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SDI Interoperability - It's just a word

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The word 'Interoperability' conjures up different things to different people, therefore it is not surprising it has caused concern and confusion in the geospatial market place and with IT professionals. The geospatial market is a collection of professionals, paraprofessionals and end users that have their roots in diverse disciplines including geography, cartography, surveying, remote sensing, etc. This market segment is getting on with the familiar job of delivering mapping services to its traditional end users and at the same time some are slowly branching out to make geospatial data and services available to the broader community via the Internet as part of the global trend to support Spatial Data Infrastructure (SDI) requirements. This means they have to consider the use of their services from a different perspective which is typically outside their current terms of reference but which they believe has implicit value to the broader community. To successfully achieve this transition they need to understand and embrace the concept of interoperability or the transparent connectivity of an infinite array of different systems and applications to their services. This article expands on the concept of interoperability and provides an analogy to SDI interoperability that we can all relate to.

Background

Over the past 5 or more years we have seen and heard a lot about Spatial Data Infrastructures, Spatial Data Catalogues, Homogeneous Data Models, Open Interface Standards, etc. All these initiatives are focusing on the same end goal, that of an altruistic future whereby the millions of gigabytes of geospatial data collected by governments for its citizens around the world can be discovered, understood, and processed by many independent systems and applications. This clearly yields incremental benefits to our communities over and above those that justified the collection and maintenance of these data sets in the first place.

However, the organizations responsible for the collection of these data sets (data custodians) are not typically charged with this additional 'external' responsibility. Their responsibility, in most cases, includes the undertaking of the data collection and maintenance of their data assets for their own internal use. In addition, the concept of service connectivity for all spatial users of an internal organization is an easier issue to address when you have absolute control over the end user's tools and application interfaces. However, to publish data services on the Internet in a way that many different systems and applications can use those services means that they have to put in place technology and resources that may depart from their own internal geospatial technologies and capability. Many, realizing the difficulty to support broader communities, will naturally want to take the least path of resistance and prefer to implement a 'publish-and forget'

model which simply implies, here's what you can have and you can use it for whatever but don't ask us to provide specific connectivity to your unique systems.

To branch out and provide an interoperable service is a task that may or may not be funded by the organization or supported by a national SDI program. Few countries including the United-States and Canada have recognized SDI requirements and have set aside government funding to facilitate the establishment of a truly distributed SDI.

So how can interoperability help in this scenario?

Interoperability

When you try to figure out what this word really means it makes little sense to consult a dictionary because it is all in the context and not in the literal definition. To complicate things a bit more, the context is hidden behind layers of technologies and is not accessible by most people except to the domain experts. An analogy of interoperability in the context of SDI requirements is far more descriptive. Closer to our daily activities, the road infrastructure can serve as a good analogy considering that this infrastructure is a collaborative effort of many different jurisdictions maintaining different parts of it at different levels such as local, state and even federal governments. While in constant evolution, the road infrastructure is mature and if we just put aside its vagaries like road accidents, traffic jams, etc it is fair to conclude that the road infrastructure is embedded in our cultural and socio-economic framework and that we have come to depend on it more than we give it credit.

The road infrastructure is very similar to the SDI but subtly different. When we think of a road infrastructure we mainly focus on the road network which our governments build and maintain; whereas when we think of an SDI we think of it more in terms of the data and services and how to find and use them paying very little attention to the Internet which is the equivalent to the road network but is something that is commercially built and maintained. But users of the roads and the many communities serviced by the road network are also considered to be part of the road infrastructure or a thematic component of the road infrastructure such as an Ambulance Services Infrastructure or a Local Tourism Infrastructure. All these will depend on a foundational road network.

What we observe in a road network is that the roads all link up and you can travel from one community to another community via any number of alternate routes. You can also travel in virtually any commercially available vehicle that is approved for travel in a particular country or across jurisdictions. The road network is just there for our use and of course there are rules as to how we can use that network such as how fast we can travel, which side of the road to drive on, safety rules, etc. The road network and its rules could care less where we are travelling to and from, what type of vehicle we are travelling in, the type of people we are or even how we were collected together to make the journey in the first place. The road network joins communities and in effect provides us with a road infrastructure that supports interoperability between communities of people within a framework of road networks and rules.

Standards

Standards for supporting such an infrastructure do not happen by accident. There are many bodies involved in many jurisdictional aspects covering the entire road infrastructure. There are many standards established by federal bodies that the various jurisdictions are required to adhere to such that the road infrastructure appears seamless and homogeneous. There are also engineering standards that are required to ensure that the quality and safety of the road infrastructure is consistent. Vehicles and rules for using the infrastructure are standardized across all jurisdictions so that the behavior and usage is seamless within a country. The road infrastructure is also policed by each state jurisdiction using these standardized rules. It is clear that standards play a fundamental role in the building, maintenance and operations of the road infrastructure that we all use every day.

In an SDI environment, the mechanisms are very similar in that the Internet has its standards and protocols for the transmission of data and transactions via any digital route to get to the end destination. However, it gets a little more complicated in that at the ends of these destinations the systems that receive these packets of information must be able to accept them and interpret them. In the road infrastructure analogy, this may relate to common communication languages used between the people travelling and the people at the destinations. Without a communication language the experience is limited if not impossible. Infrastructures heavily depend on standards for communications, transmission protocols and rules that all participants of the infrastructure can unambiguously interpret. So as in the case of the road infrastructure, interoperability standards are also extremely important for an SDI.

Just imagine what would happen in a road infrastructure if it were mandated that, due to the inability to define a standard that every user could easily comply with, the road authorities decided to limit the use of the infrastructure to only one or two brands of vehicles? Imagine also what would happen if they insisted that only English speaking people could travel on the road infrastructure? These limitations are clearly unacceptable but when a custodian publishes their data in an SDI in a proprietary way they are in effect doing just that. The SDI is fundamentally implemented using open (accessible) and interoperable standards. Forcing the use of proprietary solutions on the road infrastructure would render the infrastructure crippled and ineffective and the same applies to an SDI.

As in a road infrastructure, a Spatial Data Infrastructure is being built by many different organizations responsible for many different jurisdictions that may geographically overlap with each other's responsibility for different aspects or themes. This is a collaborative model that will enable the SDI to evolve in a modular and scalable way just like a road infrastructure has evolved. Data will be published at its 'point-of-truth' by the owners or custodians of these data services. But to achieve this, participants must all indirectly or directly collaborate by agreeing to and adopting a set of standards geared towards broader interoperability.

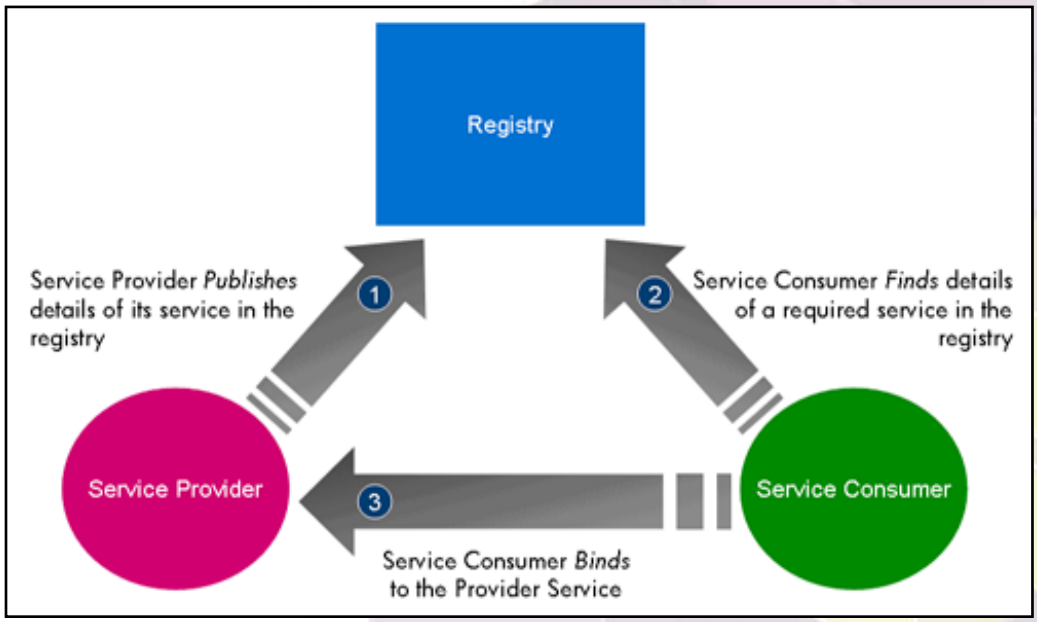
So the prickly question of which interoperable standards to adopt inevitably arises. At the national level these standards may be determined by some federal authority such as USGS in the United-States, GeoConnections in Canada, or ANZLIC in Australia. However, at a more global level, many of these standards have already been developed by organizations such as ISO/TC211 and the Open Geospatial Consortium (OGC). Following up on these activities, the approach selected by the United-Stated, Canada, and many European countries was to contribute and adopt open and interoperable standards already voted by international organizations. These countries are promoting collaborative implementations of SDIs using imple-

mentation standards adopted at the international level. These standards specify methods, tools and services for analyzing, accessing, presenting and transferring such data between different users, systems and locations. In addition, many SDI development programs are funded by federal/national governments thus treating them in a similar way to the development of any other infrastructure asset.

Frameworks

However, whilst standards support interoperable infrastructures it is important to separate the establishing of the infrastructure standards from its usage. A physical infrastructure gets built (e.g. the road network or the Internet) and then operating rules are laid down on how systems, organizations and people can use this infrastructure in the form of an operating model or framework. These frameworks can be generic or they can be thematically defined. In a road infrastructure the road network is built and many other organizations are involved with defining the operational framework such as road protocols, rules, etc. Similarly, an SDI requires a usage framework and many organizations are contributing to defining the roles and responsibilities of each participant to the infrastructure. Whilst the road infrastructure is mature and many organizations are already in place to manage its operation for a wide range of themes such as emergency services or tourism, this is not clearly apparent for the emerging SDIs – who architects this operational framework and who oversees its construction and operation?

Many countries participate in the building of the SDI standards within the mandate of standard organizations such as the International Organization for Standardization (ISO), the Open Geospatial Consortium (OGC), the World Wide Web, OASIS, etc. Many countries have already adopted standards from these organizations in particular the OGC® Service Framework (OSF) model designed by consensus between members of the Open Geospatial Consortium (OGC®). This model outlines the three fundamental usage roles of any SDI and how they should interoperate via a set of open Internet standards. Figure 1 below outlines the OSF model which is described as a Publish-Find-Bind operational architecture. Meaning that there are three fundamental classes of participants who's roles are conceptually independent but clearly defined.



OGC Service Framework

Broker - a role which registers published services from Providers and provides a discovery service to Requestors.
Provider - a role which allows Providers of services to publish their services to a Broker and fulfills any service requests from the Requestor.
Requestor - a role which searches for published services according to some Requestor specified criteria from a Broker and binds all discovered services provided by the providers.

This model expands from the standard Web model and assumes that there is already in place a communications network such as the Internet and that all three role players can connect and use it within its operating standards. An SDI is really only one operational theme that makes use of the Internet as its foundation. This is an information framework and in the case of a road infrastructure there is are civil engineering frameworks that are very different. In a road infrastructure you have vehicles that travel to and from destinations within operational limitations and rules. The point is that the interface to these infrastructures is via operational frameworks that can vary for any number of themes. In the case of an SDI this framework has already been determined at an international level.

Conclusion

It is clear that a Spatial Data Infrastructure can only achieve the benefits of other infrastructures such as road, telecommunication, power, water, etc. by collaborating on standards and deploying SDI capacity that can operate in a distributed manner supported at its foundation by open, interoperable standards and constructed using tools and materials based on those standards. The road infrastructure proves that we can collaborate and build significant assets from which all our communities can use and benefit. In fact the road infrastructure as we know it today is so transparent that we simply take it for granted – its always there and it works – even though there are a plethora of rules and standards that we have been conditioned to and comply with every time we use it.

Interoperability is just a word that has profound impact in the meaning and purpose of any infrastructure. Interoperability is by definition one of the critical success factors of an infrastructure and can be expressed in standards that impact the development, operations and sustainability of that infrastructure. Interoperability will transform the infrastructure as a community asset that can function with minimal apparent constraints on the consumers of its services. In effect interoperability is fundamental to the establishment of truly transparent and effective infrastructures that benefit our communities. So like for any other infrastructure, once governments and private sector recognize the SDI as an emerging national asset and funding becomes available for its development, there should be no reasons why an interoperable SDI could not evolve in most countries as is happening right now in few countries across the world.

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