Challenges of Implementing Defence Spatial Data Infrastructures

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30/03/07

The Brave New World on the Horizon

Service Oriented Architectures (SOA), and their geospatial derivatives, commonly called Spatial Data Infrastructures (SDI) are gaining visibility as key future technologies in a range of commercial, civil and defense environments and in a number of cases are becoming reality.

All areas of commerce and government, encouraged by the rapid evolution of the Internet, as a communications framework, and easily available clients e.g. Google Earth and Microsoft Virtual Earth, are identifying the benefits of being able to readily access geospatial information no matter where and on what GIS infrastructure it is served. In fact, the whole concept of a GIS 'system' is being broken down with SOA, heralding integration of all types of information in GI Systems, business systems, scheduling and planning systems, etc. allowing people to concentrate on the business need.

Technology has also moved on from being a '*bright idea*' to something which is now clearly defined and specified (note the range of ISO19100 Standards of which there are many dealing with coordinate systems, feature catalogues and dictionaries, geospatial models, temporal models etc) and, more importantly, being deployed. The ESA portal delivering vast amounts of Imagery and Terrain data is one example. However, SDI is not only about the service infrastructure but also about open and formal data models as highlighted by Ordnance Survey adoption of the open standard Geography Mark Up Language (GML), an XML encoding supported by ISO Standards, for their MasterMap data.

In addition we are moving into a new phase, where programs such as the European Community 'INSPIRE' program, with the aim of achieving accessibility of geospatial information currently held in dusty corners of government bodies on a wide scale across Europe, is seen as a key catalyst. In less than 2 years government bodies throughout Europe will need to publish their data holdings in a compliant form as Metadata and within 5 years will have to support access to this geospatial information as open services or downloads, and either supplied free or accessible via an e-business model.

How Does Defense Fit in?

Defense (which in my view includes Homeland Security) has a more immediate need for geospatial information system integration than most domains. Defense has moved away from deployment of massive power to a precision approach exploiting information to carefully target resources both defensively and offensively when necessary. In particular, Theatres of Operation are globally dispersed, large and varied (covering everything from remote deployments to supporting local initiatives in relation to a terrorist attack in the Homeland). Defense is also vulnerable from the evolving SDI technologies as well as the desire to exploit their benefits. SDI is hard to completely restrict and for example imagery of sensitive sites has been published on some of the new commercial geo-services before being identified and withdrawn when the issue was discovered. Thus, in this respect, Defense also needs to have a watching brief of SDI developments.

Defense is more often than not at the forefront of many of the SDI developments. It is understood that particularly in terms of geospatial information delivery it needs the agility that SOA and SDI offers. In particular key programs such as the NATO BiSC AIS Core GIS program, which will deliver many Terabytes of vector data, terrain and imagery to hundreds of users throughout NATO, is a key example. This initiative took contributions of data from many nations and will provide the backbone of future NATO geospatial services.

Why is SDI so Important?

Firstly, the Defense problem space is very geospatial. It also has a very broad range of requirements and information types. Everything from solid objects, such as lighthouses and railways, through to meteorological products, which are both geospatially vague and time varying, are required. In addition the information needs to be consistent, coherent and accurate. Defense has always been good at formalizing data (for example knowing who and how it was captured) but has tended to develop a broad range of specialist formats, with different models of the same concept in different products. The coastline in a land product is typically referenced to mean sea level; for a maritime product to lowest astronomical tide. In addition, although exchange is possible, because of differing collection methods, differing formats and physical separation of air, land and sea agencies producing the data, the fusion of air, land and sea data has been a very hit and miss affair until very recently.

Envitia was one of the first organizations to achieve fusion and did so in 1999 under MoD trials of the concept of Rapid Environmental Assessment (REA) with a product called ChartLink and subsequently the concept and practice has become more and more important with the Recognized Environmental Picture (REP) becoming a key component of geospatial data

delivery. The goal was to deliver a wide range of geospatial data types to meet land, aeronautical and maritime requirements and supporting foundation data as well as additional in theatre or remotely sensed data feeds.

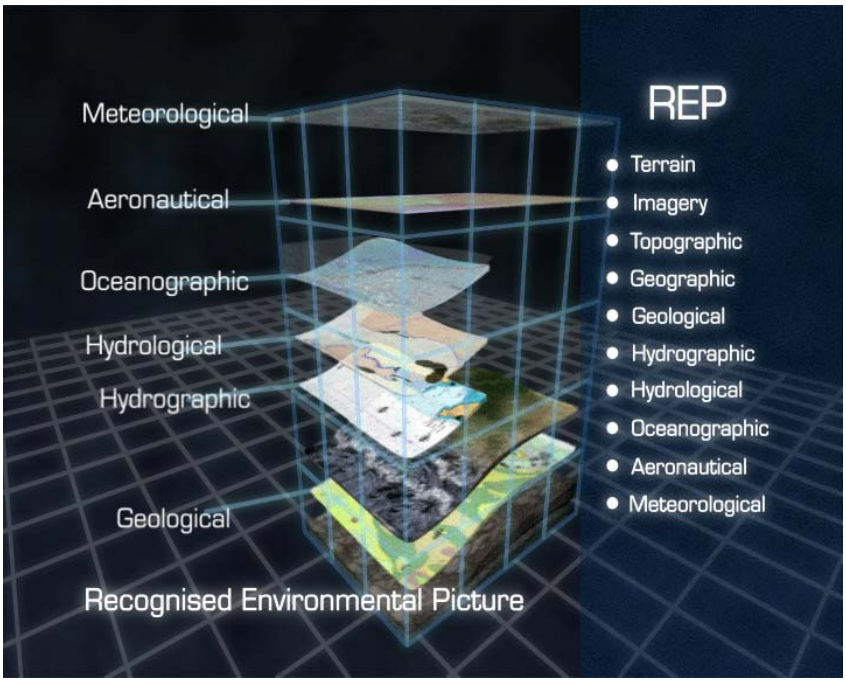


Figure 1 – The components of a Recognized Environmental Picture

The REP has evolved significantly in the last 5 years and the UK agencies now collaborate much more closely at source enabling stronger integration. It is expected that the evolution of SOA will make this integration easier over time.

Geospatial Data Modeling

This element is key to the success of SDI. The advent of both XML, with formalized but flexible data models, and the service model has allowed both the modeling and infrastructure to develop in parallel. From a modeling perspective it is important that all of the detailed concepts used in the plethora of specific data formats are possible in a common model. If this is not the case not all of the functional requirements of a system can be met and another format springs up to add confusion. XML and GML in particular help to avoid such a situation occurring. It can model a very wide range of geospatial data concepts. On one map a lighthouse is a point and on another it is a circle, and both of these are unrelated (because they came from two different paper maps, one at small scale and the other at large

scale). In addition thus far, GI Systems and users have assumed that the geometry of an object defines the object; they are one and the same thing.

A key aspect on the new data models within an SDI is the identification of the object separate from its geometry. Thus as well as a road having a property of '*name*' it may also have a property of '*Centre Line*' which is a line and '*Extent*' which is a polygon. It may also have sub-components such as '*central reservation*', and '*carriageway*'. It is equally possible to model an ephemeral property such as rainfall within the model.

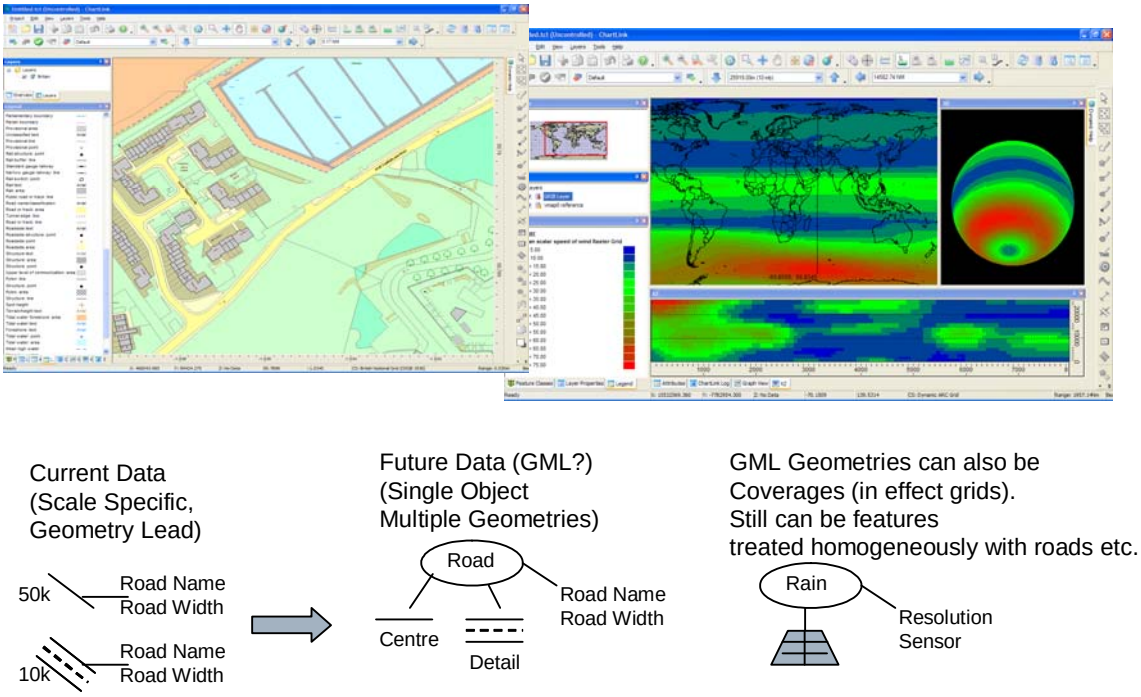


Figure 2 – Effective Geospatial Information Models

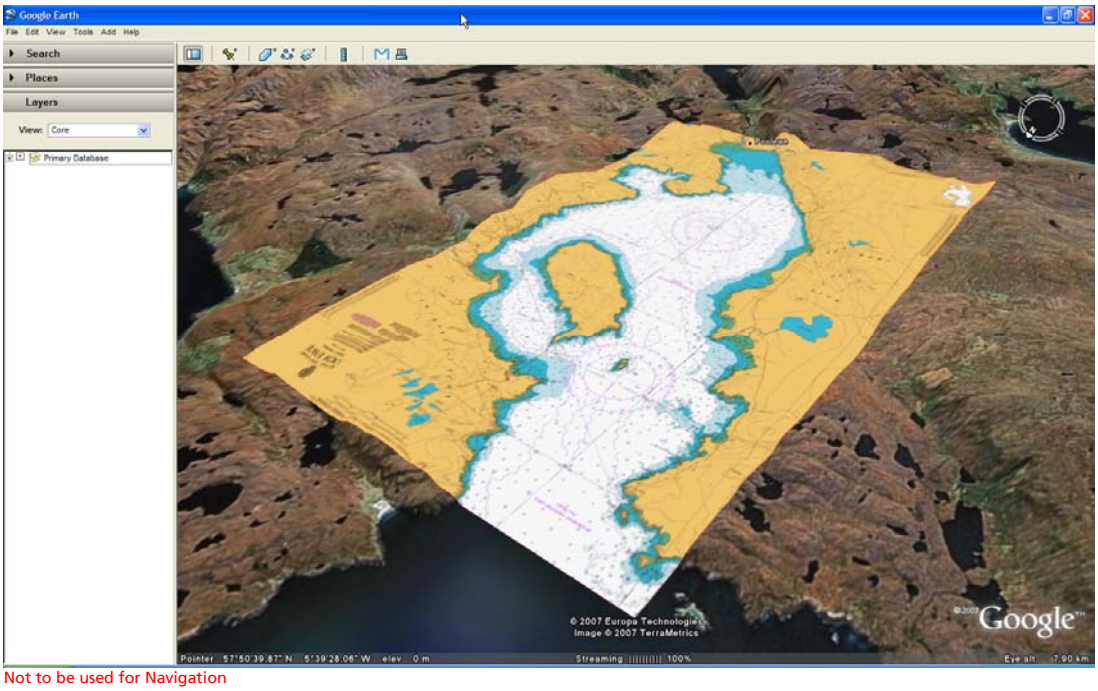
This model allows for very integrated data, where the conceptual relationships of objects are captured as well as their spatial relationships.

The Spatial Data Infrastructure Itself

The SDI infrastructure is critical to success. We are moving away from a world where doing an analysis on a specialist package involved the complete export of the dataset, its modification and then re-integration into the original source. From a service viewpoint, SDI allows access to just the information needed on-line and allows users in different geographic locations to access Geo-databases as if they were local. In the case of Defense this means immediate access by a geospatial specialist to work completed in

another agency including access to in-theatre information from deployed servers.

The first level of spatial data integration could be considered to be the Web Map Server (WMS). This server can be added to many existing systems and infrastructure to publish a geospatial display based on an XML service request. This simple capability allows significantly more integration than is possible otherwise. Although it does not allow any interchange or update of the real data, it does allow the user's choice of application program to display a composite geospatial picture from multiple sources.



Not to be used for Navigation

Figure 3 – Google Earth showing a maritime chart sourced from an Envitia/UKHO WMS.

The next and more extensive level of spatial integration uses Web Feature Servers (WFS) and Web Coverage Servers (WCS) illustrated below with Envitia's ChartLink4D product. These allow access to the data rather than providing a picture of it. The result is the option for combined analysis of data from two sources and the possible update of the sources as a result.

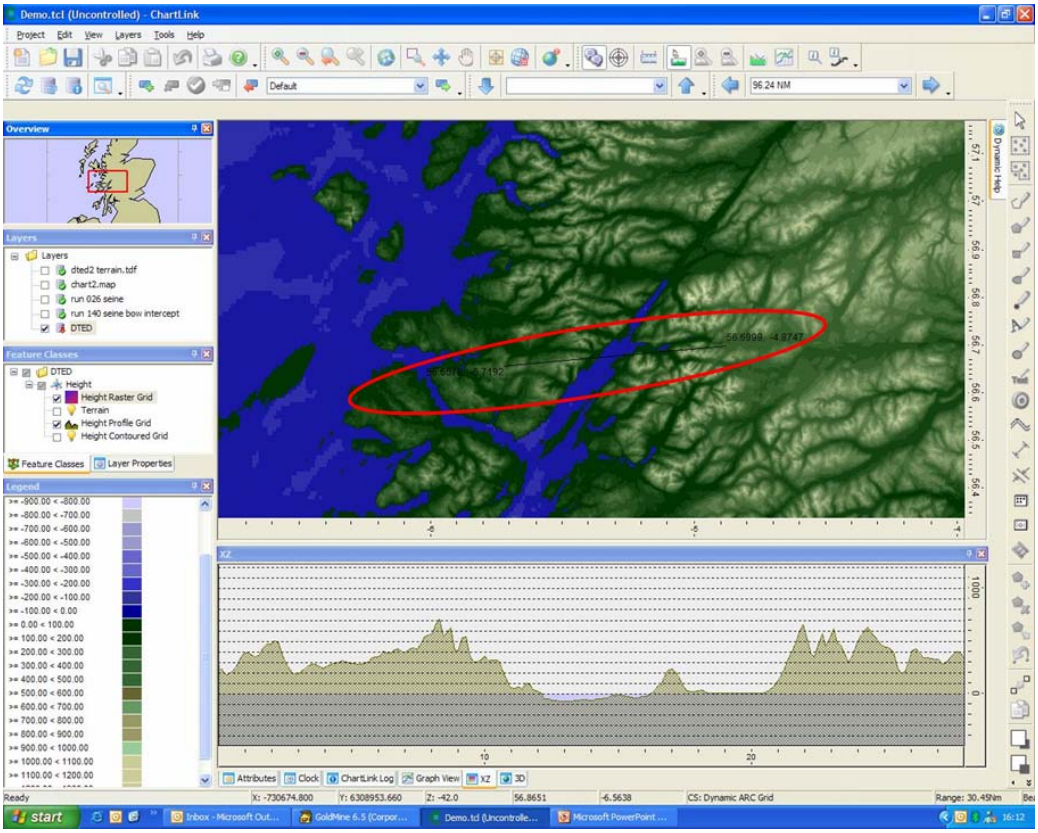
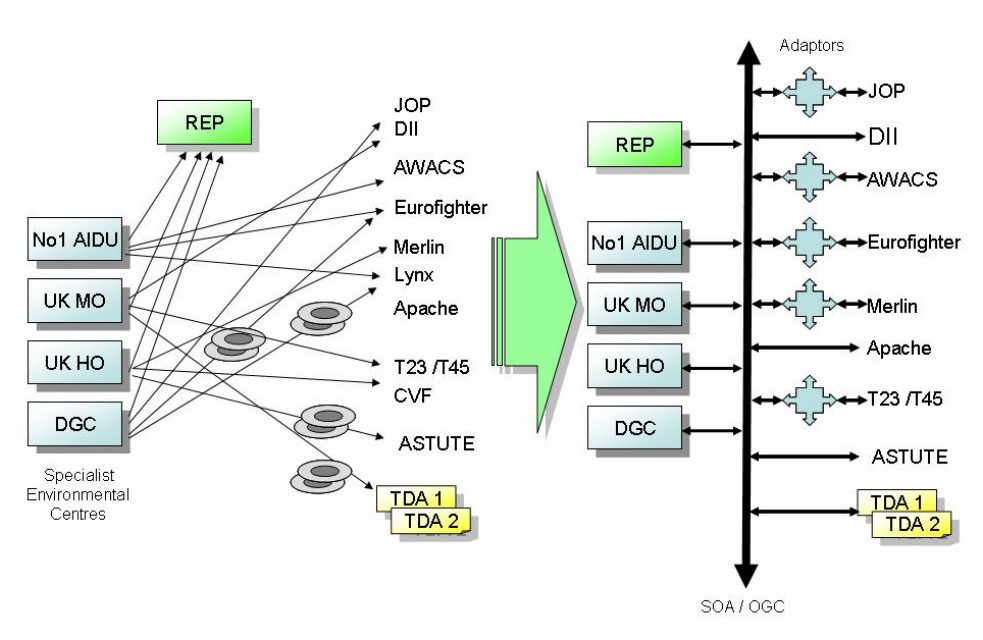


Figure 4 - Analysis of Terrain and Bathymetry Accessed via SDI

Defense is more aware of the issues (benefits and problems) than any other domain as the users are disparately located and often have variable levels of physical communications. SDI actually does address many of Defense's problems as the ability to abstract physical location, replicating data through a network of redundant servers, is not a significant problem. In addition, even when off-line access is required, SDI concepts allow in effect asset tracking of data and offer the possibility to revolutionize the delivery of geospatial data, delivering increments rather than a vast array of CDs or DVDs.

Lastly it has to be recognized that many systems were developed 10s of years ago and will not migrate easily. But SOA offers a solution, because it simply defines the boundary and separates content from format, it is quite possible to construct adapters (sometimes called in-ramps and out-ramps) which connect to a conceptual SOA bus. As a result SOA really does offer a model which is both revolutionary and evolutionary if correctly handled.



A real benefit of SOA/SDI is that it does not require the wholesale replacement of infrastructure, but allows it to be accessible by the publication of appropriate service connection points. This allows the incremental integration which is often the only option in many Defense Infrastructure Projects.

Conclusion

The adoption of Service Oriented Architecture and Spatial Data Infrastructure concepts is beginning to accelerate. In the Defense domain as well as the commercial domain, it does depend on individual projects and programs to fund its implementation and therefore progress is not swift as perhaps it could or should be. However, the initial discussion and prototyping phase has moved on and now industrial strength Spatial Data Infrastructures are being assembled in Defense. This is likely to lead to improved integration of information from all domains. Our view is not before time!