**Geospatial Platform:**

**Technical Architecture and Standards**

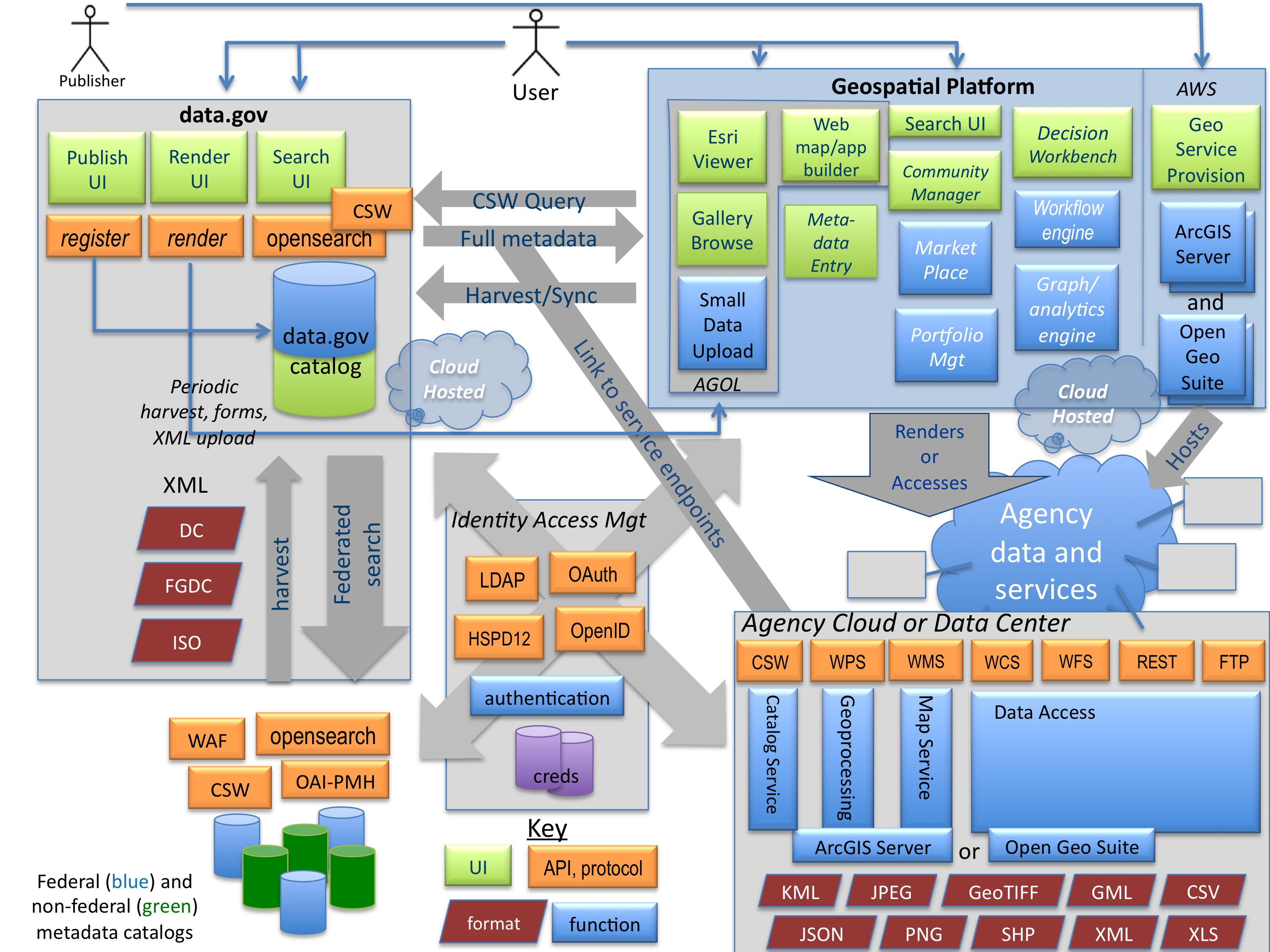
White Paper

Douglas Nebert

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Abstract: The Geospatial Platform initiative is an evolution of the coordination activities supporting the Geospatial One-Stop portal and the Geospatial Line of Business, with a focus on facilitating publication of geospatial data and maps as services, highlighting nationally-significant geospatial assets, and providing portfolio management for multiple-use geospatial investments. The Platform’s Web presence currently consists of a metadata catalog, co-managed with the data.gov effort, an interactive portal to allow users to browse resources organized by category, and an integrated viewer that supports mapping and query of data and map services in common views (Web maps). The Platform also incorporates a data publication feature where publishers can upload small data sets for mapping. A full geospatial service capability (GeoCloud) is also deployed in a commercial Cloud environment where FGDC can host agency public map and data servers for assets registered in the Platform. This paper describes the current and near-term technical architecture supporting the Geospatial Platform, and an overview of the standards relevant to its operation.



The figure, above, illustrates the current and near-term elements of the Geospatial Platform Architecture as of September 2012. In early 2013, ArcGIS Online for Organizations (AGOL) will be used to host Platform core functions and the GeoPlatform.gov site will integrate additional capabilities and use the next generation of the data.gov catalog as its sole metadata repository.

Capabilities manifest primarily as user interfaces are shown in green, application or service interfaces are shown in orange, general services and functions are shown in blue, and encoding formats are shown in brown. Items in italic text within the Platform are flagged as planned capabilities. Certain new capabilities of the Portal (Decision Workbench, Workflow engine) and support of authentication are planned for FY 2013 and beyond.

**Agency Cloud or Data Center**

The Platform relies on the service of data and maps from participating agencies and organizations. The Agency Cloud or Data Center shown in the diagram is one of many – one per organization – that host geospatial information and services to be accessed over the Internet. Although this capability may be physically located in facilities outside of the control of the Platform, reliance on standard services registered with the Platform is paramount. Data access may be provided through file download (REST , HTTP, or ftp) or through standard Web service interfaces. The most common standard geospatial data access interfaces are the Open Geospatial Consortium (OGC) Web Feature Service, for point/line/area data, and OGC Web Coverage Service for imagery and raster data, shown as WFS and WCS, respectively. The main service interface expected by the Platform is the OGC Web Map Service (WMS) that provides vendor-neutral rendering of raster maps from agency data, and allows the interactive query of features and their properties. A proprietary equivalent of this service, shown as REST, is supported for access to ArcGIS Server generated maps.

Two additional service types may be anticipated as agency data services. One is the OGC Catalog Service for the Web (CSW) that exposes agency metadata for search or harvest. These metadata describe the data and services being shared with the Platform. The other service offering from an agency may be a geoprocessing service, shown as OGC Web Processing Service (WPS). WPS allow for the construction of standard service query and response to suit a specific application. An example would be a service that estimates the number of people that fall within a query polygon. WPS may return structured information (i.e. total population) or even a new geographic feature for further use in GIS. These services may be documented as applications and registered with the Platform for discovery and re-use as shared services.

Agency Web services return standard data formats in response to a service request over the Web using these interfaces. Well-known data (encoding) formats are shown as brown parallelograms at the bottom of the Agency Cloud or Data Center sub-figure. These are a selection of the most popular formats; the list shown is not exhaustive.

The Platform activity has coordinated a Geospatial Cloud Sandbox Initiative (GeoCloud) for the past two years. The Sandbox is intended as an incubator for agencies to conduct the migration of agency-operated geospatial servers to the Cloud environment, monitor cost and performance, and perform system assessment and accreditation (A&A). Two standard Platform as a Service (PaaS) images have been coordinated by the GeoCloud community – one using the Esri ArcGIS Server on Windows 2008, the other using OpenGeo Enterprise Suite and GeoNode on CentOS (Linux). Shared PaaS image development accelerates deployment times for multiple agencies, and leads to the potential sharing of A&A documentation to speed agency security approvals. Both PaaS solutions include support for OGC WMS, WFS, and WCS to encourage interoperability with a variety of geo-services clients. GeoCloud instances operate in the same general Cloud environment (Amazon EC2) that is used for hosting the Platform, but interact using Web service standard APIs rather than custom Cloud APIs.

**Registration of items with the Platform**

Once data or map services are available for public use, their existence must be documented and published to the Platform. There are two complementary catalogs currently operating – a detailed metadata catalog of all federal and non-federal resources, a successor to the Geospatial One-Stop catalog, and a basic set of map service and “Web Map” descriptions managed within the Portal for ArcGIS environment. The catalogs support the OGC Catalog Service for the Web (CSW) and OpenSearch interfaces to enable searching via standard APIs for all types of geospatial resources.

A prospective publisher or user must register with a registration facility backed by a common LDAP directory for both the geo.data.gov and Platform environments. ***Publisher*** registration enables one to register map services and mashups with the Platform, or identify individual data sets and agency metadata catalogs for harvest by geo.data.gov. ***User*** registration enables individuals to save map sessions (Web maps) and share them with others in private groups that are established in the Platform.

**Basic Platform Capabilities**

The primary interaction of most users with the Platform is through the Geospatial Platform user interface exposed at [www.geoplatform.gov](http://www.geoplatform.gov) (shown below). This UI allows a user to browse through a **Gallery** of selected maps, create their own **Map** from registered resources, and browse by thematic **Groups** roughly affiliated with OMB A-16 data themes. Registered users can create their own maps and even upload small static data files (KML point files, CSV) bundled into Web maps under **My Content**.



Users perform basic text search against the two catalogs for Maps, Services, and Applications through the search widget in the upper right (**Find maps…).** Descriptions - known as metadata - for data, services, and applications, are discoverable through the browse and search interfaces, and certain resource types (i.e. map services and “Web maps”) are usable and actionable in the Platform viewer or in ArcGIS Desktop. Results of search are presented in a tabbed view, with one tab for Platform “nationally significant data” and the other tab for all other data sources, including state, local, tribal, and academic contributors.

Maps can be shared and re-published as links to the viewer, or as specialized Web applications for use with common Web browsers. A number of design templates are available for users to deploy their interactive map applications, showing or hiding various panels, buttons, applying styles and color schemes, depending on the scope and intent of the application. These apparently are created using HTML 5, CSS and javascript.

Using agency ArcGIS Server and client toolkit environments, mapping and analysis applications can also be created for iOS and Android mobile devices. Although not technically hosted within the Platform, URLs to these mobile applications can be registered with the Platform for discovery and download, and be published through the Apple iTunes and Android Play Store.

Behind the Platform user interface(s) are a number of APIs that are used for the mapping and external clients to communicate with the data services and the rendering services of the portal. The primary protocol being used for clients and servers to communicate is the Esri REST GeoServices API. This supports a breadth of service capabilities, including map, data, routing, geoprocessing, and analysis services. At present, the primary use of the REST API is to provide “Esri mapserver” access to the javascript client, shown as “Esri Viewer” in the first figure. Viewer support for map display, legend display, and feature query is available through the proprietary REST interface.

Map sessions are saved in a format used within the Platform environment for re-display by others. Each map composition references one of several raster base maps, and one or more map services drawn from Esri mapserver or WMS sources. Map compositions (web maps) can be created and published for others to use, specifying the desired map extent, base map data layers, and order of the layers to be presented. These create a session or context for interacting with the live map and data services specified by a user/publisher that can be used only by the Esri viewer client. The OGC Web Map Context and OWS Context specifications are not currently supported by the Platform environment but are anticipated in future Platform deployments.

Agencies can create additional base map services from tiled caches of raster maps generated at predetermined levels of zoom. The OGC Web Map Tiling Service (WMTS 1.0) is the standard supported for integration of such base map services. The integration of new base maps requires custom configuration of the Platform environment.

Other than HTML and javascript, the primary standard supported by the Platform viewer client is the OGC Web Map Service, various versions (1.0.0 – 1.3). The web client currently supports only the GetCapabilities and GetMap requests. There is no current ability for the client to query features or to display a legend graphic, although these are supported by the WMS standard. The client is able to search its own (Platform) catalog and ArcGIS Online catalog for map services to add to the current map, also using a catalog flavor of the REST interface.

The Platform search client supports query against OpenSearch and CSW-based catalogs. Geo.data.gov has deployed the Geoportal Server (Open Source) to host the main metadata inventory. External CSW clients can (soon?) access both the geo.data.gov catalog and the Platform catalog for search and action on relevant mappable resources. The geo.data.gov catalog supports indexing and display of both the FGDC Content Standard for Digital Geospatial Metadata (CSDGM, Version 2, 1998) and the ISO Metadata Standard IS-19115 and its XML representation per TS-19139. Enhancements planned for Q3 2012 include support for full ISO metadata capture and presentation and synchronization of the Platform and geo.data.gov catalogs into one virtual catalog. This latter functionality will also facilitate sync with other agency portal catalogs to eliminate the need to republish metadata.

**Future developments**

Identity, Credentials, and Access Management (ICAM) is only supported in a limited fashion in the current environment, supporting LDAP authentication of a username and password from a single provider. Agencies have introduced the need to provide additional levels of security on sensitive information and restrict search and access to selected resources in a networked environment. Potential standards to be evaluated in the Geospatial Platform include Open Authentication (OAuth), OpenID, and multifactor authentication services such as those used with government ID cards (HSPD-12). Research into integration of more advanced security in the Platform will take place during FY 2013.

A feature of the Geospatial One-Stop was the ability to manage metadata for planned geo-data collection activities. Although this was not migrated into the current Platform environment, support for posting and discovery of Planned items is anticipated in Q3 2012. Known as “Marketplace” this will allow federal and non-federal agencies to share planned geospatial investments, and facilitate cost-sharing, co-acquisition, or exchange. The Marketplace will use existing metadata standards and catalog query standards (CSW) to manage and interact with planned item descriptions.

Portfolio Management is an extension to the Market Place concept that will record and track investments in selected nationally-significant geospatial data. It will monitor use and service level agreements between agencies for the collection and update of data for multiple agency use and support reporting to OMB for data expense, potential savings, and cost avoidance. This should be integrated in early 2013. Input will be solicited from OMB on metrics and performance measures to be incorporated in the Platform software environment.

Geo-analytics will enable rapid query into data sets and visualization of geospatial data properties in the form of graphs and interactive graphical displays. This will extend the practice of business intelligence and analytics to geographic data, integrating graphical display on the maps themselves, and allowing for the saving and republishing of such analysis. Support for this item is planned for mid-2013. Standards to be used in this work item are likely to include the data access standards WFS, WCS, Simple Features SQL, and the encoding standards of JSON and XML.

An analytical workbench environment is planned for the Platform to let users easily create workflows or geoprocessing functions on published data services and re-publish them as services. This will either include a scripting environment of a visual graph-builder programming environment to chain service inputs and outputs together as executable workflows. Standards envisioned to support these capabilities include the OGC WPS and Business Process Execution Language (BPEL) and related workflow management specifications.

**Standards referenced**

Business Process Execution Language (BPEL)

Cascading Style Sheets (CSS)

FGDC Content Standard for Digital Geospatial Metadata (CSDGM)

Homeland Security Presidential Directive, Number 12 (HSPD-12)

ISO – Geographic Metadata standard, IS-19115:2003, TS-19139:2007

Lightweight Directory Access Protocol (LDAP)

OGC KML, version 2.1

OGC Web Map Service, 1.3, also ISO 19128

OGC Web Coverage Service, 1.0

OGC Web Feature Service 2.0, also ISO 19142

OGC Web Processing Service, 1.0

OGC Catalog Service for the Web, 2.0.2

OGC Simple Features SQL

Open Archives Initiative, Protocol for Metadata Handling (OAI-PMH)

Open Authentication (OAuth)

Open Identity (OpenID)

OpenSearch

JavaScript Object Notation (JSON)

eXtensible Markup Language (XML)

HyperText Markup Language (HTML)