SDI – National to Global: perspectives from the UK academic sector

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1. The UK national academic Spatial Data Infrastructure (SDI)

Geodata Services, EDINA, based at the University of Edinburgh, develops and delivers a portfolio of world-class online services and expertise that benefit research and education in the United Kingdom (UK) and beyond and that form a comprehensive spatial data infrastructure (SDI) on behalf of the academic community.

As part of service delivery, Geodata Services have promoted and utilised the use of open source software (OSS), international open geospatial standards, and open geographic data as integral components in the development and promotion of the academic SDI typified by: the development and delivery of innovative online services (subscription/open); the provision of online resources; and extensive user support (helpdesk, training). Increasingly, work in the mobile application development domain is providing newer, innovative (often open) delivery platforms incorporating responsive design principles. This work extends into the citizen science domain too. The importance of digital infrastructures is highlighted by Smyth (2016).

Geodata expertise has also extended into other sectors with integral components of the UK national and regional government SDIs supported by EDINA, e.g. the UK Location Infrastructure metadata editor has been developed by EDINA as part of www.data.gov.uk (Locationmde.data.gov.uk, 2015).

From a UK policy perspective, the work of Geodata services at EDINA forms a significant part of the contribution that Jisc (a national education ICT charity), makes as a champion for the use of digital technologies in the UK education, research and skills sectors; acting as a Jisc-designated centre for digital expertise and online service delivery, EDINA is charged to fulfil the Jisc Strategic Objectives in their national Geospatial Solutions area (Jisc, 2015).

Given the nature and scale of service operations (active user bases > 250k+), there are many opportunities for components and tools of the EDINA infrastructure to inform, or have applications in other countries or sectors to empower, improve outcomes/benefits and increase impacts in a cost-effective way.

In 2014, EDINA was awarded the 'RSGS Bartholomew Globe award' for excellence in the assembly, delivery or application of geographical information through cartography, GIS and related techniques (RSGS, 2015).

2. The importance of effective SDI services at national level

The principal Geodata services (Edina.ac.uk, 2015a) that form the basis of the UK academic SDI are:

- **Digimap** – online web mapping and data download service (with comprehensive mapping/data and learning resources) (Wikipedia, 2015).

- **Digimap for Colleges** - online web mapping service (Digimapforcolleges.edina.ac.uk, 2015).
- **Digimap for Schools** - online web mapping service (& learning resources) (Digimapforschools.edina.ac.uk, 2015).
- **Digimap Mapstream** – a WMS offering licensed Ordnance Survey (OS) data (Mapstream.edina.ac.uk, 2015).
- **Digimap Openstream** - a WMS offering Open OS data (Openstream.edina.ac.uk, 2015).
- **GoGeo** – comprehensive open geospatial resource 'discovery' service utilizing GeoNetwork (includes information, learning resources, events and services) (Gogeo.ac.uk, 2015a; Mathys, 2015; Geonetwork-opensource.org, 2015); includes a metadata editor tool, **GeoDoc** (Gogeo.ac.uk, 2015b). The service promotes the use of ISO standards for the discovery, sharing (**ShareGeoOpen** repository for open data access to freely contributed datasets), re-use and creation of standards compliant metadata (Sharegeo.ac.uk, 2015). Also, ***GoGeo App*** for iphone.
- **UNLOCK** – open middleware (gazetteer and geo-referencing) service to extract and locate place-names in text documents and metadata; also, search tool for place-names, locations and shapes across geographic information sources. **UNLOCK Places** (GitHub, 2014) is an open service using open data sources (Edina.ac.uk, 2015b) and **UNLOCK Text** is a RESTful API utilising parsers (Ltg.ed.ac.uk, 2015; GitHub, 2015a). UNLOCK powers data discovery in GoGeo.
- **Fieldtrip GB App** – Android/iPhone mobile app for data capture including schema compilation using open datasets.
- **Fieldtrip Open –** Android mobile app software development code kit (SDK) available on GitHub for global use (GitHub, 2015b).

2.1. Technical implementation of open source software

Whilst there are varied technical implementations, in terms of our main web mapping service – Digimap, the systems architecture is predominantly predicated on OSS use (Opengeospatial.org, 2015a; Opengeospatial.org, 2015b), with Shibboleth authentication (Shibboleth.net, 2015); Geodata services runs its own Shibboleth IdP to allow in-house access and to create teaching accounts to showcase our services externally. Open services are accessible to all, not requiring registration or subscription.

Specifically, Digimap is a multi-tiered application stack providing access to comprehensive geospatial information and maps with 'mapping' and 'download' client functionality. The main mapping stacks are: Topographic, Geology, Hydrospatial, Historic and Environmental.

The architecture is split over multiple (task specific) machines across two geographical locations, with concurrent LIVE-LIVE capability to load balance across sites as well as allowing engineers to deal with site specific problems and/or to upgrade applications seamlessly without user impact/downtimes. Overall, a DEV/BETA/LIVE setup environment exists to allow full unobstructed lifecycle development, testing and release.

A conceptual architecture for Digimap is shown in Figure 1.

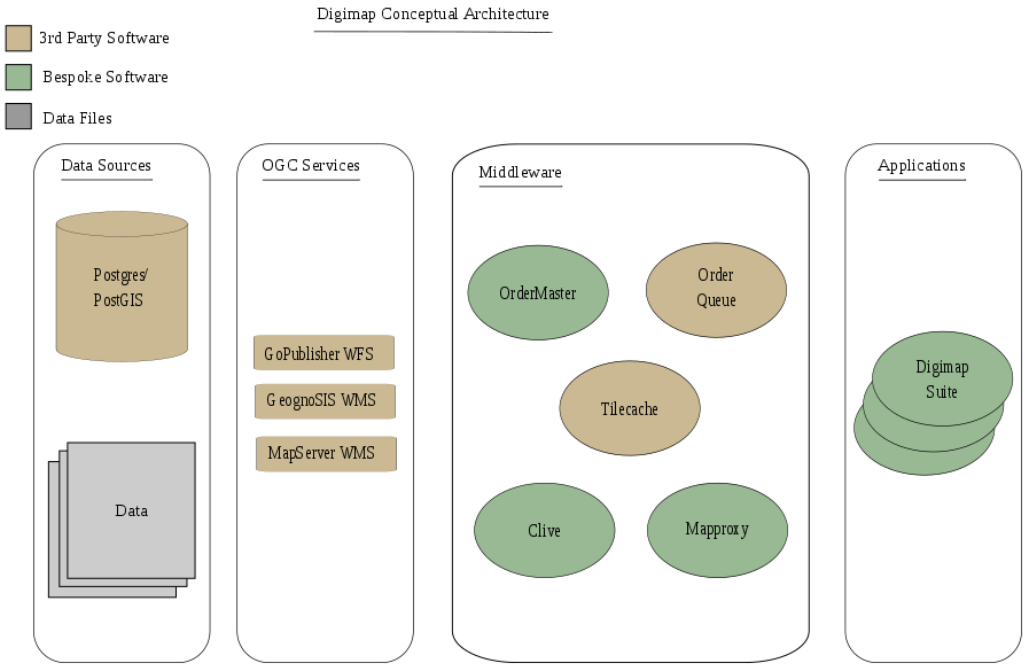

Figure 1. Digimap Conceptual Architecture

A number of open source tools, standards protocols, frameworks and script libraries are currently implemented to provide comprehensive GIS functionality: Java; Apache Tomcat & Webserver (Tomcat.apache.org, 2015; Activemq.apache.org, 2015; Group, 2015); Tilecache (Tilecache.org, 2015); OpenLayers (Openlayers.org, 2015); Mapserver (Mapserver.org, 2015); PostgreSQL (Postgresql.org, 2015); PostGIS (Developers, 2015).; Spring; and ExtJS, with a requirement for some proprietary software components, e.g. Cadcorp GeognoSIS (Cadcorp.com, 2015)., Snowflake GoPublisher software (Snowflakesoftware.com, 2015), and formerly, Oracle.

All our bespoke applications are written in Java SE8 (Docs.oracle.com, 2015) and run on Tomcat application servers, some of which are fronted by Apache webservers (depending on whether access to shared geographic information is required, or not).

2.2. Geospatial standards

Where applicable, Geodata Services utilise OGC standards (Opengeospatial.org, 2015c), namely: WMS; WFS; and WCS, as well as a range of international metadata standards and profiles such as: ISO 19115 (Iso.org, 2015).; Federal Geographic Data Committee (Fgdc.gov, 2015); Dublin Core Metadata Initiative (Dublincore.org, 2015); UK AGMAP 2.1 (XML/PDF) (Gogeo.ac.uk, 2015c).; UK GEMINI 2.2 (BSI 1ST/36, CEN/TC287, 1SO/TC211) (User, 2015); EU DIRECTIVE 2007/2/EC - INSPIRE – Infrastructure for Spatial Information in Europe (Inspire.ec.europa.eu, 2015). Workshops on metadata standards are an important part of educating those in the sector.

In terms of Digimap, Mapserver and GeognoSIS are OGC WMS applications that handle map generation. PostGres databases (formerly Oracle) hold all data that the WMS servers interact with to generate maps. Oracle was used to hold OS Mastermap data – however GoPublisher software now supports PostGres affording a more open software infrastructure.

2.3. Geographic information and open data

A diverse range of geographic information and data is utilised and managed within Geodata services, furthermore, datasets are deposited in ShareGeo Open, accessible to anyone.

In addition to third-party national coverage licensed datasets from public and commercial data suppliers (via Jisc), there are many open and accessible datasets in utilization, ranging from organisations such as OS (Ordnancesurvey.co.uk, 2015a) and BGS (bgs.ac.uk, 2015a) (at times integrated into subscription services) to more diverse international open datasets.

With trends in open data, it is expected that more and more open data will form part of our offering. Importantly, the evaluation and prioritization of new digital data content is an on-going process influenced by community need (for subsequent delivery).

Key 'licenced' datasets are: OS, BGS, Historic (Landmark.co.uk, 2015), Marine - Hydrospatial (Seazone.com, 2015), Land-use (Ceh.ac.uk, 2015). Key 'open' datasets are: OS (Ordnancesurvey.co.uk, 2015b), BGS (bgs.ac.uk, 2015b), Open Street Map (Openstreetmap.org, 2015), contributed open data (in ShareGeo). In UNLOCK, a range OS open data is used, plus Natural Earth, DEEP (Digital Exposure of English Place-names) and GeoNames (Edina.ac.uk, 2015b).

3. Why a SDI and services matter to UK academia

3.1. Motivators

The central premise for establishing and maintaining a single national academic SDI supported by services has been to consolidate skills, expertise, technical, data and support infrastructures to benefit the UK academia; note that open services exist too.

3.2. Benefits

The primary benefit of an established SDI is that of provision and (authenticated) access to standards based services, data and knowledge or support. EDINA has considerable expertise in the development and management of national online geospatial content services that eliminate duplication at the institutional level promoting economies of scale in areas such as data acquisition, licensing (where relevant), management, and access (lower overall costs). facilitate enhanced teaching and learning.

3.3. Barriers

As a national SDI acting on behalf of Jisc, there are some barriers – relating to: (a) access (b) licensing and/or (c) funding. These can be at service and/or data content levels.

(a) access to services is either by subscription or entirely 'open'. In the former, data by default is accessed via active institutional service subscriptions.

(b) licensing of content can be a barrier from a cost and/or service feasibility perspective.

(c) the ability to provide relevant services and content is often funding constrained.

3.4. Challenges

In an era of rapid sectoral and technology change, there are challenges: increased user expectations; reduced funding; and increasing demands on resources to continuously improve (multi-platform) services, are significant. Also, 'open' data necessitates business model re-evaluation to ensure future service sustainability.

3.5. Future developments

In terms of strategic vision, Geodata services seek to expand their expertise and provision of geospatial content services to support the sector as well as establish new collaborative partnerships to develop innovative projects and services in the UK and internationally; including a greater focus on mobile applications development. With maturity, OSS has the potential to remove the need for proprietary software.

4. Conclusion

The development of a national academic SDI has served to benefit users for over 15 years. The impact of EDINA's work is far-reaching and has been built on an enviable reputation for innovation and the adoption of largely open geospatial technologies and standards. Whilst primarily focussed on the academic sector, EDINA supports external partners, such as UK government. Many activities are exemplar models for wider applications elsewhere.

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