ADVANCE CONTRACT AWARD NOTICE (ACAN)

1. Title

Open Geospatial Consortium (OGC) Testbed 15

2. Definition

An Advance Contract Award Notice (ACAN) allows departments and agencies to post a notice, for no less than fifteen (15) calendar days, indicating to the supplier community that it intends to award a good, service or construction contract to a pre-identified contractor. If no other supplier submits, on or before the closing date, a Statement of Capabilities that meets the requirements set out in the ACAN, the competitive requirements of the government's contracting policy have been met. Following notification to suppliers not successful in demonstrating that their Statement of Capabilities meets the requirements set out in the ACAN, the contract may then be awarded using the Treasury Board's electronic bidding authorities.

If other potential suppliers submit Statement of Capabilities during the fifteen calendar day posting period, and meet the requirements set out in the ACAN, the department or agency must proceed to a full tendering process on either the government's electronic tendering service or through traditional means, in order to award the contract.

3. Background

The department of Natural Resources Canada (NRCan) has ministerial responsibilities to lead the national GeoConnections program. GeoConnections is a national program with the mandate and responsibility to lead the Canadian Geospatial Data Infrastructure (CGDI) through the use of standards-based technologies and operational policies for data sharing and integration.

NRCan high level requirements to be addressed via the OGC Testbed 15 process include:

Machine Learning Opportunity
Recent advancement in Artificial Intelligence (AI) has demonstrated the value of using Machine Learning (ML) approaches for automated image and vector data processing. However, the availability of data to efficiently train ML models is still an issue. A large variety of geospatial data are available through standardized OGC interfaces that could facilitate the discovery and access to datasets used to feed ML tools.

The proposed ML development will help to explore the utility of existing GOC web services (OWS) to support a large scope of ML tools including EO data processing, image classification, feature extraction and vector attribution. The design of standardized ML interfaces will explore how such tools would access and publish their input and outputs using OWS. This research may also suggest a path for the development of future OWS.

Big Data Challenges
With the increase in EO sensors and the availability of LiDAR data at provincial scales, Big Data is a major concern for research teams trying to utilize the latest data to address policy and science questions. Volume and velocity of these datasets are only two issues related to Big Data for various NRCan sectors. The computational infrastructure that is required to maintain and process these large-scale data sets is also a significant challenge even for large organizations.

The proposed work will explore how NRCan researchers could process large datasets in a reasonable time, and how the emerging ML capacity could reduce expensive processes.

Data Silo Challenges
To understand important aspects of the water cycle, it is often vital to relate many kinds of hydro features, from the subsurface to the surface and atmosphere. This involves hydro data that are stored in distributed databases and are relatively isolated, making it difficult to capture relations between features and keep them current.

By improving Linked Open hydro data environment, NRCan anticipates a series of business benefits include: Improved discoverability, Improved access, improved connectivity: datasets are no longer Improved interoperability, enhanced infrastructure and enhanced openness.

Furthermore, to understand water related socio-economic issues, it is often necessary to relate various statistical data with various water feature geospatial data.

Feature Mapping Challenges
Image and LiDAR analysis techniques are often used to classify an image into two classes, water and land. Vectorization of the resulting classification can produce a nice cartographic vector dataset but will not determine where the boundary exists that separates a lake from a large river entering or exiting it, or where the respective boundaries are at the confluence of two large rivers.

An AI enabled, automated means of creating lake and river features from general water boundaries is required. For end user applications, this differentiation is required and should be coupled with routines for the automatic extraction of water from imagery and/or LiDAR. NRCan expects to move away from manual lake-river differentiation, gaining consistency and efficiency from this AI approach. The NRCan and ECCC water programs, the National Hydro Network (NHN), the Common Hydrology Features (CHyF) initiative, and their user communities would benefit from this development. The idea of applying AI to geospatial objectives is both very wide and very deep. Pushing specific issues as is done here should be seen as complementary and likely very informative. If this project is successful, it will have immediate practical benefits and augment other NRCan AI related projects.

SDI Services and their Actual Usage Challenges
There are thousands of geospatial services available in .ca domain. How many of such services representing a specific type of forest, its health condition in a specific location? Which service provide data on Richelieu River water features? What relationship of these features? Which services provide lake and river maps over Quebec? Are lakes and rivers differentiated? What is best of approach to leverage Canada investment in these web services?

By feeding the CGDI list of web services as potential data sources to all machine learning models will allow solution provides extended data/service sources. Which may potentially reduce data gaps, reduce the need for new data acquisition, and foster more application development.

4. Requirement

The GeoConnections Program, as part of the Canada Centre for Mapping and Earth Observation Branch (CCMEO) of Natural Resources Canada, has the following requirements.

- The development and demonstration of the following Machine Learning (ML) models
  - Petawawa Super Site research forest change detection
  - Province of New Brunswick forest supply management decision maker
  - Richelieu River hydro linked data harvest
  - Delineate lake and river features from an undifferentiated waterbody vector dataset
  - Arctic web services discovery

- The OGC Engineering report that document the above ML models.

- The solution developed for NRCan via this contract shall be open geospatial standards based. The solution development shall be carried out in a multi-vendor, co-development, international open standards consortium environment, such that NRCan can leverage the requirements and solutions for other open geospatial consortium members and the solution may be adopted by others in geomatics communities in Canada and internationally. The solution development for NRCan should also inform future open geospatial standards developments and implementations.

5. Testbed 15 Detailed Requirements

5.1 Petawawa Super Site Research Forest Change Prediction ML Model

Cloud cover is an unavoidable presence in remotely sensed data. Estimates of the mean annual global cloud cover over land surfaces ranges from 35% (Ju and Roy, 2008) to 66%(Zhang et al, 2004). Clouds affect remotely sensed data dramatically.

As a first step towards an automated forest change prediction system, the contractor will demonstrate the use of Machine Learning to remove clouds and high altitude cloudets (popcorn clouds) from historical datasets from the Petawawa super site. Existing products and algorithms have helped to identify and segment clouds on Landsat Level-1 data products. These algorithms utilize a multi-pass algorithm that use decision trees to label pixels in scenes, validate and discard and create masks for shadows. These algorithms work well on certain clouds, cloud shadows, snow and ice pixels, however the identification of high altitude cloudets over bright objects such as snow, ice or lakes are unsatisfactory. By introducing expert knowledge and supervised classification along with a decision tree algorithm into a ML methodology, we hope to see improvements in the cloud detection process.

The contractor will deliver to Natural Resources Canada a forest change detection ML model for the Petawawa Super Site research forest through a live demo and document such model in an OGC Engineering Report. The ML model will:

1. Discover datasets of the area (Petawawa) over a given time frame from OGC Catalogue (CSW)
2. Discover which images are usable (less than 70% cloud coverage from Landsat and possibly Sentinel 2 products)
3. Using machine learning and convolutional neural networks to detect features, segment cloud and shadow pixels based on training data provided (surface reflectance and expert knowledge) with tensorflow
4. Creation of a cloud free mosaic will be delivered to Natural Resources Canada by assembling best non-cloud segments
5. Produce a Land cover classification from cloud-free mosaic based on ML using provided land classification training data plus DTM/DSM and LiDAR data where applicable. Study how optical imagery (RGB or multi-spectral) can be combined with height above ground information (derived from LiDAR) to feed ML Land Cover classification

NRCan will facilitate access to the following materials to the Open Geospatial Consortium

1. The Canadian Forest Service has collected and curated a mass volume of data surrounding the Petawawa Research Forest. Data from the late 70's to present is being made available via OGC Web services. This includes historical Landsat (Collection 1 Level-1) scenes from Landsat 5, 7, 8 from 1983 to 2018, Sentinel 1,Sentinel 2, LiDAR, multispectral data and aerial photography missions.
2. A set of classified cloud image segments based on surface reflectance CFMask products (Zhu and Woodcock algorithm) and expert knowledge for high altitude (popcorn) cloudets can be used for training data. This dataset will be published through a WFS and WMS service.
3. A set of manual classified Land cover products with associated raw landsat 8 datasets for training data for land classification use. This dataset will be published as a WFS and WMS
4. The CGDI list of Web services may contain other data sources

Constraints:

1. We propose that the new testbed focuses on best practices for distributing and managing big data (LIDAR and imagery), and processing datasets using machine learning algorithms for auto classification and with future use in change detection
2. NRCan forestry data can be accessed via OGC services such as Catalogue services, Web Feature, Web Mapping and Web Coverage service. https://saforah2.nfis.org/index.html
3. Continue the work of cloud computing from Testbed 13, 14 with work on WPS and possibly CWL (Common Workflow Language), and continue the LiDAR best practices work from Testbed 14.
4. Solution is to be compatible with NRCan's Boreal Cloud (OpenStack cloud environment) and access to the Boreal Cloud will be negotiated.

5. Use of open source libraries such as TensorFlow, PyTorch or others for Machine Learning

5.2 Forest Supply Management Decision Make ML Model

The contractor will deliver a forest supply management decision maker ML model for the province of New Brunswick forested areas through a live demo and document such model in an OGC Engineering Report. The ML model will

1. Recommend the most efficient optimized path from forest to market -"wood flow model"; this model addresses optimal allocation of resources and flow of products to secondary and tertiary processing.
2. Recommend new road construction that will be the most efficient over time and safety being considered. Work may include life-cycle analysis for bridge/culvert infrastructure.
3. Recommend the best time for road conservation closure that will cause the least negative impact

NRCan will make the following datasets available:

1. Enhanced forest inventory (imagery, LIDAR, Forest Resources Information), terrain models (slope, elevation, visual quality) available from the province of New Brunswick.
2. NRCan and provincial data access via: http://nb.nfis.org/ and other CGDI sources
3. The CGDI list of Web services may contain other data sources

Constraints

1. The ML model will utilize spatial data such as secondary infrastructure (secondary roads, logging roads, bridges, wood lots, sort yards), primary infrastructure (highways, bridges, dams, power, mills, paper mills) and current market prices of lumber and fuel/energy
2. Existing OGC, ISO and other Best practices and standards such as WPS, WCS, WFS, WMS, along with up and coming standards to handle BigData dissemination.
3. Use of open source libraries such as TensorFlow, PyTorch, hadoop or others for Machine Learning
4. Continue the work of cloud computing from Testbed 13, 14 with work on WPS and possibly CWL (Common Workflow Language), and continue the LiDAR best practices work from Testbed 14.
5. Solution is to be compatible with NRCan's Boreal Cloud (OpenStack cloud environment) and access to the Boreal Cloud will be negotiated.
6. Reference to OGC testbed-14 D013 PointCloud Data Handling ER

5.3 Richelieu River Hydro Linked Data Harvest

The contractor will harvest hydrological relations from the web for the Richelieu River / Watershed area, for inclusion in the Linked Hydro Data pilot project.

Deliverables to Natural Resources Canada include:

1. Digital file containing relations organized as a set of triples, in a format to be specified.
2. OGC Engineering Report describing the methods and results.
3. Any software code as mutually agreed

The harvesting might use three types of data sources:

1. Semantic Web: mine existing Semantic Web infrastructures for relevant relations, e.g. DBPedia, GeoNames, or others as mutually determined.
2. Online geospatial data: search existing geospatial databases, geospatial web resources (e.g. MapML) or hydrological models for relevant information.
3. The Web: use AI (e.g. Machine Learning) techniques to identify relevant relations on the web and/or in relevant publications.

NRCan will make the following available:

1. Ontologies (schemas) for types of features and relations to be harvested.

2. Specification of format for results (as triples).
3. Specification of url identifier pattern to be used in triples.
4. Example file containing existing relations in the specified format.

Constraints:

1. Restricted to specified region (Richelieu) and types of features and relations
2. Use of open source software where possible, especially for any code to be transferred.
3. Spatial Data on the Web Best Practices to be respected.

5.4 Lake – River Differentiation ML Model

Image and LiDAR analysis techniques are often used to classify an image into two classes, water and land. Vectorization and correction of the resulting classification can produce a nice cartographic vector dataset but will not determine where the boundary exists that separates a lake from a large river entering or exiting it, or where the respective boundaries are at the confluence of two large rivers. An automated means of creating lake and river features from general water boundaries is required.

The contractor will deliver an ML model to delineate lake and river features from an undifferentiated waterbody vector dataset. The ML model will be applied against undifferentiated hydrographic network data from Québec (géobase du réseau hydrographique du Québec (GRHQ), with adjacent lakes and double-line rivers merged together to form general waterbody features), with the intent of generating an GRHQ equivalent with the lake and double-line rivers differentiated as distinct features. Supporting data includes DEM data and place names with locations. The work should proceed with the data just described, and then separately taking into account the National Hydro Network (NHN) for the same area.

The ML model will:

1. Recommend if a given waterbody needs to be split into lake/river features.
    a. If a split does not need to be made, then determine whether the feature is a lake or a river.
    b. If a split should be made, recommend where the division(s) between lake and river features should be placed based on terrain topography provided through DEM or LiDAR data.
2. Evaluate the confidence level of each recommendation.
3. Apply the recommendations, defining the feature type and the boundary of each waterbody feature.
4. The final geospatial results will be provided in vector format; thus, if raster processing is used, conversion to vector format must be carried out.

NRCan will facilitate access to the following datasets:

1. GRHQ hydrographic network data for Québec, with the lakes and double-line rivers already differentiated (as the expected result)
2. GRHQ hydrographic network data for Québec, with the lakes and double-line rivers not differentiated (as the dataset to be differentiated)
3. National Hydrographic Network (NHN) for Québec, with the lakes and double-line rivers already differentiated
4. Gridded elevation dataset (DEM - GeoBase CDEM) for Québec
5. Gridded elevation dataset (DEM - from LiDAR) for Québec
6. Place names with associated point locations for Québec
7. The CGDI list of web services or the Open Maps site may contain other data sources

Note: The size of the area will be determined by the contractor in consultation with NRCan personnel.
Note : The input vector dataset (except DEM) are vector products. They may or may not require rasterization for use in a ML environment; this is at the discretion of the contractor.

Constraints

1. No gaps or overlaps between adjacent features are allowed. This applies to lakes and double-line rivers, as well as to these features and the adjacent land.
2. Not all lakes or rivers will have place names, and for those that do, the place names do not necessarily fall on the feature.
3. The data at its different stages should be displayed using MapML served by WFS 3.0.

5.5 Arctic Web Services Discovery ML Model

The contractor will deliver to NRCan a component capable to build an evergreen catalogue of relevant arctic circumpolar web services. The ML model will:

1. Discover OGC and Esri REST web services that have some relevance to circumpolar science.
2. Evaluate the confidence level of each recommended service using both metadata and data parameters.
3. Include the review of multiple datasets within services in this evaluation.

NRCan will facilitate access to:

1. A training list of services deemed relevant to circumpolar arctic science.
2. A boundary file that can serve as a definition of the Arctic

Constraints

1. Solution is to be compatible with OGC Catalogue Service Implementation Specification [Catalogue Service for the Web] (2.0.2)

Use of open source libraries such as TensorFlow, PyTorch or others for Machine Learning. Solution is to be compatible with other OGC Testbed 15 cataloguing requirement and solutions.

6. Project Requirements

6.1 Deliverables and Milestones

The list below assumes shared requirements, among OGC Testbed 15 participating members. The number of components and deliverables will be adjusted in consultation with GeoConnections during OGC Testbed 15 Call for Proposal (CFP) releasing process. Draft list of work-packages incudes:

D100	Petawawa cloud mosaicing ML model
D101	Petawawa land cover classification ML model
D102	New Brunswick forest ML model
D103	Semantic Web link builder and triple generator
D104	Quebec river-lake vectorization ML model
D105	Quebec model MapML WFS3.0
D106	Quebec model MapML WFS3.0 Client
D107	Arctic Discovery Catalog
D001	Semantic ER
D002	ML ER
D015	Catalog ER

Deliverables	Date Completed
Testbed 15 OGC Call for proposal posted, evaluation completed, solution providers selected	March 31, 2019
Initial Engineering Report	May 31, 2019
Component Implementation Design	July 30, 2019

Initial Engineering Connectivity Tested & Early Implementations	August 31, 2019
Initial Engineering Connectivity implementation Readiness Review	September 30, 2019
Initial Engineering Component Implementations completed; Preliminary Draft Engineering Report is ready for review	September 30, 2019
Ad hoc TIE demonstrations & Demo Assets posted to Portal; Near-Final DERs posted to Pending & WG reviews requested.	October 31, 2019
Final Draft ER delivered	November 30, 2019
Final ER posted	December 31, 2019
Final Demo Event	January, 2019

6.2 Reporting Requirements

- One preliminary kick-off teleconference will be held to initiate the start of the contract;
- OGC project communications (e.g. CFP, Tender Evaluation, Stakeholder consultations)
- The contractor will provide a monthly all-sponsors teleconference to review status across the testbed;
- The contractor will provide a monthly written report to include the following:
    - Work status overview;
    - Schedule progress;
    - Current-period work accomplished, by deliverable;
    - Next-period work planned, by deliverable;
    - Any open issues or risks and associated remediation status;
- The contractor will provide one final meeting to demonstrate how testbed deliverables can be expected to support end-user operating scenarios.

6.3 Method and Source of Acceptance

All deliverables and services rendered under any contract are subject to inspection by the Project Authority. The Project Authority shall have the right to reject any deliverables that are not considered satisfactory, or require their correction before payment will be authorized.

7. Other Terms and Conditions of the SOW

7.1 Contractor's Obligations

The Contractor shall:

- Respect GeoConnections requirements with regards to proprietary information, as needed;
- Consult other OGC members and GeoConnections in its OGC Testbed 15 CFP to ensure NRCan requirements will be met to the fullest extent possible;
- Maintain all documentation in a secure area, as needed;
- Return all materials belonging to NRCan upon completion of the Contract, as needed;
- Participate in teleconferences, as needed;

7.2 NRCan's Obligations

NRCan shall:

- Provide approval of the final GeoConnections requirements that will be included in OGC Testbed 15 CFP upon OGC completes requirement specification from all OGC participating members.
- Provide feedback on or indicate acceptance of project deliverables within a reasonable, predetermined period of time;
- Provide access to relevant documentation and materials relevant to the project;
- Provide access to the GeoConnections Project Authority or delegate to provide guidance and answer questions as required.

8. Period of the Contract

It is anticipated that the contract will begin upon date of award and end **January 31, 2020**.

9. Estimated Cost

The approximate cost of this requirement will not exceed $240,000.00 CAD, excluding all applicable taxes.

10. Trade Agreements

Applicable Limited Tendering Provision under NAFTA (Article 1016.2)
1016.2(b) - where, for works of art, or for reasons connected with the protection of patents, copyrights or other exclusive rights, or proprietary information or where there is an absence of competition for technical reasons, the goods or services can be supplied only by a particular supplier and no reasonable alternative or substitute exists;

Applicable Limited Tendering Provision under Canada-Chile (Article Kbis-09)
Kbis-09 (b) - where, for works of art, or for reasons connected with the protection of patents, copyrights or other exclusive rights, or proprietary information or where there is an absence of competition for technical reasons, the goods or services can be supplied only by a particular supplier and no reasonable alternative or substitute exists;

Applicable Limited Tendering Provision under CFTA (Article 513.bi)
506.12(b) – where there is an absence of competition for technical reasons and the goods or services can be supplied only by a particular supplier and no alternative or substitute exists;

Applicable Limited Tendering Provision under Canada-Honduras (Article 17.11)
17.11.2 b) a good or service being procured can be supplied only by a particular supplier and a reasonable alternative or substitute does not exist because:
(i) the good or service is a work of art,
(ii) the good or service is protected by a patent, copyright or other exclusive intellectual property right, or
(iii) there is an absence of competition for technical reasons;

Applicable Limited Tendering Provision under Canada-Panama (Article 16.10)
16.10.1b) a good or service being procured can be supplied only by a particular supplier and a reasonable alternative or substitute does not exist because:
(i) the good or service is a work of art,
(ii) the good or service is protected by a patent, copyright or other exclusive intellectual property right, or
(iii) there is an absence of competition for technical reasons;

11. Exception to the Government Contracts Regulations and applicable trade agreements

Sole Source Justification - Exception of the Government Contract Regulations (GCR):

(d) Only one person or firm is capable of performing the contract

The Supplier must be able to meet all of the following criteria:

- Must be an international geospatial standards development and testing organization who develops international open geospatial standards in an open environment with governance linkages to the broader standards and Web communities (ISO and W3C)
- Must have developed geospatial data analysis using machine learning model technologies;
- Must have experience in developing an adopting open source libraries such as TensorFlor, PyTorch, hadoop or others from Machine Learning;
- Must have experience developing Earth observation data including LiDAR cloud data (bid data) and federated cloud security technology, based on OGC and other relevant standards, with relevant OGC standard/domain working groups;

- Must have experience in identifying hydrological relations based on existing linked data environment geospatial web services via linked open data technologies;
- Must have experience in geospatial web service and application development using regional or national hydrographic network data, and must have experience in delineating lake and river features from an undifferentiated waterbody vector dataset.

The selected Supplier is the only vendor able to meet all of the above criteria as well as meet all of the requirements described in Section 6 – Project Requirements.

12. Name and Address of the Proposed Contractor

Open Geospatial Consortium

13. Inquiries on Submission of Statement of Capabilities

Suppliers who consider themselves fully qualified and available to provide the services/goods described herein, may submit a Statement of Capabilities in writing, preferably by e-mail, to the contact person identified in this Notice on or before the closing date and time of this Notice. The Statement of Capabilities must clearly demonstrate how the supplier meets the advertised requirements.

14. Closing Date

Closing Date: January 2, 2019
Closing Time: 2:00 p.m. EST

15. Contract Authority

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