

## Questionnaire on interoperability patterns in the geospatial domain

Where R1,R2,R3,R4,R5,R6,R7,R8 are respondents

### Questionnaire

1. Which of the following best describes your primary role during software development/ geospatial domain? (e.g. proprietary software developer; open source developer, teacher; student; Geospatial expert, researcher)

- R1: Open Source Solution Architect
- R2: GIS expert and Support Analyst at GIS Software development organization
- R3: Proprietary GIS Solution Architect
- R4: chief IT officer/ Proprietary GIS Solution developer
- R5: open GIS Solution developer
- R6: Software developer
- R7: Proprietary GIS Solution developer
- R8: Proprietary GIS software Developer and presales specialist

3. Describe the application domain of your system (e.g Land registration, Mapping, etc )

- R1: open GIS solutions for land registration and mapping implemented in over 5 countries
- R2: international supplier of GIS software for environmental mapping and all other domains, with over 80 distributors and 20 regional offices.
- R3: data infrastructure, development of geoportals, spatial planning and land information system in over 40 countries currently-40 projects
- R4: enterprise GIS solutions integrated with enterprise resource planning systems (ERP) capabilities, 3D GIS for utility mapping, and physical planning applications in over (projects in over 20 countries)
- R5: GIS consulting services in agriculture, location-based services, and environmental modeling (2 countries)
- R6: in-house GIS integration effort in a public authority (1 Country)
- R7: GIS solutions for publishing, integrating, and enable access between enterprises data over the cloud **for** Geomatics, land registration, Mining, property ownership government institutions etc
- R8: integration of GIS resources for utility, asset management, transport and logistics markets applications with enterprise resources...../SCADA (2 countries)

4. Describe your system solution! (e.g. DB software; desktop GIS software; mobile GIS software; distributed system (such as web-based application); Cloud GIS)

- R1: A 3-tier application with database, services layer and desktop front end. Refer to Software Architecture Document for technical details (see attached)/ webserver and mobile GIS client – (enterprise applications)
- R2: geodatabase management and web GIS applications such as Software As A Service (SAAS) mapping platform (cloud), GIS server applications, focused GIS apps, GIS data, Mobile and desktop GIS software
- R3:3 tier** Server architecture, web, mobile, desktop GIS applications (Enterprise solutions)
- R4: 2 tier and 3 tier GIS server applications, Desktop apps and mobile apps (Enterprise solutions)
- R5: Desktop GIS software, mobile GIS, Web GIS depending on client (enterprise applications)
- R6: 3 tier server/ two tier server, desktop, web GIS application and mobile applications
- R7: Web/Cloud GIS provide software as a service and platform as a service. (Distributed systems), mobile, and desktop apps that can connect to cloud depending on client requirements
- R8:**3 tier** Server technology with web and mobile and desktop applications,

5. Does your system interoperate with other systems (internal and external systems)?

- R1: Yes
- R2: yes
- R3: yes
- R4: yes
- R5: yes
- R6: yes
- R7: **Yes—access of data from other databases-**
- R8 yes

**Commented [1]:** Defn: , Interoperability patterns utilize insights from software engineering and knowledge representation research to ensure reusable solutions to recurring interoperability problems (Smith & Meyers, 2006)

Research questions

- What interoperability patterns exist in the IT domain?
- Which of these interoperability patterns are used in the GIS domain?
- What other emerging Interoperability patterns in other domains are applicable to the GI Ecosystem?

**Commented [2]:** RQ1. Which of the widely used interoperability patterns are adopted in the GIS domain? RQ2. What new emerging interoperability best practices exist in the GIS Ecosystem?

If yes, with what systems does your solution interoperate? What are the primary functions of the other systems compared to your solution? List any three interoperability scenarios

	Interoperation system	Functions and scenarios
R1	OGC Webservices <b>Via services</b>  Notification email  Other multi- tier applications	SOLA can integrate with any Web Map Server (WMS) compliant mapping server such as GeoServer or MapServer.  SOLA uses the JavaMail API to integrate with any SMTP mail service for sending notification emails. The SOLA services layer implements a web services based architecture that is consistent with the principles of Service Oriented Architecture (SOA). Integrations with other multi-tier applications can be achieved via custom developed service to service or service to database integrations. Preferred integration patterns are Gateway ( <a href="https://msdn.microsoft.com/en-us/library/ff647277.aspx">https://msdn.microsoft.com/en-us/library/ff647277.aspx</a> ) for simple integrations and/or a middleware solution for medium to complex integration scenarios
R2	External software <b>Via (services, direct data access and integration)</b>	The software suites interoperate with a number of other software on the market, for example, ---AutoCAD, image processing software (such as ENVI, Erdas Imagine), Postgis database , Web services and maps e.g google , openstreet basemaps etc,
R3	Independent internal and external systems in various organisations <b>Via (services for interoperability)</b>	--making sure that system interoperate with other systems i.e CCO IS, SLAAC so that multiple tenure titles are not created on a single piece of land, --SDI/LIS development---extend geographic database using information from other public organizations __so as to be able to develop numerous business applications --Planning --access services from other complementary organizations
R4	LAPs/LIS/ institutional data <b>Via direct data access/integration and consuming services</b>	does interoperate at <b>data model</b> , service level with banking systems, Land information systems e.g. LIS in planning applications, -- <b>consuming services</b> from other organizations e.g. through wcf (Windows Communication Foundation), WFS wms
R5	Integrate with existing APIs, and processing services	integration with already existing APIs and services with e.g. integration with mapping apis, like open street maps, web based cartodb,---store spatial information mapbox --- various layers for presentation. This is necessary to store data for experts to be able to query multiple repository datasets e.g. which stores are located at X as well as query spatial relationship  Access processing functionality/ <b>services</b> from process providers---- integration is one way
R6	Right of way management system, Road management system, Finance system, Road maintenance system, <b>Via</b>	The Right of way management system requires data from contract management system, Road management system, Road maintenance system, and Finance system... all the systems are interrelated and consume data from either system,

	(services, direct data access)	
R7	Government organisations and any other participating entities Via (services, direct data access and integration)	Get External data from other organizations --- take copies from them to their cloud applications. All data hosted by us and some hosted by both due to security reasons—where it is impossible for client to duplicate sensitive data
R8	Finance/billing systems, workforce and task management, other GIS applications depending client via services, direct data access and integration	Provide information to finance billing system, workforce management system needs to be aware of where leakages and maintenance for utility system has been done etc

If no, are there any desirable interoperability scenarios,?

Are there any solutions?

#### 6. What would you like to achieve through interoperability?

Respondents	Reason for interoperation
R1,R2,R3,R4,R5,R6,R7,R8	Interoperability is necessary to allow the functionality of GIS software to be extended to support user requirements that are complementary to application domain. For example, integration with a financial system may be necessary to support fees and transaction payments. If the organization implementing GIS software has an existing document management system (DMS), it may be necessary to integrate with that system in preference to using the default document storage service provided by GIS software.
R1,R2,R3,R4,R5,R6,R7,R8	To integrate or consume services/ of another system
R8	Efficiency; and Access information residing in another system or share information to another system. No processing of data is done (due to ownership issues i.e who owns the product?)

#### 7. How is your solution expected to interoperate with these other systems (both existing and desirable scenarios)?

R1,R3,R8: Service to service/API integration is the preferred integration mechanism or service to database integration where the target system does not provide suitable services or interoperability API. – 1 or 2 way integration desired depending on requirements

R2: The main issue with respect to interoperability of the software relative to other software packages on the market is related to data interoperability. Can data created in AutoCAD be imported into software, and vice versa?

**R3:** Access services and functionality of external systems like banks, taxation, National Identification system, conservation areas database (e.g forestry) and other land related systems etc –Two way interoperation desired

**R4:** consume services of an external system e.g LAPs information – one way integration

**R5:** access functionality of other systems through open API –desirable access processing services to reduce complexity if further data processing – one way integration

**R6:** Access multiple roads and enterprise related data bases with in a single client (ROMDAS, CMS and ROWMIS) – two way integration needed, Direct data integration through an API

**R7:** access to external databases access and internal databases in the cloud application---not really much of a desired situation as they depend on requirements rather than strategic thinking (ideal solution only when there are few or no policy issues)

**R8:** a one-way or two-way direction in such a manner that only access to required geoinformation is granted while manipulation and management are left to the parent interoperating systems. Integration is through web services composition

## 8. Do you have any interoperability API?

- **R1:** Yes. All SOLA Services support the SOAP web services protocols. The SOLA services can also be extended to support Representational State Transfer (REST) if required.
- **R2:** Yes- driven by business assets i.e in this case its data
- **R3:** No-- but desire to have one
- **R4:** No..but desire to have one
- **R5:** No- have no API created by themselves but rather utilize API from other specialized GIS firms e.g CartoDB API, Google maps API, openlayers API,. These API are driven by domain use cases -- this could be an emerging best practices depending on context--implications on the solution is created
- **R6: NO** but desire to have one
- **R7:** No but desire to have one
- **R8:** Yes (driven by business assets)

9. Have you used and/or written any of the following interoperability best practices?

The responses are coded as very useful (+), not sure/not applicable 0 and not useful (-)

Geoknowledge	-	+	-	+	-	-	-	-	
Data model patterns	+	+	+	+	-	+	+	-	
Ontology design patterns- (Content patterns, Lexical syntactic, engineering/correspondence patterns etc)	-	-	-	-	-	-	-	-	
<b>Do you know of any other patterns?</b>									
Data model transformation	0	0	0	+	-	0	-	-	
Aggregated view	-	+	-	+	-	0	+	-	
n-tier(2-3 tier)	+	+	+	+	+	+	+	+	

Have you heard about ontologies and semantics?

Yes- R1, R2, R3, R4, R5, R6, R7, R8

If yes—have you used any semantic technology?

Yes-R3, R2, R7

No – R4, R1, R5, R6, R7, R8

10. From the same list of patterns, we would like to know your views and experiences of up to three patterns that you have found MOST useful. ...Please identify the FIRST (SECOND; THIRD) pattern that you have found to be most useful.

- SOA
- Query/Response
- N-tier server architecture
- Workflow pattern

11. What other best practices (for the knowledge domains below) that have not been captured above.

- Data
- Services
- Tools
- Processes
- Any other

- R4: Documentation of patterns and other best practices to enable users to be able to find them and use them
- R2: Identification of more patterns and examples of how patterns can be used for building interoperability solution. This will go a long way to ease reuse
- R4: Agile processes which incorporate all stakeholders and tooling have to be adopted
- R5: Modular development of GIS integration and retrieval to hide detail from domain experts
- R1,R2, R3 R4,R5,R6,R7,R8: Use accepted standards like ISO tc211/OGC standards (All of them use them to ensure interoperability)
- R7: identifying best practices for eliminating Policy barriers
- R5 need to ensure data validity and integrity of data /
- R1,R2, R3 R4,R5,R6,R7,R8: There must be mechanisms to guarantee security, availability of data

**Problem** with interoperation is it is hard to convince clients to have their systems interoperate due to issues like asset responsibility (ownership issues), trust. It is psychological as many prefer to keep a fence around their work.

R2, R3, R4, R6, R7, R8: must have a comparable data model constructs to interoperate