Exploring the OpenSearch extension to disseminate Earth observation data

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Abstract. The usage of Earth observation data, produced and managed by space agencies around the world, is extremely important in many areas of application, however the access is not always easy or simple. Space agencies adopt different forms for the provision of their data, so that users have to understand and be able to interact with different technologies and different catalogs. More recently, international organizations that bring together different space agencies have sought to set standards, specifications and best practices for building catalogs that are more simple and interoperable. This work aims to apply the standard specifications of the OpenSearch in the Earth observation data produced by INPE in order to make its dissemination simpler and compliant to the standards accepted in the geospatial community.

Keywords: remote sensing, imagery, web services sensoriamento remoto, imagens, serviços web

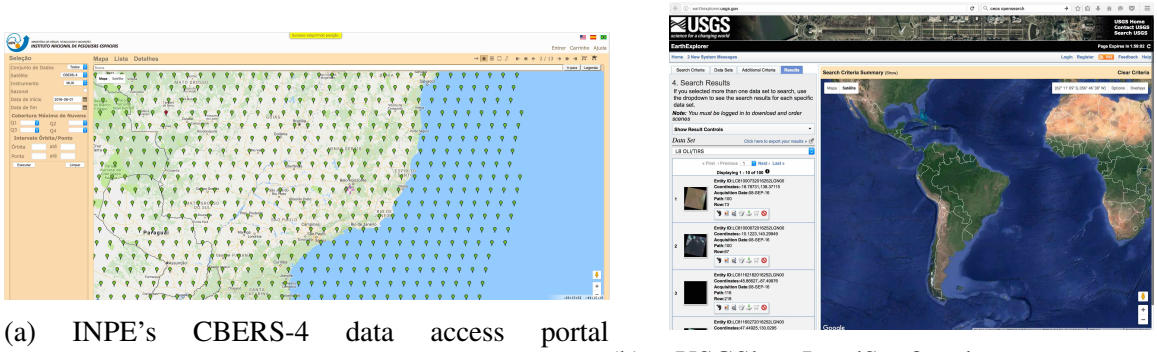
1. Introduction

Nowadays, geospatial information is being incorporated into various applications in the government as well as into the private sector. It plays a crucial part in environmental studies, social-economic activities, multi-disciplinary studies and education. Geospatial applications need to handle large amounts of data in order to provide policymakers with useful analyses for formulating responses to their problems (HAMILTON, 2005). Geospatial applications deployed in the internet environment is a way to make the best use of geospatial information. The concept of WebGIS including remote sensing imagery data. It brings the benefits of regarding costs reduction and efficiency, the use of the Internet environment is interoperability is the key concept to achieve broad access and reuse of resources.

Interoperability is a component of *Spatial Data Infrastructures* (SDIs) that can be summarized as the enabling environment in which all stakeholders can co-operate with each other and interact with technology, to better achieve their objectives at different political/administrative levels (RAJABIFARD; WILLIAMSON, 2001). Another important aspect of SDI's is data policy. Geospatial data is costly to produce and store and often data producers, even in the public sector, have restrictive access policies. Fortunately, when it comes to data acquired by Earth-orbiting satellites, open access policies have been increasingly adopted in the last two decades. In Brazil, the National Institute for Space Research (INPE) since 2005 has a free and open access policy for its Earth observations data and products. More than 2 million satellite images were distributed by INPE between 2005 and 2016. The Landsat series of satellite missions has collected imagery of the Earth's surface since 1972 and since 2008, all new and archived Landsat data held by the United States Geological Survey (USGS) have also been made freely available over the internet to any user (WULDER et al., 2012).

As for the technological aspect of SDI's, the use of geospatial services can be considered the most effective way to promote interoperability. The Open Geospatial Consortium (OGC)[1]

[1] http://www.opengeospatial.org/



(a) INPE's CBERS-4 data access portal (www2.dgi.inpe.br/CDSR/

(b) USGS's LandSat-8 data access portal (earthexplorer.usgs.gov)

Figure 1: Examples of imagery catalogs.

is the widely recognized non-profit organization that provides abstract specifications, reference models, best practices and engineering reports regarding various types of geospatial data and processing[2]. Among the hundreds of OGC standards, some are more mature than others. Arguably, OGC's standards have not yet provided a consensus solution to the discovery and access to remote sensing imagery.

With the motivation to contribute to the discussion of how to facilitate access to Earth Observation (EO) data, this article presents the use of the OpenSearch Specification as a more simple way to discover EO data. It also shows a prototype implementation developed to access INPE's imagery repository.

2. Problem statement and related work

When it comes to remote sensing imagery, most providers have invested in dedicated web portals, that serve as front ends to catalogs where users can query the available datasets in a non-standard way. This requires users to get familiar with, similar, but different portals. Even with an open data access policy user are also required to register an account before downloading the data. Due to the complex process of processing the data to be user ready, is not rare that there are no permanent online access URLs to the images, which requires users to place an order for some image and wait for a notification to their registered email with a temporary URL to the requested data (see examples in Figures 1a and 1b).

Catalogues can also be accessed through web services. OGC's Catalogue Model (NEBERT; VOGES; BIGAGLI, 2016) standards specify the interfaces, bindings, and a framework for defining application profiles required to publish and access digital catalogues of metadata for geospatial data, services, and related resource information. Providers of resources, such as content providers, use catalogues to register metadata that conforms to the provider's choice of an information model. Client applications can then search for geospatial data and services in very efficient ways.

There has been very little literature about implementing the OGC's metadata catalog service itself. (BAI; DI, 2011) discussed how OGC's catalog service standard could be realized through lightweight data structures and algorithms, but it requires a mediator from the local metadata database to the CSW interface. The Working Group on Information Systems and Services (WGISS) from the Committee on Earth Observation (CEOS) have developed an integrated catalog, based on a mediator layer, that aims to integrate different catalogues and provides a universal data discovery mechanism, called CEOS WGISS Integrated Catalogue (CWIC).

[2]http://www.opengeospatial.org/standards

As of August 2012, seven data catalogues were integrated in CWIC (SHAO et al., 2013), OAA CLASS, USGS Landsat, NASA ECHO, Brazil INPE, JAXA, NODC/GHRSST and China AOE. Within the CWIC, data user queries and retrieves data from heterogeneous data catalogues using the CSW interface, facilitating the distribution of datasets and their metadata through a single point of access. The integrated catalogue solves one of the problems mentioned previously, it provides a single point of access to data from different agencies using a common interface based on OGC's CSW standard, however, it still requires specialized clients to expose it to users.

As mentioned in (NÚÑEZ-REDÓ et al., 2011), the geospatial community can benefit from discovery interfaces that have been widely spread in other information communities in the context of Web 2.0. One such interface is the OpenSearch discovery interface.

3. Using OpenSearch to discover remote sensing imagery

Recently, alternatives based on the OpenSearch standard has been explored by remote sensing imagery providers as means of data discovery. OpenSearch is a collection of simple formats for the sharing of search results (OpenSearch.org, 2016). OGC's Geo and Time extension (GONCALVES, 2014) extends OpenSearch query protocol with a series of parameters that can be used to geographically and temporally constrain search results such as limiting bounding boxes, arbitrary geometries or a certain radius from a given latitude-longitude point. It can also limit data having a certain containment relation (intersects, contains, disjoint) with a geographic constraint, or matching geographic names. Temporally, it is possible to search for data with a start and end of a temporal extent and having a certain temporal relation (intersects, contains, during, disjoint, equals) with a temporal constraint.

Imagery and other Earth Observation (EO) products have specific characteristics like the orbit number, processing centre and acquisition station that follow a specific logic inherent to the EO community of users of satellite datasets. OGC's OpenSearch Earth Observation Extension extensions that allow data providers to develop search engines able to inform clients about EO specific query parameters. OpenSearch operates on metadata only and allows a performant view of the data, by using slimmer output formats such as GeoJSON or Atom/RSS XML structures.

The OpenSearch Specification Description Document (OSDD) is the format to describe a search engine so that it can be used by search client applications. The OSDD exposes a template to the queries supported by the OpenSearch search mechanisms. Figure 2 shows the client interaction with an OpenSearch discovery server.

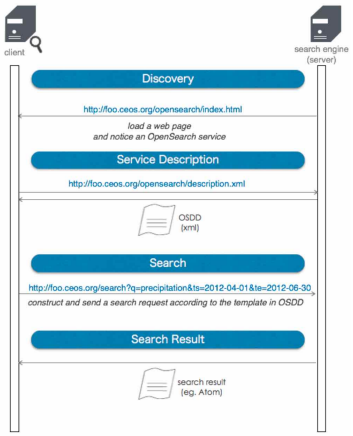


Figure 2: OpenSearch client-server interaction (Source: (Commitee On Earth Observation (CEOS), 2015)).

4. Results

Our implementation aimed at providing an OpenSearch discovery mechanism to access INPE's imagery repository, to complement the current web portal (Figure 1a) with no impact or inconsistency between the two search mechanisms. To assure that, it used the same metadata database used by the web portal and that is integrated to the ground station processing system, continuously receiving the data. Figure 3 exemplifies a client interaction case.

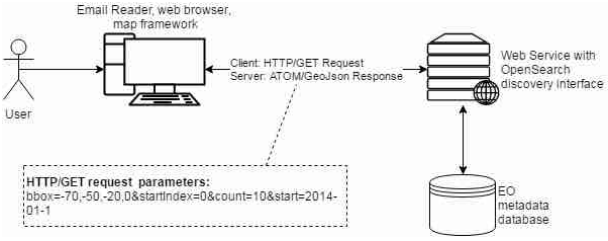


Figure 3: Use of INPE's OpenSearch mechanisms.

Figures 4 and 5 shows the OpenSearch responses in ATOM and GeoJSON formats being displayed in common frameworks used to produce maps on the web environment.

Figure 4: OpenSearch responses being displayed over the Google Maps API.

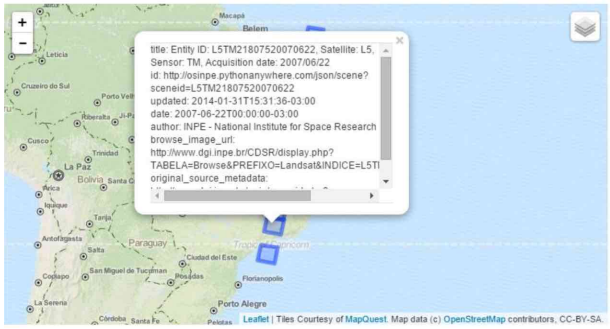


Figure 5: OpenSearch responses being displayed over LeafLet API.

Another interesting application of the OpenSearch responses is that it can be bookmarked in regular web browsers and email readers so that users can be notified of new data being available, accordingly to their search parameters (Figures 6 and 7).

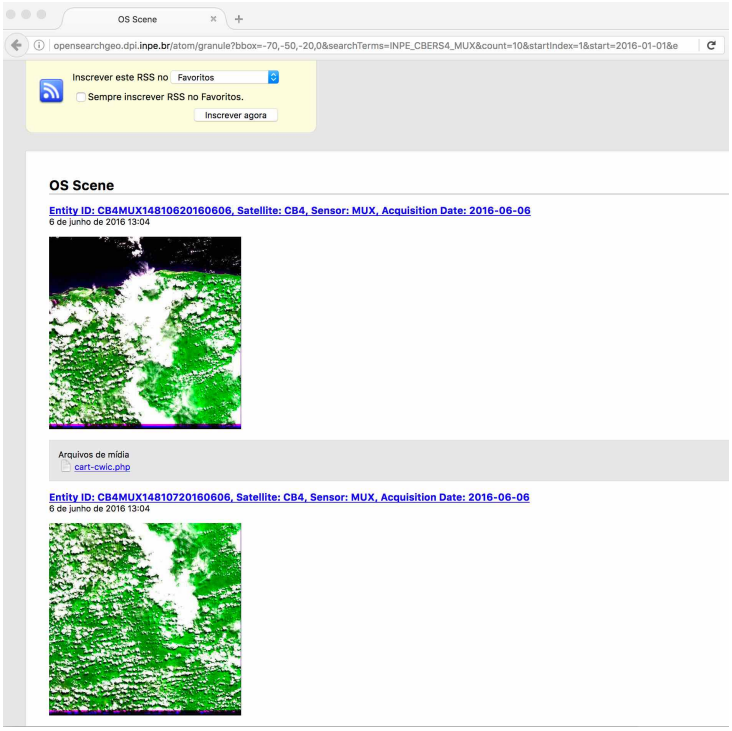


Figure 6: OpenSearch responses being displayed in a web browser.

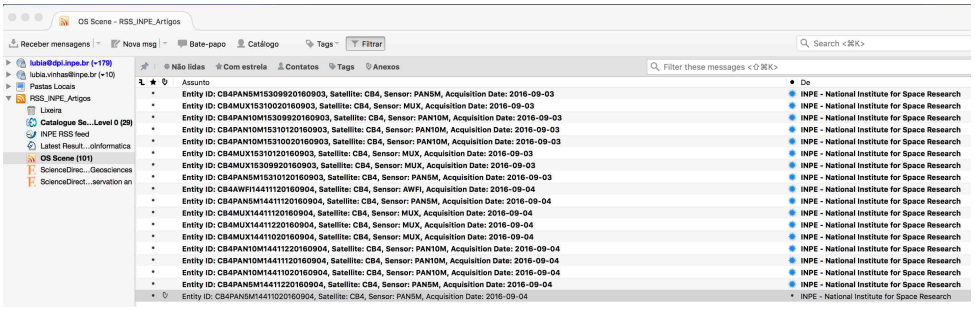


Figure 7: OpenSearch responses being displayed in a mail reader.

5. Conclusions

This paper shows how EO data can be discovered and accessed more easily using the OpenSearch standard. The main advantage of using OpenSearch is the possibility to use common clients such as web browsers or email readers to receive notifications about data availability, reducing the user's need to deal with various web portals. The OpenSearch standard is not a replacement for the current way of acquiring EO data using specialized web portals, but rather a complement that focuses on simplicity.

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