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LETTER OF INTEREST
LETTRE D'INTÉRÊT

Title - Sujet SPECTRUM MONITORING SYSTEM	
Solicitation No. - N° de l'invitation UT255-210561/A	**Date** 2021-06-03
Client Reference No. - N° de référence du client UT255-210561	**GETS Ref. No. - N° de réf. de SEAG** PW-$$HN-477-80087
File No. - N° de dossier hn477.UT255-210561	**CCC No./N° CCC - FMS No./N° VME**

Solicitation Closes - L'invitation prend fin
at - à 02:00 PM Eastern Daylight Saving Time EDT
on - le 2021-06-30 Heure Avancée de l'Est HAE

F.O.B. - F.A.B.
Plant-Usine: ☐ **Destination:** ☑ **Other-Autre:** ☐

Address Enquiries to: - Adresser toutes questions à: Lahaie, Sasha	**Buyer Id - Id de l'acheteur** hn477
Telephone No. - N° de téléphone (613) 293-3296 ( )	**FAX No. - N° de FAX** ( ) -

Destination - of Goods, Services, and Construction:
Destination - des biens, services et construction:

Specified Herein
Précisé dans les présentes

Comments - Commentaires

Instructions: See Herein

Instructions: Voir aux présentes

Vendor/Firm Name and Address
Raison sociale et adresse du fournisseur/de l'entrepreneur

Delivery Required - Livraison exigée See Herein – Voir ci-inclus	**Delivery Offered - Livraison proposée**

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Name and title of person authorized to sign on behalf of Vendor/Firm (type or print)
Nom et titre de la personne autorisée à signer au nom du fournisseur/ de l'entrepreneur (taper ou écrire en caractères d'imprimerie)

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Canada

REQUEST FOR INFORMATION (RFI)
SPECTRUM MONITORING SYSTEM
INNOVATION SCIENCE AND ECONOMIC DEVELOPMENT CANADA (ISED)

PART 1 – PURPOSE AND NATURE OF THE REQUEST FOR INFORMATION (RFI)

1.1 Introduction

Public Service and Procurement Canada (PSPC) on behalf of Innovation Science and Economic development Canada (ISED) is seeking feedback from industry related to potential hardware and software solutions that are currently commercially available to support the spectrum monitoring system requirements of government and regulatory organizations.

1.2 Purpose

ISED has a requirement for a national (Canada-wide) spectrum monitoring system that shall provide the means to execute a number of functions such as: Spectrum analysis, automatic direction finding, and demodulation and technical parameter measurements of radio frequency signals that can cause interference to communication in Canada. It is Canada's intention to issue contracts to the winning bidder(s) for a future RFP to supply system components capable of fulfilling this requirement. A component of the system can be defined as test & measurement hardware such as: Spectrum Analyzer, direction finder, receiver/demodulator, associated sensors, antennas, power supplies and interconnecting cabling. A system can be defined as the combination of all the individual components provided.

The purpose of this RFI is to assess industry's implementation capabilities of such a spectrum monitoring system to be used in fixed, transportable and mobile deployment scenarios. This document elaborates on these required functions and describes in detail the monitoring system that ISED is interested in acquiring. To this end, knowledgeable industry suppliers/vendors are invited to submit responses to the questions contained in this document and to the draft Statement of Requirements (SOR) contained in the attachment. In addition, Canada invites vendors to supply any additional information and observations that they believe would inform this procurement process.

1.3 Background

Innovation, Science & Economic Development Canada (ISED), Spectrum and Telecommunications Sector (STS) staff presently have the capability to localize narrowband radio emissions for radio interference, compliance and enforcement work. However, there is a developing requirement to localize broadband (i.e. 5G), random short-duration, and/or pseudo-random frequency-hopping emissions that intentionally or unintentionally radiate from devices found throughout Canada.

Consultation with all regions regarding equipment being used by officers in the field has revealed that the current equipment has become obsolete. With the deployment of 5G systems a strong need for updated equipment has been revealed in order to meet current and emerging technology demands. This will enable ISED to effectively manage spectrum using these new technologies at higher operating frequencies

1.4 Objectives

The objectives of this RFI process are as follows:

a) To seek feedback from industry on the proposed technical requirements to support the finalization of the intended RFP. This includes the desire for a better understanding of:
    1) Industry capabilities and constraints;
    2) Time and cost estimates of the technical components of proposed capability (e.g., hardware, customized packaging and fitment of the equipment, software and software development);
    3) Time estimates of the acquisition component of the proposed capability;
    4) Time and cost estimates of the support component of the proposed capability; and
    5) Required adjustments/changes to the technical requirements, if any, that are required to ensure that a viable system can be delivered at an acceptable cost.
b) To confirm potential bidder compliance with the technical requirements in the draft SOR; and
c) To establish a formal communication channel with industry that will remain open until a formal RFP is released.

PART 2 – INSTRUCTIONS TO RESPONDERS

2.1 Format of Responses

Respondents have the choice to provide submissions for solutions covering all the requirements specified in this RFI or individual sub requirements based on their capability to supply solutions.

ISED is interested in receiving responses directly from vendors having combined software and hardware solutions, though solutions from other parties, such as value added resellers (VAR's), offering OEM hardware from multiple manufacturers is also of interest.

Respondents are requested to provide their comments, concerns, and, where applicable, alternative recommendations regarding how the requirements or objectives described in this RFI could be satisfied. Respondents should explain any assumptions they make in their responses.

Notes to Interested Suppliers

- This RFI for the supply of a national (Canada-wide) spectrum monitoring system is not a bid solicitation and does not constitute a commitment, implied or otherwise, that the Government of Canada will take procurement action in this matter. The issuance of this RFI 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. The issuance of the RFI does not create an obligation for Canada to issue a subsequent RFP, and does not bind Canada legally or otherwise, to enter into any agreement or to accept any suggestions from suppliers. Canada reserves the right to accept or reject any or all comments received.

- The Government of Canada will not be responsible for any cost incurred by suppliers in furnishing responses to the RFI process.

- A review team composed of representatives of PSPC and ISED will review the responses on behalf of Canada.

- There will be no short listing of suppliers for purposes of undertaking any future work, as a result of the RFI. Also, participation in the RFI is not a condition or prerequisite for participation in a future RFP.

- Confidentiality:

    - Suppliers are advised that any information submitted to Canada in response to this RFI may be used by Canada in the finalization of a competitive solicitation.

    - All industry consultations will be documented and this information is subject to the Access to Information Act. Suppliers should identify any submitted information that is to be considered as either company confidential or proprietary. Canada will not reveal any designated confidential or proprietary information to the public and/or third parties.

2.2 Submission of Responses

Responses are not considered bids but, for expediency purposes, the PSPC Bid Receiving Unit is the designated location where written responses shall be sent. However, electronic submissions are also acceptable and may be sent by email to the RFI Authority as described herein

a) **Time and Place for Submission of Responses**: Responses are to be submitted electronically to the RFI Authority in Section 2.3, ***by June 30, 2021.***
b) **Responsibility for Timely Delivery**: Each respondent is solely responsible for ensuring its response is delivered on time to the RFI Authority in Section 2.3.

The Respondent's name, return address, RFI number and closing date should be clearly visible on the response. Responses to this RFI will not be returned.

2.3 RFI Authority

The Public Service and Procurement Canada (PSPC) RFI Authority is responsible for the management of the procurement and RFI process.

Sasha Lahaie
Public Services and Procurement Canada (PSPC)
Acquisitions Branch
Industrial Products and Vehicles Procurement Directorate (IPVPD)
"HN" Division
L'Esplanade Laurier, East Tower, 4th Floor,
140 O'Connor Street
Ottawa, ON K1A 0S5
Telephone: (613) 293-3296
E-mail address: sasha.lahaie@pwgsc-tpsgc.gc.ca

2.4 Enquiries

PSPC will not necessarily respond to enquiries in writing or by circulating answers to all potential suppliers as this is not a bid solicitation process. However, respondents with questions regarding this RFI may direct their enquiries to the RFI Authority named above.

2.5 Official Languages

Responses may be in English or French, at the preference of the Respondent.

2.6 Response Confidentiality

Respondents are requested to clearly identify those portions of their response that are proprietary. The confidentiality of each Respondent's response will be maintained. Items that are identified as proprietary will be treated as such except where Canada determines that the enquiry is not of a proprietary nature. Canada may edit the questions or may request that the respondent do so, so that the proprietary nature of the question is eliminated, and the enquiry can be answered with copies to all interested parties.

2.7 Methods of Communication

Communication between ISED, PSPC, and respondents as part of this RFI process will consist of

1) Written exchanges via email and,
2) Optionally, verbal exchanges via either:
    a) A teleconference or
    b) A face-to-face meeting.

Written responses to the RFI questions must be submitted by email. Potential respondents may pose clarifying questions in writing via email; all such questions will be published as part of the RFI record.

Verbal exchanges will be limited to a single one-on-one meeting between ISED/PSPC and each interested respondent to communicate and clarify the goals, draft requirements, and questions in the RFI. Respondents are requested to specify (a) whether or not they wish to participate in a one-on-one meeting and (b) Depending on COVID-19 restrictions which type of meeting they prefer (teleconference or face-to-face).

PART 3 – QUESTIONS AND COMMENTS ON THE DRAFT STATEMENT OF REQUIREMENTS

In the following, references to 'requirements' refer to the contents of the attached draft SOR. A component of the system can be defined as test & measurement hardware, associated sensors, antennas, power supplies and interconnecting cabling. A system can be defined as the combination of all the individual components provided.

3.1 Questions for Industry

Technical

Question 1:

a) What system design would meet the draft requirements in Appendix 1? Please provide a detailed technical description of the system and how the core hardware can be made to be interchangeable between mobile, fixed and transportable installations.

b) Can the system configuration be modified to offer higher measurement performance when used in multiple deployment scenarios (i.e. provide options for a larger aperture DF antenna for fixed site installation to improve sensitivity and bearing accuracy compared to the smaller DF antenna used for mobile installation)?

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Question 2:

Are there particular requirements and/or parameters that are especially challenging and/or difficult to achieve with current technology, or that could make it unfeasible to deliver a compliant system as per outlined in Appendix 1? Please provide details as to the reasons.

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Question 3:

With respect to automatic Direction Finding (DF) solutions please provide additional details as to how your products would perform under challenging operational conditions such as:

a) Mixed co-channel signal environments (i.e. either wideband or narrowband undesired signal in the presence of the desired narrowband or wideband victim signal). Please provide details as to the Signal / Noise and Carrier / Interference and advanced signal processing (i.e. super resolution algorithms) requirements that you address that could be needed in these types of scenarios.

b) DF bearing acquisition using complex spectrum mask or time gating triggers from a real-time spectrum display.

c) Off-horizontal axis DF targets acquisition performance (i.e. aeronautical mobile targets).

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Question 4:

With respect to both primary and secondary automatic Direction Finding (DF) solutions, please provide detailed information on the following:

a) System performance data (i.e. RF sensitivity and RF overload characteristics (i.e. maximum field strength before overload occurs and maximum field strength before antenna electronics are damaged)), bearing accuracy and acquisition time based on your specific product band splits by antenna grouping (if any) and on emission type being tracked.

b) Graphical user interface to control the system and how results are presented to the end user.

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Question 5:

a) Is there additional technical information (e.g., alternative equipment or designs) that would inform this procurement process and potentially result in a superior technical solution?

b) What are the relative benefits and drawbacks of the proposed requirements compared to the suggested alternative solutions?

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Question 6

Considering the SOR presented in this RFI, is infrastructure delivered through a single manufacturer's offering rather than via multiple manufacturer's products advantageous? Would it be more beneficial to have other parties, such as value added resellers (VAR's), offer OEM hardware from multiple manufacturers to provide the solution?

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Question 7

It is expected that ISED continue to purchase their vehicles through Public Works and Government Services Canada's (PWGSC) Government Motor Vehicles Ordering Guide. Installations must be adaptable to suit a variety of differently sized all-wheel drive vehicles such as large Sport Utility Vehicles (SUV) cut-away custom chassis platforms down to intermediate sized SUV. The government is also transitioning some fleet vehicles to Hybrid and/or electric. Can the respondent provide the following with respect to the technical requirements specified in the attached SOR:

a) Monitoring system equipment?
b) System equipment packaging per ISED requirements?
c) Vehicle fitment services including engineering design and outfitting services in consultation with ISED to meet ISED design requirements?
d) In the case of Hybrid and/or electric vehicle fitment can the proposed Monitoring system equipment offer the benefit of low power consumption? Are there any known challenges that could be experienced with installations in hybrid and/or electric vehicles?
e) Please provide logistics and capacity for this type of service.

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Question 8

a) Can the respondent accommodate the following ISED design requirements in relation to Question 7?
    1) Monitoring system: (i.e. mechanical and electrical installation, software installation/configuration, initial system testing)
    2) Security and Safety: (i.e. vehicle alarm system, secure hardware installations to deter theft & enhance collision impact resistance, vehicle occupant protection via various measures such as safety bulkheads, fire extinguishers, safety beacons)
    3) Operator Ergonomics: (i.e. user workstation, RF patch panel(s), storage compartments for equipment/antennas and associated installation requirements, interior task lighting)
    4) Antennas: (i.e. antenna selections along with mounting requirements, installations to allow for easy removal and installation of all rooftop antennas by one person within 5 minutes)
    5) Power Systems: (i.e. upgraded vehicle alternator, isolated "house" battery system to power mission package, sine wave power inverter (500 Watts) to provide 120 VAC power, shore power charging system)
    6) Equipment platforms to be operated via a touch screen-based workstation accessible from the driver and front passenger seat locations.

b) Does the respondent have facilities to complete the fitment in Canada?
c) How long would it take the respondent to complete the design?
d) Please provide packaging and installation details, examples and photos of such a system.

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Question 9:

a) Can the vendor provide software integration to control (locally and remotely via VPN) all platforms, including 3rd party platforms? If yes, please provide details of what the software will be capable of operating and tasks it can perform?
b) Is the vendor able to provide this software integration on an ongoing basis? Please provide costing model for such service.
c) Please provide details of proposed remote & local control system architectures, (i.e. client-server based, embedded web server onboard instruments, or Windows RDP session into onboard control computers in instruments), backhaul requirements (i.e. types of backhaul that would work and data throughput/latency requirements and limitations imposed on real-time operation due to link data throughput and latency constraints), and how access security is implemented.
d) ISED has implemented a commercial software solution for the majority of their integrated Spectrum Management requirements outside of spectrum monitoring. That software solution is centered around the LS telcom SPECTRA Suite of products. Can the integrated software be linked to LS telcom SPECTRA Suite of products?
e) Can the vendor provided software solution preform the following system management capabilities?

    1) Monitoring of the system and equipment operational status.

    2) Reporting system failures.

    3) Monitoring and reporting system usage statistics.

    4) Monitoring systems peripherals such as temperature, security sensors, power.

    5) Report use of specific monitoring equipment.

COST

Question 10:

a) What would be the approximate estimated procurement cost (i.e. to procure initial hardware and software) of a system, that meets the technical requirements in Appendix 1? (*see quantity and breakdown in Annex A section 1.11*)

b) Please include a breakdown of commercial-off-the-shelf (COTS) and any proprietary custom components. (*see quantity and breakdown in Annex A section 1.11*)

c) What would be the approximate cost of the software integration (if applicable) to control (locally and remotely through VPN) all platforms, including 3rd party platforms? *(see quantity and breakdown in Annex A section 1.11)*

d) What would be the approximate estimated cost for custom packaging and fitment of system components for mobile, transportable and fixed operations? *(see quantity and breakdown in Annex A section 1.11)*

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Question 11:

a) What would be the approximate estimated ongoing cost of after-sales service, maintenance, calibration and intellectual property (i.e. software licensing) for the proposed system?

b) Please provide logistics detail for each of these services.

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Question 12:

a) What capabilities do you offer to provide customer training on your components and/or system that cover: Installation, configuration, operation and maintenance.
b) Based on your previous experience of deploying your products what would you consider would be the appropriate training methods and amount of time needed to train the end user.
c) Do you offer customer on-site training for your components and/or system. What is the estimated time and cost for this service?

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TIMING/DELIVERY

Question 13:
Given the scope and scale of the project, can fixed pricing be accommodated over multiple fiscal years?

Question 14:
Please identify potential factors that could affect delivery and provide risk mitigation strategies.

3.2 Comments

In this section of the RFI, PSPC invites Respondents to provide their general comments on the draft Statement of Requirements (SOR) or to propose ideas not envisioned by the draft SOR. Please note, the draft SOR is subject to change at PSPC's discretion.

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Annex A - Draft Statement of requirements for Spectrum Monitoring System

1.0 Scope

Innovation, Science & Economic Development Canada (ISED) has a requirement for a national (Canada-wide) spectrum monitoring system that shall provide the means to execute a number of functions in fixed, transportable and mobile stations. It should be noted that ISED would ideally like to have the required infrastructure delivered through a single manufacturer's offering rather than via an integration of multiple manufacturer's products which complicates installation and can result in several points of potential failure. ISED is interested in receiving responses directly from vendors having combined software and hardware solutions, though information from other parties, such as value added resellers (VAR's), offering OEM hardware from multiple manufacturers is also of interest. Suppliers should indicate that the software and hardware offerings are currently available with one or more versions/releases in production throughout the supplier's customer base.

1.1 Background

ISED, Spectrum and Telecommunications Sector (STS) staff presently have the capability to localize narrowband radio emissions for radio interference, compliance and enforcement work. However, there is a developing requirement to localize broadband (i.e. 5G), random short-duration, and/or pseudo-random frequency-hopping emissions that intentionally or unintentionally radiate from devices found throughout Canada.

As the current equipment used by the officers in the field has become obsolete and with the deployment of 5G systems, ISED has a requirement to update the equipment in order to meet current and emerging technology demands. This will enable ISED to effectively manage the spectrum of the new technologies that are using higher operating frequencies.

1.2 Instructions

The following instructions apply to this specification:

a) Requirements, which are identified by the word "**must**", are mandatory. Deviations will not be permitted.
b) In this document "provided" **must** mean "provided and installed".
c) Where a technical certification is referred to in this specification, a copy of the certification or an acceptable Proof of Compliance **must** be supplied for the Component and System when requested by the Technical Authority.

1.3 Technical Specifications

The Contractor must provide the requested system and /or system components in accordance with the technical specifications detailed in Appendix 1.

1.4 Standard Design

The components and/or system design must be the manufacturer's latest model.

1.5 Identification
The following information should be permanently marked in a conspicuous and protected location:

a) Manufacturer's name, model and serial number.

1.6 Component and/or System Manuals
A component of the system can be defined as test & measurement hardware, associated sensors, antennas, power supplies and interconnecting cabling. A system can be defined as the combination of all the individual components provided.

1.6.1 Component and/or System Manuals

Full documentation on the system devices, installation, operations, software and maintenance of the complete components and/or system, including sub-systems, must accompany each component and/or system, shipped to each location.

1.6.2 Operator's Manuals

The operator's manuals must be bilingual (English/French) and must include the following:

a) Instructions for the safe installation and operation of each component and/or system.
b) Daily operator maintenance instructions/checks.
c) Safety warnings.

1.6.3 Maintenance Manuals

If they are available, the service/maintenance manuals should be bilingual (English/French) and should include the following:

a) A trouble-shooting guide, showing the steps and tests required for determining the exact cause of a problem and an explanation of what steps would be required to correct a problem.
b) Identify any special tools/equipment needed for troubleshooting and service.

1.7 Accessibility requirements

The manuals should be delivered in an accessible format, in compliance with the European Standard 301 549 for accessible Information and Communication Technology (ICT), clause 10 for non-web documents.

Any other instructions provided with the component and/or system should conform to those standards for web-based documents, electronic documents, and hard copies. Any data output from the component and/or system should also conform to these standards.

The provision of facilities, tools and services, and all associated costs, to make the component and/or system and deliverables of this project accessible must be at the Contractor's expense.

1.8 Warranty

a) Each component and/or system purchased must include one (1) year standard warranty.
b) Each custom installation and fitment (i.e. fixed and vehicle installations performed by the vendor or his authorized sub-contractor(s)) shall have a materials and workmanship warranty of 1 year.
c) The Contractor must provide a list of all Canadian designated warranty service providers that will honour the warranty for the component and/or system procured under this contract, including the contact person and phone number at each warranty provider. Where no Canadian designated warranty service providers are available, the Contractor must provide a list of intermediate depots located in Canada that will facilitate the transit of the warranty component and/or system to outside Canada for servicing. The Contractor must include the contact person and phone number at each depot. The Contractor will be responsible for the cost of handling and shipping the defective part/component and/or system to the factory for repair. The Contractor will be responsible for handling, packaging and shipping the replacement part/ component and/or system to the designated ISED destination.
d) The warranty must include coverage for material and labor for covered repairs and when necessary any re-calibration that is triggered by the repairs.
e) The Contractor must provide contact information, name and phone number, for warranty support.
f) The Contractor must provide options for extended warranty. The exercise of the extended warranty will be at the discretion of Canada.

1.9 Component and/or System Lifecycle

The life cycle of component and/or system will be a ten (10) year period from date of delivery or the date of acceptance, whichever is later.

1.10 Service Support

The Contractor must ensure that full service support is available for a period of 10 years following the delivery of the component and/or system or the date of acceptance, whichever is later, of the component and/or system.

a) Calibration Support
   Initial factory calibration must be included as part of the original delivery.
b) Hardware Maintenance and Support
   The Contractor must ensure that full repair support and replacement parts are available during the component and/or system life cycle following the date of delivery or the date of acceptance, whichever is later, of the component and/or system. In the event the component and/or system parts are no longer available, the Contractor must provide the Technical Authority sufficient notice to ensure that ISED may purchase the parts that are no longer available.

c) Software Maintenance and Support

1) The Contractor must provide free "maintenance" related updates, including system firmware improvements and bug fixes via local user installation as opposed to "return to factory" for updates, over the life cycle of the component and/or system from Contract Award.
2) The Contractor must advise the Technical Authority when upgrades are available during the lifecycle of the component and/or system.
3) The Contractor must ensure "pay for upgrades" support, including adding functionality to measure and analyze evolving emission types and adapting to new software via local user installation as opposed to "return to factory" for installation, is available over the life cycle of the component and/or system.

d) On-going Technical Service Support

The Contractor must provide a contact for ongoing customer support to review system issues, enhancement requests and scheduled enhancements to be released during the life cycle of the component and/or system and for what is not identified in 1.10 (b) and 1.10 (c).

The Contractor must provide free ongoing service support to help Canada to address questions with respect to the equipment that include, at the minimum:

1) E-mail technical support with a response within 48 hours excluding weekends and public holidays.
2) Internet and on-line help resources.

1.11 List of Deliverables

1.11.1 Deliverables

	Item N°	Description	Approximate Quantity
Goods	1.	System Spectrum Analyzer (meeting section 2.1)	170
	2.	System Demodulation (meeting section 2.3)	170
	3.	System Direction Finding (meeting section 2.2)	170
	4.	Portable power solution (meeting section 5.0)	90
	5.	Antenna switching Matrix (meeting section 4.0)	170
	6.	Portable antenna kits (meeting section 3.0 (a))	110
	7.	Vehicle mounted antenna kits (meeting section 3.0 (b))	80
	8.	Transportable antenna kits (meeting section 3.0 (c))	90
	9.	Fixed antenna kits (meeting section 3.0 (d))	20
	10.	Software integration to control (locally and remotely through VPN) all platforms, including 3rd party platforms	170
	11.	Client software to remotely connect to item 10 of the initial deliverables table	220
	12.	Black Box computers (i.e. single board IBM PC compatible computer integrating, CPU, RAM, solid state mass storage, video, and interface ports in a compact, environmentally hardened enclosure allowing for operation and storage to MIL-PRF-28800F CLASS 2 specifications) to be used in the system to provide the software integration in item 10 in the deliverable table	170
	13.	All required COTS software.	170

Services	14.	Vehicle fitment services for the System	70
	15.	Single custom packaging of all monitoring system platforms that is interchangeable between mobile, fixed and transportable installations	170
	16.	Completion of required software integration and specialized software.	170

Appendix 1: Spectrum monitoring system detailed requirements

1.0 Key Functions and Features of the Spectrum monitoring System

The following list is meant to be common required Features of the complete system and are by no means inclusive. They are intended to be a guide in setting the direction and expectations for the new spectrum monitoring system.

Common System requirements	
Item #	**Requirement**
001	System may be comprised of fixed, lightweight transportable, mobile assets and autonomous sensors (equipment may or may not be all from one vendor). Local stations and remote controllers can be added, modified, removed any time independently from all others. See definitions (Appendix 2) for details of what local stations and remote controllers are composed of.
002	The primary system electronics (minus power systems which may be customized in a separate enclosure) must be capable of being packaged in a standardized, ruggedized compact enclosure to accommodate these various deployment scenarios. If possible, it is desirable that the vendor provide suitable enclosures for this requirement.
003	System must be capable of monitoring radio frequencies currently used in the radio environment of Canada and its immediate neighbours. The primary operating range of the spectrum monitoring system shall be from 9 kHz to 7.125 GHz with options for expanded frequency ranges. These are minimum performance requirements and it is expected they will be exceeded by the spectrum monitoring system proposed for implementation. The frequency measurements precision must be Per ITU-R SM.377-4 or better. Specific frequency range requirements for the different platforms (Spectrum Analyzer (SA), Demodulation requirements, Direction Finding (DF)) are noted in their respective sheet tabs.
Common Hardware requirements across platforms	
Item #	**Requirement**
004	Whether via external means (protective coverings) or by inherit design, devices must meet or exceed appropriate sections of MIL-PRF-28800F, CLASS 2 for: operating temperature, storage temperature, operating humidity, random vibration, functional shock.
005	Provide capability for unit to be powered by an external 12 VDC power source.
006	Provide either an internal or an external AC power supply for the system electronics.
007	System electronics shall be small enough and light enough to be mounted within a customer specified enclosure solution without tools using “quick release” hardware
008	If not already self-contained in its own low profile, ruggedized outdoor transit case system electronics shall be small enough to fit into such an enclosure and allow for easy removal (without tools) for repair and calibration purposes.
009	Must provide for local control and display of all monitoring system hardware. (either via portable display/data input hardware or via local network connectivity to an external laptop computer for maintenance and installation where a remote desktop connection via the network is not available).
010	Ideally shall function equally in the role of a lightweight transportable, mobile and fixed monitoring station (same equipment for all 3 station types).

011	Primary communications interface of all platforms shall be 100/1000 BaseT Ethernet.
012	Auxiliary communications interface(s) of all platforms shall be USB.
013	Provide Internal 10 MHz frequency reference for all platforms with Stability over operating temperature range: +/-1.0 ppm.
014	Provide Internal 10 MHz frequency reference for all platforms with Long term aging rate (1 year): +/- 1.0 ppm.
015	Provide External 10 MHz frequency reference input port for all platforms (preferably a BNC connector).
016	Provide a COTS GPS receiver to provide navigation/position data to the system in using standard interface/messaging (i.e. NMEA).
017	User Interface (UI) to provide user adjustable tuning increment steps down to 1 Hz.
018	User Interface (UI) to provide a "virtual" onscreen and/or physical tuning knob.
019	User Interface (UI) to provide "virtual" onscreen and/or physical numeric "direct keyboard" frequency entry down to 1 Hz resolution.
020	User Interface (UI) to provide user adjustable “virtual” onscreen and/or physical rapid “up/down” per frequency decade tuning capability.
021	User Interface (UI) to provide user capability to set tuned frequency based on standardized channel plans such as ARFCN, UARFCN, Wi-Fi channels and provide choice as to whether the uplink and downlink frequency is the target frequency.
022	User Interface (UI) to provide user capability to set tuned frequency based on custom user created channel plans and provide choice as to whether the uplink or downlink frequency is the target frequency.
023	COTS GPS receiver must have a GPS locked 10 MHz frequency reference for system to improve frequency stability beyond baseline frequency stability specifications.
024	COTS GPS receiver must have 4 output connectors to distribute 10 MHz to internal instruments and outside of the electronics package enclosure.
Common Software requirements across platforms	
Item #	**Requirements**
025	The system architecture shall provide for a multi-tasking and multi-user capability.
026	All hardware (i.e. spectrum analyzers, DF systems, receivers, etc.) functions must be capable of being operated simultaneously and independently of each other (including normal instrument settings, power on/off/hibernate switching and hardware restarting when instrument becomes unresponsive) via real-time local instrument control, external physical interfaces/switching (i.e. external power cycling for forced hardware reboots or dry contacts for external reboot initiation), OEM and possible future 3rd party remote control software and off-line, unattended programmable tasked mode supervised by a local PC or controller.
027	Demodulation and storage with continuous time stamp of recorded audio for a single target frequency over a user-defined reporting period.
028	All vendor-supplied OEM remote control/access software must be compatible with Corporate OS (at time of response).
029	All vendor provided software shall allow for ISED to manage installation of said software on ISED computers via automated corporate software deployment systems (i.e. new software and software updates).
030	All platforms shall have the ability to be seamlessly networked via high-speed TCP/IP-based connections (minimum of 4G or higher for wireless) into the ISED Wide Area Network (WAN).

031	All the system functions and capabilities for a vendors' own equipment (i.e. multiple instruments) shall be, by default, controlled by a single OEM COTS software control suite.
032	Vendor software shall be capable of integrating with third party equipment including but not limited to: spectrum analyzers, receivers and DF systems during the full life cycle of the system.
033	Vendor must provide API/SDK kits and programming guides for systems and devices for customer and/or 3rd party support of end-user software and equipment drivers. Documentation to be provided via searchable/printable softcopy and relevant software to be provided on standard distribution media (i.e. USB flash drive, CD/DVD-ROM, etc.).
034	Vendor shall provide for remote system control functionality via web browser connection (i.e. Secured by HTTPS protocol, VPN or equivalent method) for users that don't have a dedicated remote control software application installed on their computer/tablet/smartphone).
035	Vendor must provide for remote system control functionality (i.e. via simple remote Windows 10 Enterprise desktop and/or packaged OEM software).
036	System software shall be user-friendly and reasonably easy to use (i.e. Touch screen technology or click point technology suitable for use in a vehicle).
037	System shall detect and trigger alerts (i.e. Pass or fail annunciator for emission masks) or predefined actions upon the occurrence of abnormal real-time measurement thresholds. (i.e. Trigger an I/Q or audio demod recording or a time stamped DF bearing with emission measurements based on a marker amplitude threshold).
038	Vendor provided software applications must be able to function correctly in a Microsoft Windows 10 Enterprise desktop environment (with the exception of embedded operating systems and firmware in test and measurement equipment).
039	Vendor to provide a toll-free support phone line that operates from Monday to Friday during ISED working hours 7:30 AM to 7:30 PM EST for users to contact a technical representative for help with using features of the equipment.

2.0 Mandatory Platform Minimum Requirements

The following list is meant to be Mandatory minimum requirements for each component of the system and are by no means totally inclusive. They are intended to be a guide in setting the direction and expectations for the new spectrum monitoring system. To be compliant, specifications must be guaranteed and not typical.

2.1 System Spectrum Analyzer (SA) platform requirements.

Item #	Hardware	Required specification
001	RF pre-amplifier (internal)	Provide an internal user switchable wideband low noise pre-amplifier.
002	RF input attenuator (internal)	Provide an internal user adjustable RF input step attenuator capable of being stepped in equally sized increments from zero (0) to maximum available attenuation.
003	Calibration signal	Provide an internal fixed frequency/level calibration signal source.
004	Self-Diagnostics	Provide internal hardware built-in test (BIT) for system health check and malfunction diagnosis. Tests to include: Power supply diagnostics, CPU diagnostics and RF diagnostics.
005	Tracking generator	Provide an internal tracking generator option that operates up to 2.9 GHz with user adjustable output power level.
006	Vector network analyzer (VNA)	Provide internal hardware and necessary firmware to provide full 2-port VNA measurement capability over the entire frequency range of the analyzer. Measurements to include but not limited to the following: - Two port measurements: IL, RL, phase/magnitude, smith chart, VSWR, log/linear magnitude, real/imaginary impedance, Z impedance. -Single port measurements: RL, cable loss and DTF functionality.
007	Connectivity	Shall provide live stream external I/Q output available to the user.
008	Internal non-volatile storage	Shall provide internal non-volatile storage to store I/Q data (5-second block length minimum) and trace data for local recall for playback and/or analysis or for export for external playback and/or analysis.
009	Wideband baseband "demod" output port	Provide a wideband baseband demodulated signal output port with a frequency response flat from 0 to 100 kHz.
Item #	**RF performance**	**Required specification**
010	Tuning frequency range	9 kHz to 7.125 GHz (continuous, no gaps in frequency coverage).
011	Tuning resolution	Within +/- 1 Hz across entire tuning range
012	RF scan rate	10 GHz/sec minimum at full span (RBW at 100 kHz).
013	RF Digitizer capture BW	40 MHz minimum.
014	Local Oscillator Re-radiation	Shall be less than -90 dBm at the RF input port(s).
015	Local Oscillator tuning accuracy	Within +/- 0.1 Hz across entire tuning range.
016	Amplitude	Maximum safe continuous RF input level of +15 dBm, 0 VDC (input attenuation 0 dB and internal pre-amps off).
017	Amplitude	Provide guaranteed amplitude accuracy of +/- 2.0 dB or better across the entire tuning range

018	Third order Intercept (TOI)	TOI ≥ + 10 dBm typical.
019	Displayed Average Noise Level (DANL)	DANL 1 MHz to 2 GHz, normalized to a 1 Hz RBW, without the use of a pre-amplifier shall be less than or equal to -152 dBm/Hz.
020	Displayed Average Noise Level (DANL)	DANL for frequencies between 2 GHz and 8 GHz, normalized to a 1 Hz RBW shall not exceed -148 dBm/Hz.
021	Phase noise	Typical phase noise at 1 GHz of -106 dBc/Hz at 10 kHz and greater offsets. Vendor shall provide graph of phase noise performance from the highest non-down converted input frequency to the maximum tunable frequency in the analyzer for analysis.
022	Spurious free dynamic range	In swept mode of operation spurious free display dynamic range (i.e. SFDR=TOI-DANL normalized to 1 Hz resolution bandwidth at 2.4 GHz) must be greater than or equal to 100 dB with internal pre-amplifier off.
023	Probability of Intercept (POI)	Shall have a 100% probability of intercept (POI) for minimum signal duration of 15 microseconds for real-time spectrum analysis.
Item #	**Software**	**Required specification**
024	Visual "signal intensity" indication	Provide a numeric signal strength display.
025	Demodulation	Provide user selectable demodulation IF BW's (demodulation IF BW shall be independent of and not coupled with the spectrum display RBW in any way).
026	Demodulation	Shall demodulate and provide baseband audio output to the user of the following analog signal types: AM, FM.
027	Demodulation	Provide the capability to demodulate and provide wideband baseband output for secondary signal analysis (internal or external using a second analyzer) of sub-carriers (i.e. FM broadcast sub-carrier program material) within the same digitizer capture BW window.
028	Classification	Perform real-time automatic signal classification including an estimate of confidence level of modulation type(s) identified and a summary of signal measurement results.
029	Demodulation	Shall provide capability for user to add custom user defined signal types into the stock catalog of pre-scanned emission types available to the signal classifier algorithm.
030	Demodulation	For digital emissions, attempt automatic station identification via demodulation/decode of appropriate OSI stack layer closest to the physical RF layer to obtain station ID.
031	Digital Signal Measurements	Must be capable of analyzing down to the bit/symbol/frame/timeslot level (i.e. zero span time domain) digitally modulated signals (constant modulation format as opposed to dynamically changing modulation formats), to obtain signal timing information which may include but are not limited to the following emission types : - FSK, MSK, GMSK, DMSK, BPSK, QPSK, Offset-QPSK, DQPSK, 8PSK, D8PSK, π/4-DQPSK , 3π/8-8PSK, π/8-D8PSK

		- mQAM (m= 16, 32, 64, 128, 256, 512, 1024, 2048, 4096) - 16APSK/DVB-S2, 32APSK/DVB-S2, 2ASK, 4ASK, π/4-16QAM, -π/4-16QAM.
032	Digital Signal Measurements	Must be capable of doing basic VSA (vector signal analysis) measurements that include and are not limited to: RHO, EVM, eye diagram and I/Q constellation diagrams.

033	Digital Signal Measurements	Provide 3G, 4G and 5G real-time advanced digital modulation (i.e. dynamic modulation format changing emissions and OFDM/A) measurements which may include but not limited to the following common KPI's: - automatic station/enodeB identification via decode of appropriate OSI stack layer closest to the physical RF layer to obtain carrier, network, station ID's & Pn/scrambling codes - modulation scheme(s) in use by carrier and/or sub-carrier - traffic derived BER estimation - demod filter type & coefficient determination - RSSI - RSSP - RSRQ - RS-CINR - Eb/No (bit signal to noise ratio) - Es/No (symbol to noise ratio) - EVM - RHO - constellation diagram - eye diagram - CCDF.
034	Digital Signal Measurements	Must provide time-domain multichannel CISPR 16-1-1 compliant APD measurement capability.
035	Digital Signal Measurements	Provide APD measurement capability.
036	Digital Signal Measurements	Provide CISPR 16-1-1 compliant APD measurement capability.
037	Digital Signal Measurements	Provide CISPR 16-1-1 compliant rms-average detector measurement
038	Analog emission measurements	Shall be capable of measuring as per ITU-R recommended procedure and standard units of measure, and storing in real-time the following parameters for all emission types including complex ones having multiplexed analog and digital sub-components: - Carrier frequency - Frequency Error - Total channel power - Adjacent channel power - Field strength - Power spectral density - Power flux density - Signal amplitude - Occupied bandwidth (% power BW method) - FM deviation (+/- peak, average) - AM % modulation (+/- peak, average).

039	Control	Must provide a mechanism (on a per user level) to allow user measurement configuration/state to be saved on demand and/or automatically at shutdown based on the users' preference in non-volatile memory.
040	Control	In real-time (RTSA) mode the unit must provide user adjustable display span settings from minimum available span up to maximum digitizer capture bandwidth (must maintain rated Probability of Intercept (POI) throughout entire span range).
041	Control	Provide contiguous swept /"stitched" RTSA block capture capability. POI degradation must be no worse than single digitizer block POI multiplied by the number of blocks swept plus any OEM specified "inter-block dead zone" processing time to achieve desired span setting.
042	Control	Provide user configurable non-contiguous frequency segmented sweep capability in swept analyzer mode.
043	Control	Provide user configurable span step sizes in standard steps.
044	Control	Provide a user configurable "Fstart/Fstop" frequency-setting mode.
045	Control	In swept mode, the unit must provide display span settings from zero span to maximum frequency range of instrument.
046	Control	User must be able to apply positive or negative reference level offsets.
047	Control	Provide a log (power) amplitude spectrum display mode with user adjustable scaling steps.
048	Control	Provide a log (voltage) amplitude spectrum display mode with user adjustable scaling steps.
049	Control	Provide a linear (power) amplitude spectrum display mode with user adjustable scaling steps.
050	Control	Provide a linear (voltage) amplitude spectrum display mode with user adjustable scaling steps.
051	Control	Spectrum display RBW must be capable of auto-coupling to the span/acquisition time/sweep speed settings to maintain a calibrated display state and can be user un-coupled if needed.
052	Control	Provide user configurable spectrum display RBW.
053	Control	Spectrum display RBW must be selectable in user adjustable steps.
054	Control	Provide individual detector modes per trace including: RMS, positive peak, negative peak, sample, average and peak to peak.
055	Control	Provide a quasi-peak detector and associated standard EMI bandwidths (i.e. 200 Hz, 9 kHz, 120 kHz & 1MHz) per trace.
056	Control	For units that provide adjustable sweep time minimum sweep times must be as follows: when span = 0 Hz: 1 µs or less, when span > 0 Hz: swept tuned mode 1 ms or less.
057	Control	Provide user configurable sweep triggering (beyond standard modes such as line, free run, and single sweep mode). May include but not limited to modes such as time gated, RF burst and emission mask triggered sweep modes.

058	Control	Provide a minimum of 3 simultaneous, superimposed, independently configurable traces with individual settings for detector/trace mode and markers. (for all span settings i.e. 0 span to maximum span). These markers, marker functions and traces must also be available for FM deviation (+/- peak, average), baseband FM demodulated spectrum and AM % modulation (+/- peak, average) screens.
059	Control	Provide user adjustable trace averaging.
060	Control	Trace modes must include: live, max hold, min hold, and averaging (average count to be user configurable).
061	Control	Provide a minimum of 6 independently configurable markers.
062	Control	Provide a marker table display for all active markers.
063	Control	Provide a user adjustable "delta" marker along with delta marker measurements.
064	Control	Provide a user configurable "gated" marker frequency count function. Count resolution minimum 1 Hz.
065	Control	Must record measurement configuration/state settings and time stamp when signal analysis screen shots are saved. These settings must be visible during local recall of screen shots and be available for review with any post processing tools used to analyze signal analysis screen shot files.
066	Control	Provide user configurable spectrum emission mask measurement.
067	Control	Measurement configuration/state settings saved shall include as a minimum any system settings that a user has the capability to adjust, including items such as, but not limited to: - RF input attenuation - Internal LNA on or off - tuned frequency - receiver/digitizer settings - panoramic adapter settings - DF system settings - time & date of measurement - System calibration/alarm status flags.
068	Control	Shall provide capability for the user to search and retrieve stored signal analysis and instrument settings data from internal archive.
069	Display	Provide a frequency deviation vs time output display with user adjustable scaling (frequency deviation & sweep time per division). Minimum acceptable deviation range is +/- 100 kHz. This display will be fully independent of the spectrum display zero span display mode and can be run simultaneously with the spectrum display.
070	Display	Provide an amplitude vs time baseband output "oscilloscope" display with user adjustable scaling (amplitude & sweep time per division). This display will be fully independent of the spectrum display zero span display mode and can be run simultaneously with the spectrum display.

071	Display	Provide a real-time user configurable frequency spectrum vs time display.
072	Display	Provide user-selectable reporting units of measure for signal amplitude.
073	Display	Provide user configurable control of the number of horizontal frequency display points in the spectrum display. Ensure that odd number counts are provided so that centre frequency always falls on the center display point and that primary spectrum display point count is not reduced when other secondary displays (i.e. such as waterfall, spectrogram, measurement result screens, DF bearing and map screens, etc.) are active.
074	Display	Provide real-time user configurable 2D spectrum display mode with signal "persistence" (i.e. Y-axis = amplitude, X-axis= frequency, persistence represented in colour).
075	Display	Provide real-time user configurable 2D spectrogram "waterfall" display (i.e. vertical axis = time, horizontal axis = frequency, colour= amplitude).
076	Display	Provide real-time user configurable 3D waterfall display (i.e. Y-axis= amplitude, X-axis = frequency, Z-axis = time).
077	Display	Real-time spectrum analysis with a variable, colour-weighted persistence-type display mode.
078	Display	Spectrum analysis display shall be continuous and adjustable from zero span to full frequency range of the instrument.
079	Display	Provide on-screen operator feedback for any "un-cal" states and any "un-coupled" control settings.
080	Display	Provide operator feedback when system is locked to an external frequency standard and/or internal GPS frequency standard.

2.2 System Direction Finding (DF) platform requirements.

Item #	Hardware	Equipment requirements
001	DF antenna environmental	DF antennas must meet or exceed appropriate sections of MIL-PRF-28800F, CLASS 2 for: operating temperature, storage temperature, operating humidity, random vibration, functional shock.
002	DF antenna mounting specification	Manual and Automatic DF antenna must not be mounted or use attachment that use the vehicle doors opening for mounting.
003	DF Antenna	Maximum DF antenna weight (including attached mounting hardware) 12 Kilograms. (1 person installable on vehicle rooftop).
004	DF Antenna	Maximum DF antenna height (including radome and mounting base) 50 centimetres.
005	DF Antenna	Maximum permissible wind speed (with 3 centimetres radial ice deposit) 180 km/h.
006	DF Antenna	Antenna easily installed/removed by one person.
007	DF Antenna	Antenna removable from vehicle and tripod mountable for portable use.
008	Internal GPS Receiver	Shall have GPS to provide output for latitude/longitude, heading, altitude, and current speed in WGS84 datum.
Item #	**RF performance**	**Required specification**
009	AOA DF frequency range	20 MHz to 7.125 GHz.
010	TDOA DF frequency range	20 MHz to 7.125 GHz.
011	Digitizer BW	Must have a minimum digitizer bandwidth of 20 MHz for "wideband" DF functionality. However, product must be capable of providing a valid DF bearing and specified POI when limited to looking at a portion of wider channels that are in excess of 20 MHz wide.
012	Digitizer BW	Shall have options for digitizer bandwidths greater than 20 MHz for DF functionality.
Item #	**Software**	**Required specifications**
013	AOA/Correlative Interferometer DF UI display	Minimum requirement is to display compass rose (normalized to true North and front of vehicle), DF bearing, signal strength and/or bearing quality indicator, bearing averaging count and latitude/longitude.
014	AOA/Correlative Interferometer DF UI display	Provide option for real-time geo-mapping of target bearing on to a map display (map tiles must be open source available).
015	TDOA DF UI display	Minimum requirement is to display compass rose (normalized to true North and front of vehicle), DF bearing from user selectable control node location, signal strength and/or bearing

		quality indicator, averaging count and latitude/longitude of center of target ellipsoid.
016	TDOA DF UI display	Provide option for geo-mapping of target ellipsoid on to a map display (map tiles must be open source available).
017	DF Results Display Storage	Must provide capability for the user to store and recall DF map and bearing screen snapshots.
018	DF functionality	Must be capable of locating a radio emitter using a hybrid mixture of Angle of Arrival (AOA) radio direction finding, and Time Difference of Arrival (TDOA) radiolocation methodologies.
019	Display	Must display all connected DF sensor data as an overlay on a map using discrete lines of bearing (LOB) from receiver towards source for AOA-generated data, and probability arcs from receiver towards source for TDOA-generated data.

020	Display	Vendor shall offer netted TDOA and/or AOA DF system capabilities. i.e. system must be capable of integrating and representing multiple simultaneous received signals along with their relative bearings in a Cartesian coordinate system: Cartesian: Where the x-axis = latitude and y-axis = longitude of a triangulated target.
021	Display	Offer an AOA DF system capable of representing multiple simultaneous received signals along with their relative bearings in a Polar system: Polar: Where the origin represents the DF sensor position, the polar axis represents frequencies under observation, so that each point on the display describes a frequency and polar angle (bearing) to an emitter.
022	Display	Shall indicate estimated emitter location on map via Circular Error Probability (CEP) ellipse and/or colour-weighted "heat diagram" plot, including estimated Lat/Long.
023	Display	For each connected DF sensor and in addition to the reported LOB or probability arc, the system shall report the following parameters: - carrier frequency - measurement confidence - received signal level.
024	Display	Shall be capable of displaying a continuous histogram of reported bearings for the target frequency. The histogram will track all qualified (above receiver squelch threshold) bearings and plot the number of times a particular bearing was received (y-axis) as a function of the received bearing (x-axis, scaled to 0-359 degrees in 1 degree steps). The histogram shall also provide for a user “reset” or “clear all bearings” or “user defined running buffer function” as a means of de-cluttering the display and starting over. Finally, the histogram shall provide a means of narrowing the display or “zooming in” on a range of bearings of interest by allowing the user to specify a start and stop (i.e. 150-200 degrees) value for the x-axis of the display.
025	Control	Measurement configuration/state settings saved shall include as a minimum any system settings that a user has the capability to adjust, including items such as, but not limited to: - RF input attenuation - Internal LNA on or off - tuned frequency - receiver/digitizer settings - panoramic adapter settings - DF system settings - time & date of measurement - System calibration/alarm status flags.

026	Control	Must record measurement configuration/state settings & time stamp when screen shots are saved. These settings must be visible during local recall of screen shots and be available for review with any post processing tools used to analyze signal analysis screen shot files.
027	Control	Must provide a mechanism (on a per user level) to allow user measurement configuration/state to be saved on demand and/or automatically at shutdown based on the users' preference in non-volatile memory.
Item #	**Direction Finding (DF)**	**Required specification**
028	Primary DF method	Primary DF capability to be provided by Angle of Arrival and/or Correlative Interferometric methods.
029	Primary DF sensitivity	Better than 20 uV/m from 20 MHz to 110 MHz.
030	Primary DF sensitivity	Better than 10 uV/m from 110 MHz to 1 GHz.
031	Primary DF sensitivity	Better than 10 uV/m from 1 GHz to 3 GHz.
032	Primary DF sensitivity	Better than 10 uV/m from 3 GHz to 7.125 GHz.
033	Primary DF valid bearing acquisition time (POI)	Must have a 100 percent probability of intercept (POI) for minimum signal duration of 10 milliseconds or better for DF bearing capture.
034	Primary DF performance-Bearing accuracy at rated DF sensitivity	Maximum error of ± 5 degrees RMS.
035	Secondary DF method	Must provide additional radiolocation capability by using Time Difference of Arrival (TDOA) method. With the use of more than one unit.
036	Secondary DF performance-Valid bearing acquisition time (POI)	Must have a 100 percent probability of intercept (POI) for minimum signal duration of 10 milliseconds or better for DF bearing capture.
037	Secondary DF performance-Processing delay from time of signal event	Computed target ellipsoid displayed in less than 1 second from time of initial signal acquisition.
038	Secondary DF performance-Bearing accuracy, under optimum conditions	Maximum target ellipsoid semi-major axis size of 30 metres in a non-reflective environment.
039	Hybrid DF	System to allow for hybrid operation using AOA/correlative interferometric and TDOA modes simultaneously.

2.3 System Demodulation platform requirements

Item #	Hardware	Required specifications
001	RF input attenuator (internal)	Provide a multiple step internal user selectable RF input attenuator.
Item #	**RF Performance**	**Required specifications**
002	Amplitude	Maximum safe continuous RF input level of +15 dBm, 0 VDC (input attenuation 0 dB and internal pre-amps off).
003	Third Order Intercept (TOI)	TOI = Worse case greater than or equal to +7 dBm (guaranteed) across operating frequency range.
004	Tuning frequency range	10 kHz to 3 GHz (continuous, no gaps in frequency coverage).
005	Tuning frequency range	Provide option(s) to extend frequency range to 7.125 GHz. (band splitting acceptable).
Item #	**Demodulation**	**Required specifications**
006	Demodulation IF BW	Provide user selectable and adjustable demodulation IF BW's (demodulation IF BW shall be independent of and not coupled with the spectrum display RBW in any way).
007	Analog Signal Demodulation	Demodulate and provide baseband audio output to the user of the following analog signal types: - AM (Narrowband) - FM (Wideband / Narrowband) - CW (with variable or fixed BFO) - SSB.
008	Digital Signal Demodulation	Shall demodulate and provide decoded text/image output (for non-encrypted signals) to the user of the following legacy asynchronous digital emissions (i.e. FSK, AFSK, FDM, FAX).
009	Digital Signal Demodulation	Shall demodulate commercial digital broadcast emissions including AM/FM IBOC, RBDS, ATSC and Digital Radio Mondiale (DRM) and provide baseband audio and teletext (RBDS).
010	Digital Signal Demodulation	Provide 3G, 4G and 5G real-time advanced digital demodulation for signal overhead which may include but not limited to the following common parameters: - automatic eNodeB (base station) identification via decode of appropriate OSI stack layer closest to the physical RF layer to obtain various parameters such as PLMN's (containing of MCC and MNC information), and unique PN's, SC's and PCI's or equivalents. - modulation scheme(s) in use by main carrier and/or sub-carrier(s).

011	Digital Signal Demodulation	Shall demodulate and provide baseband audio output (for non-encrypted signals) to the user of the following LMR digital signal types: - APCO P25 (phase 1 and/or phase 2) - MOTOTRBO - DMR and/or dPMR - NXDN - Tetra.
012	Decoding	For digital emissions, attempt automatic station identification via demodulation/decode of appropriate OSI stack layer closest to the physical RF layer to obtain station ID.
013	Decoding	For analog emissions, demodulate and display CTCSS tone frequencies and DCS codes.
014	Automatic Signal Classification	Provide the capability (internal or external to the instrument) to perform real-time automatic emission classification including an estimate of confidence level of the modulation type(s) identified and a summary of signal measurement results within 1 second of detecting a signal of interest).
015	Automatic Signal Classification	Provide capability (internal or external to the instrument) for customer to add user defined signal types into the stock catalog of pre-scanned emission types available to signal classifier algorithm.)
Item #	**Software**	**Required specifications**
016	Control	Provide user configurable automatic scanning modes including but not limited to: user frequency list(s), start/stop frequencies at user defined increments and band scans.
017	Control	Provide user adjustable receiver squelch threshold control.
018	Control	Provide user-selectable reporting units of measure for signal amplitude.
019	Control	Must be capable of playing back stored/recorded demodulated audio and simultaneously displaying the synchronized time stamp information.
020	Control	Must provide a mechanism (on a per user level) to allow user measurement configuration/state to be saved on demand and/or automatically at shutdown based on the users' preference in non-volatile memory.

021	Control	Measurement configuration/state settings saved shall include as a minimum any system settings that a user has the capability to adjust, including items such as, but not limited to: - RF input attenuation - Internal LNA on or off - tuned frequency - receiver/digitizer settings (i.e. IF BW, detector mode, AGC timing) - panoramic adapter settings - time & date of measurement - geographic coordinates - System calibration/alarm status flags.
022	Control	Shall provide capability for the user to search and retrieve stored instrument setting data from internal archives.
023	Control	Shall be capable of recording demodulated audio to internal storage using standard lossy/compressed formats (WAV, MP3, etc.) along with continuous synchronized time stamp.
024	Display	Provide a user-friendly display for the receiver that indicates all user settings (i.e. frequency, IF BW, AGC settings, demod mode, attenuator/pre-amp status, numeric received signal level) and a panoramic spectrum display.
025	Display	Provide a simulated analog "S - meter/bar graph" display for signal strength indication.

3.0. Antennas System Requirements

3.0 (a) Portable antenna kit specifications

Area	Requirements
Hardware	Vendor shall offer portable, handheld, directional receiving antennas operating between 50 MHz (low band VHF LMR & VHF TV) to a minimum of 40 GHz with the minimum number of antennas possible.
Hardware	Vendor shall offer portable, handheld/tripod mountable, broadband, omnidirectional receiving antennas operating between 100 kHz (LF beacons) to a minimum of 8 GHz with the minimum number of antennas possible.
Hardware	Portable DF antennas shall be rated to the current revision of MIL-STD-810 for environmental exposure.
Hardware	DF antennas shall be rated to IP67 standards for environmental exposure.

3.0 (b) Vehicle mounted antenna kit specifications

Area	Requirements
Hardware	Vendor shall offer removable mounted passive, broadband, omnidirectional receiving antennas operating between 100 kHz (LF beacons) up to a minimum of 8 GHz with the minimum number of antennas possible.
Hardware	Vendor shall offer removable mounted passive, multiband, omnidirectional cellular antennas to be used for in-vehicle 4G/5G cellular radio modems.
Hardware	External, removable DF antennas shall be rated to the current revision of MIL-STD-810 for environmental exposure.
Hardware	DF antennas shall be rated to IP67 standards for environmental exposure.

3.0 (c) Transportable antenna specifications

Area	Requirements
Hardware	Vendor shall offer tripod/mast mountable passive, broadband, omnidirectional receiving antennas with temporary mounts operating between 100 kHz (LF beacons) up to a minimum of 8 GHz with the minimum number of antennas possible. These antennas shall have DC grounded outputs to prevent the formation of precipitation static charges.
Hardware	Vendor shall offer tripod/mast mountable passive, multiband, omnidirectional cellular antennas to use for in-vehicle 4G/5G cellular radio modems.
Hardware	Transportable automatic DF antennas shall be tripod/mast mountable and come with temporary mounts. Shall be rated to the current revision of MIL-STD-810 for environmental exposure.
Hardware	DF antennas shall be rated to IP67 standards for environmental exposure.
Hardware	Transportable automatic DF antennas shall have integrated lightning surge protection to minimize the possibility of lightning damage to antenna mounted electronics.

3.0 (d) Fixed antenna kit specifications

Area	Requirements
Hardware	Vendor shall offer mast mountable passive, broadband, omnidirectional receiving antennas operating between 100 kHz (LF beacons) up to a minimum of 8 GHz. These antennas shall have DC grounded outputs to prevent the formation of precipitation static charges
Hardware	Vendor shall offer mast mountable passive, multiband, omnidirectional cellular antennas to be used for 4G/5G cellular radio modems.
Hardware	Fixed site automatic DF antennas shall be mast mountable and be rated to the current revision of MIL-STD-810 for environmental exposure.
Hardware	Fixed site automatic DF antennas shall be rated to IP67 standards for environmental exposure.
Hardware	Fixed site automatic DF antennas shall have integrated lightning surge protection to minimize the possibility of lightning damage to antenna mounted electronics.

4.0 Antenna switching matrix

Item #	Hardware	Required specification
001	RF Input ports	Shall provide 4 SMA input ports.
002	RF Output ports	Shall provide 4 SMA output ports.
003	Self-Diagnostics	Provide internal hardware built-in test (BIT) for system health check and malfunction diagnosis.
004	Connectivity	Shall provide for USB (type 2 minimum) and Ethernet (100baseT minimum) ports to externally control switching hardware.
Item #	**RF performance**	**Required specification**
005	Operating frequency range	9 kHz to 7.125 GHz (continuous, no gaps in frequency coverage).
006	Input Impedance	50 ohms.
007	Output Impedance	50 ohms.
008	Insertion Loss	Shall not exceed 0.5 dB across entire operating frequency range.
009	Isolation	Isolation between “hot” path (actively linked ports) and “cold” (unselected) ports shall be equal to or greater than 90 dB.
010	VSWR	Selected path (non-paralleled output port configuration) VSWR shall not exceed 1.2:1.
011	Power Handling	3 watts (cold switching).
012	Power Handling	100 mW (hot switching).
013	Switching Process	Shall provide for “break-before-make” switching to eliminate undesired momentary connection between old and new signal paths.
014	Switching Process	Shall not ground or terminate un-selected input and output ports.
015	Switching Process	Shall allow for intentional parallel connection of multiple output ports to a common input port.

016	Switching Time	Time to reconfigure an input/output path shall not exceed 50 msec.
017	Switch Lifetime	Cold switching shall not be less than 2 million cycles.
018	Switch Lifetime	Hot switching shall not be less than 1 million cycles.
019	PIM (passive intermodulation)	Switch hardware shall maintain 3rd and higher order PIM products below –151 dBm/Hz up to rated power handling limit of the unit.
Item #	**Software**	**Required specification**
020	Control	An interactive, user customizable Windows GUI shall be provided to pre-define multiple switching paths and present these paths visually for the user to select and also allow for "on the fly" configuration of a new path.
021	Operating System (OS)	All vendor-supplied OEM remote control/access software must be compatible with Corporate OS (at time of response).

5.0 Portable power solution for transportable systems

Item #	Requirement
001	Provide an AC/DC capable system power source consisting of a lightweight, high power density, maintenance free sealed battery (i.e. lithium ion) along with an integral shore power charging system with an integral 500 W sinewave inverter for powering miscellaneous loads that is capable of charging the system battery pack and powering all mission package electronics simultaneously.
002	Provide user programmable load shedding of non-essential loads to increase battery run time for essential instrumentation and remote access for power control and alarming (i.e. AC fail, low battery voltage, low/high temperature, enclosure access, etc.)
003	Provide a small, lightweight, environmentally friendly, emergency backup power source (i.e. Tripod/mast mounted solar panel(s) to simultaneously operate the mission package and charge the on-board maintenance free batteries to allow for 24/7 operation if commercial power has been lost.
004	System power module(s) must meet the same environmental/packaging requirements as the system electronics package and be able to power the system for at least 24 hours after all power is lost (i.e. commercial AC power and emergency backup power source (i.e. solar panels).
005	AC/DC power packs, battery packs and solar panels (with mounts) shall not exceed 20 kilograms (1 person lift) in weight each.
006	Power system components must be capable of being transported to a rooftop via typical rooftop access hatches if necessary and have a mechanism to physically secure (i.e. chain and lock) them to existing rooftop tie down points to prevent theft, unauthorized equipment access for tampering and being blown of the rooftop by strong winds.

Appendix 2: Definitions and Glossary

Definitions	
Angle of Arrival DF (AOA)	Radio direction finding method producing as its result, a discrete line of bearing originating from the DF antenna location towards the emission source. (Suitable for both narrow and wideband signals).
Baseband	Range of frequencies, which modulate the carrier frequency.
BFO (Beat Frequency Oscillator)	Additional internal RF oscillator required to demodulate CW type signals.
Fixed Installation	Spectrum monitoring infrastructure, permanently installed at a suitable geographic location, typically includes significant external antenna support structure (tower), internal dual-mode AC/DC PSU.
Lightweight Transportable Installation	Self-contained, lightweight spectrum monitoring infrastructure temporarily located at a suitable geographic location and relocated as desired, typically includes portable antenna support system, internal dual-mode, AC/DC PSU.
Local Station	Typically the sensor suite itself, including all necessary hardware and software and are capable of operating in all combinations of stand-alone, networked, manual and automated modes of operation. When configured as a networked station, the station shall be able to control other networked installations and itself be remotely controlled
Portable Equipment	Spectrum monitoring infrastructure compact enough to be operated by a single individual while travelling on foot, typically includes hand-held type antennas and internal battery PSU.
Primary DF (Direction Finding) System	Primary method used for DF will be Angle of Arrival (AOA) and/or Correlative Interferometry.
Probability of Intercept (POI)	Ability of instrument to receive a time-variant signal and correctly display the entire signal envelope to the user in frequency vs amplitude (frequency domain) without distortion of the envelope shape.
Remote Controller	May simply be a computer or laptop with a TCP/IP network connection and appropriate client software suite (OEM and/or 3rd party) or web browser as the case may be. The system shall permit simultaneous access to all available monitoring assets for the purposes of interactive control of radio equipment, transfer of data files

	and programming automated tasks. Shall also provide for monitoring system status and diagnostics.
Secondary DF (Direction Finding) System	Secondary method used for DF will be Time Difference Angle of Arrival (TDOA).
Standard Mobile Installation	Spectrum monitoring infrastructure either permanently or removable (becomes "transportable" once removed) installed in a vehicle, typically includes removable rooftop antennas and portable antennas, internal dual-mode, AC/DC PSU.
System Electronics	System Electronics are defined as test & measurement hardware, associated sensors, computing equipment, instrument controllers, IT hardware (i.e. switches, USB hubs, routers, VPN appliances and cellular modems) antennas, power supplies and interconnecting cabling.
Time Difference of Arrival DF (TDOA)	Radiolocation method requiring a minimum of three reporting DF systems producing as its result, intersecting arcs of target location probability. (Suitable for wideband signals only).
GLOSSARY:	
3G	3rd Generation Technology Standard
4G	4th Generation Technology Standard
5G	5th Generation Technology Standard
8PSK	8-Phase Shift Keying
AC	Alternating Current
AFSK	Audio Frequency Shift Keying
AGC	Automatic Gain Control
AM	Amplitude Modulation
AOA	Angle of Arrival
APCO P25	Project 25
APD	Amplitude Probability Distribution
API	Application Program Interface
APSK	Amplitude Phase Shift Keying
ARFCN	Absolute Radio-Frequency Channel Number
ASK	Amplitude-Shift Keying
ATSC	Advanced Television Systems Committee
BER	Bit Error Rate
BIT	Built-in-Test
BPSK	Binary Phase Shift Keying
BW	Bandwidth
CCDF	Complementary Cumulative Distribution Function

CEP	Circular Error Probability
CISPR	Comité International Spécial des Perturbations Radio
COTS	Commercial Off-the-Shelf
CTCSS	Continuous Tone-Coded Squelch System
CW	Continuous Wave
DANL	Displayed Average Noise Level
DC	Direct Current
DCS	Digital-Coded Squelch
D8PSK	Differential 8-Phase Shift Keying
DF	Direction Finding
DMR	Digital Mobile Radio
DMSK	Differential Phase Shift Keying
dPMR	Digital Private Mobile Radio
DQPSK	Differential Quadrature Phase Shift Keying
DRM	Digital Radio Mondiale
DTF	Distance To Fault
DVB	Digital Video Broadcasting
E_b/N_o	Bit Signal to Noise Ratio
E_s/N_o	Symbol to Noise Ratio
EMI	Electromagnetic Interference
eNodeB	Base station
EVM	Error Vector Magnitude
FAX	Facsimile
FDM	Frequency Division Multiplexing
FFT	Fast Fourier Transform
FM	Frequency Modulation
FSK	Frequency-Shift Keying
GMSK	Gaussian Minimum Shift Keying
GMVOG	Government Motor Vehicles Ordering Guide
GPS	Global Positioning System
GUI	Guest User Interface
HTTPS	Hypertext Transfer Protocol Secure
I/Q	In-Phase/Quadrature
IBOC	In-Band On-Channel
ICT	Information and Communication Technology
IF	Intermediate Frequency
IL	Insertion loss
IP	Internet Protocol

ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunications Union
ITU-R	ITU Radiocommunication Sector
KPI	Key Performance Indicator
LAT	Latitude
LF	Low Frequency
LMR	Land Mobile Radio
LNA	Low-Noise Amplifier
LO	Local Oscillator
LOB	Line of Bearing
LONG	Longitude
MCC	Mobile Country Code
MOTOTRBO	Digital Radio Format
MNC	Mobile Network Code
MSK	Minimum-Shift Keying
NMEA	National Marine Electronics Association
NXDN	Digital Radio Format
OS	Operating System
OEM	Original Equipment Manufacturer
OFDM/A	Orthogonal frequency-division multiple access
OSI	Open Systems Interconnection
P25	Project 25
PC	Personal Computer
PCI	Physical Cell ID
PIM	Passive Intermodulation
PLMN	Public Land Mobile Network
PN	Pseudo-Random Noise Code
POI	Probability of Intercept
ppm	Parts per million
PSK	Phase-Shift Keying
PSU	Power Supply Unit
PWGSC	Public Works and Government Services Canada
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RBDS	Radio Broadcast Data System
RBW	Resolution Bandwidth
RF	Radio Frequency
RFI	Request for Information
RHO	Modulation Accuracy/Quality

RFP	Request for Proposal
RL	Return Loss
RMS	Root Mean Square
RS-CINR	Carrier to Interference and Noise Ratio based on Reference Signals
RSRQ	Reference Signal Received Quality
RSSI	Received Signal Strength Indicator
RSSP	Rectangle Search Space Pruning
RTSA	Real-time Spectrum Analyzers
SA	Spectrum Analyzer
SC	Scrambling Code
SDK	Software Development Kit
SFDR	Spurious Free Display Range
SOR	Statement of Requirements
SMA	Sub-Miniature A
SSB	Single-Sided Band
STS	Spectrum and Telecommunications Sector
TCP	Transmission Control Protocol
TDOA	Time Difference of Arrival
Tetra	Digital Radio Format
TOI	Third-Order Intercept
TV	Television
UARFCN	UMTS Terrestrial Radio Access Absolute Radio-Frequency Channel Number
UI	User Interface
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
VAR	Value Added Reseller
VAC	Volt Alternating Current
VHF	Very High Frequency
VNA	Vector Network Analyzer
VPN	Virtual Private Network
VSA	Vector Signal Analysis
VSWR	Voltage Standing Wave Ratio
WAN	Wide-Area Network