvements in mass and volume must be significant and/ or aligned with known target mission accommodation requirements. Clear performance metrics will be identified for each Technical Objective.

For Priority Technology 5: SAR High Speed On-Board Processing

Question 1:
HSP-2, Mandatory, Receive window duty cycle 90 % of the Pulse Repetition Interval
This requirement leaves insufficient time for a reasonable chirp length and TRM guard bands. We ask what the assumptions are for the chirp duty cycle and if the chirp length is included in the receive

window duty cycle. Or we suggest that we are making the following assumptions: Transmit pulse duty cycle of up to 15% and a guard band of 10 us, we also assume the chirp length is included in the receive window.

Answer 1:
The bidder can assume that 1) the chirp length is included in the receive window, and 2) 10us TRM guard bands. The developed OBP must be able to process a window duty cycle corresponding to 90% of the PRI. However, CSA understands that some combination of TX duty cycle, guard bands and PRF would result in an overlap with the prescribed 90% PRI receive window duty cycle, in which case it would be reduced to accommodate the TX.

Question 2:
HSP-8A, Mandatory, Longest integration time per look, 1 s
As integration time is a function of wavelength is this for L-band or Ku-band?

Answer 2:
Integration time per look applies to L-Band and X-Band. Longer integration time serves different purposes depending on the frequency. L-Band naturally require longer integration time, while it is also necessary to reach the high-resolution relevant to X-band applications. Ku-band is added for completeness, but the combination of frequency and resolution is expected to require shorter integration time. The requirement in the SOW will be clarified.

Table 1: HSP-8A

Delete:

HSP-8A	Mandatory	Longest integration time per look	1 s

Replace with:

HSP-8A	Mandatory	Longest integration time per look	1 s (L-Band to X-Band)

Question 3:
HSP-8A, Mandatory, Longest integration time per look, 1 s
Also, as HSP7A mandates 10 azimuth looks do we interpret this requirement as the longest integration time of 10s, as per the HSP-8B requirement?

Answer 3:
No. Multi-looking may be implemented as a series of images generated with a 1s integration time and therefore does not result in a longest integration time of 10s. HSP-7A target cases where the azimuth resolution is significantly better than the range resolution. In order to size the on-board processor, this requirement is clarified as only applying to cases of moderate (25 m) final image resolution, and is therefore separated from goal HSP-8B, which should be implemented for single-look only. The requirement in the SOW is clarified as follows:

Table1: HSP-8B

Delete:

HSP-8B	Goal	Longest integration time	10 s (For L-band) Shorter integration time may be considered for higher frequencies)

Replace with:

HSP-8B	Goal	Longest integration time	10 s (For L-band) Shorter integration time may be considered for higher frequencies). Single-look only.

Table 1: HSP-7A

Delete:

HSP-7A	Mandatory	Number of looks in azimuth	10 looks in azimuth/1 look in range

Replace with:

HSP-7A	Mandatory	Number of looks in azimuth	10 looks in azimuth/1 look in range. Applicable to medium final image resolution (25 m) only.

Question 4:
HSP-9A, Mandatory, Processing speed, 1/3 of real-time processing speed.
This requirement is puzzling, viz. a successful onboard processor can only be real-time and if it runs slower than real-time it will fail within a short period of time - it is not possible to implement significant memory to store data that needs to be processed. This requirement also contradicts HSP-10, which defines a latency of 1s, viz. processing an image frame of 1s collected data at 1/3 real-time will take 3s which far exceeds the latency requirement.

Answer 4:
CSA has great interest in the development of OBP capable of real-time processing, as highlighted by the goal HSP-9B. The contractor will be encouraged to target this goal.
CSA would like to emphasize that the 1s latency HSP-10 is a goal, and not a mandatory requirement. It is understood that in order to meet HSP-10, compliance to HSP-9B (real-time processing) would be required.
Also, CSA would like to point out that the SOW allows for the development of a reduced scope EM that could consist in a single unit/board of a multi-board system. In that particular case, the proposed EM could meet the HSP-9A minimum requirement, while real-time processing could only be achieved with the complete multi-board system.

For Priority Technology 6: Cloud-computing for Synthetic Aperture Radar (SAR) processing

Question 1: Front End Interface
The RFP doesn't list any user features or requirements. We interpret this as our scope is for the back end only.
What specifications, APIs, or details can you provide about the Front End interacts with any existing systems?

Answer 1:
We are targeting an open cloud approach. Standards like OCCI1 and OCCI1.1 use is encouraged. We are open in case of a proposal not based on RCM data to examine public clouds and their API. Example AWS API. In case of Public cloud, it has to align with the TBS guideline published in 2018. In case of RCM data use, a private cloud is the only available solution.
For Front end APIs, it must be a battery that supports both users and administrators requirements.

1- User Interface to support the execution of specific applications, in this case Production apps and specific office applications especially, browser, email, word processing, presentations and processing of spreadsheets.
2- Operator interface: web services, Billing system, Office applications, soft or hard quota management.
3- Administrator interface: network management (where applicable, infrastructure status, software status, storage management, run time management).
4- Security interface (where applicable): account managements, role assignment, infrastructure status, software status, storage management, run time management.

For this phase of our research project, we do not require any application development interface.

Question 2: Blockchain Details
What components or features are to be implemented on the blockchain within the project time frame?

Answer 2:
1- Data immutable.
2- Compare between decentralized and centralized approaches and implement the best approach.
3- Study distributed vs. centralized ledger approach and implement the best solution.
4- Peer-to-peer network in a secure (GoC like) network.
5- Enhanced distributed security vs the need to a centralized approach.
6- Goal: Faster settlement in case of any financial transaction over a public forwarded network.

Question 3: Programming Language
Are there any restrictions or preferences on programming languages?

Answer 3:
There are no restrictions on the programing language as long as the development environments would be accessible to GoC and the public on the global market.

Question 4: Current API
What are the existing APIs, so that we can ensure we are setting up our architecture to match?

Answer 4:
In case of RCM data use, please seek the licences from the commercial partners. In case of use of any other data or production by the bidder, CSA has no API specification to provide.

Question 5: System Administration
What sort of system administrative capabilities are required?

Answer 5:
Please see answers 1) 3-, and 6)

Question 6: System Administration/User Access
Is any sort of metering required on users or requests? e.g. rate limiting, per account limits, etc. Is there an existing system this should use or is something else acceptable?

Answer 6:
We would like to be able to have a billing like system with soft and hard quota limits and tracking of

payment or compliance. Security requirements as per ITSG 33. Reporting capability of user activities. The detailed specifications are left to the bidder.

Question 7: System Administration
What kind of monitoring/alerting is in place or is required? e.g. uptime, performance degradation, elapsed query time, high load, etc.

Answer 7:
In case of the use of data from RCM mission, hence a private cloud, a full monitoring and alerting capabilities have to be added as well as a reporting and billing capability.
In case of use of a public cloud network for mission products from other than RCM mission, a reporting and a billing capability are required. Data security service to monitor access to data would also be required.

Question 8: Data management
Does the ingested RCM data format require any additional processing before storage?

Answer 8:
RCM raw data is retrieved in FRED format

Question 9: Data management
What output formats are required to be supported? Are there any existing libraries that need to be incorporated?

Answer 9:
For RCM data, information will be made available subsequent to signing the NDA; however, it is expected that **GCD** or **GCC** representing GeoCoded Detected or Complex products or alternatively SSG or SPG product for RADARSAT-1 will be supported.

Question 10: Data management
What is the metadata associated with input/output data? e.g. Capture time, satellite operating modes, resolution, weather conditions, etc.

Answer 10:
For RCM data, information will be made available when signing the NDA. However, it is expected that Source attributes such as Radar Parameters, Orbit and Attitude Parameters as well as Image Generation and Image Reference Parameters will be associated.

Question 11: Data management
Is data pushed or pulled into the system from RCM?

Answer 11:
We have both Push and Pull.

Question 12: Data management
What is the anticipated hourly query volume, average and peak (especially under emergency circumstances)? Is this evenly distributed throughout the day or are there peak times?

Answer 12:
For RCM data, information will be made available subsequent to signing the NDA.
Other than that we can estimate a uniform distribution through between 8am to 8pm. The remaining 12h, the load could be lower by 30%. Those are rough estimates based on engineering sense and not based on a specific mission.

Question 13: Data management
What parameters are required for a query from the user?
- Geographic area
- Time frame
- Specific mode
- Etc.

Answer 13:
It depends on the Science data and the mission being used by the bidder. In case of RCM data, the details will be provided following the signature of the NDA by the selected contractor.

Question 14: Data management
What is the expected resolution of inputs and outputs? We are looking for information about the meters per pixel resolution of the incoming data and the typical data export. This will help us size the data pipeline appropriately.

Answer 14:
Here is an example of the resolution that some of the Canadian missions:
ftp://ftp.asc-csa.gc.ca/users/STDP/

Question 15: Cloud Services
Shared Services Canada lists Google as having Protected B services, but not as a Protected B provider. Is the Google Cloud Service Montreal (northamerica-northeast1) region suitable for working with RCM data?

Answer 15:
Please refer to the reference in the bid from TBS. For RCM data, the provider has to be able to provide higher than Protected B.

Question 16:
About these two TRR requirements:
- Must build the cloud computing processing prototype. ISO cloud standards ISO/IEC 1778 will be followed for quantified performance evaluation using EO Data
- Must process EO/SAR data

Could you clarify the definition of EO/SAR data? I want to know if this means “EO or SAR” allowing the bid to satisfy the requirement by processing any EO data such as optical data.
These two terms are used throughout the PT #6 SOW, could you clarify these definitions and usage?

Answer 16:
EO/SAR for CSA is clear Earth Observation Data based on SAR Technology. This project is only interested in SAR and not any other Science EO Data generated by other technologies.
EO data : Is the Science data generated from a space-based asset using SAR technology, can be either real or simulated. Our preference would be for real data generated by SAR missions.

SAR : Synthetic-Aperture Radar technology. The Radar is space-based and is used to acquire the images and science data as planed by the ground segment of a mission. The acquisition planning is not part of this project.

ALL OTHER TERMS AND CONDITIONS OF THE RFP REMAIN UNCHANGED