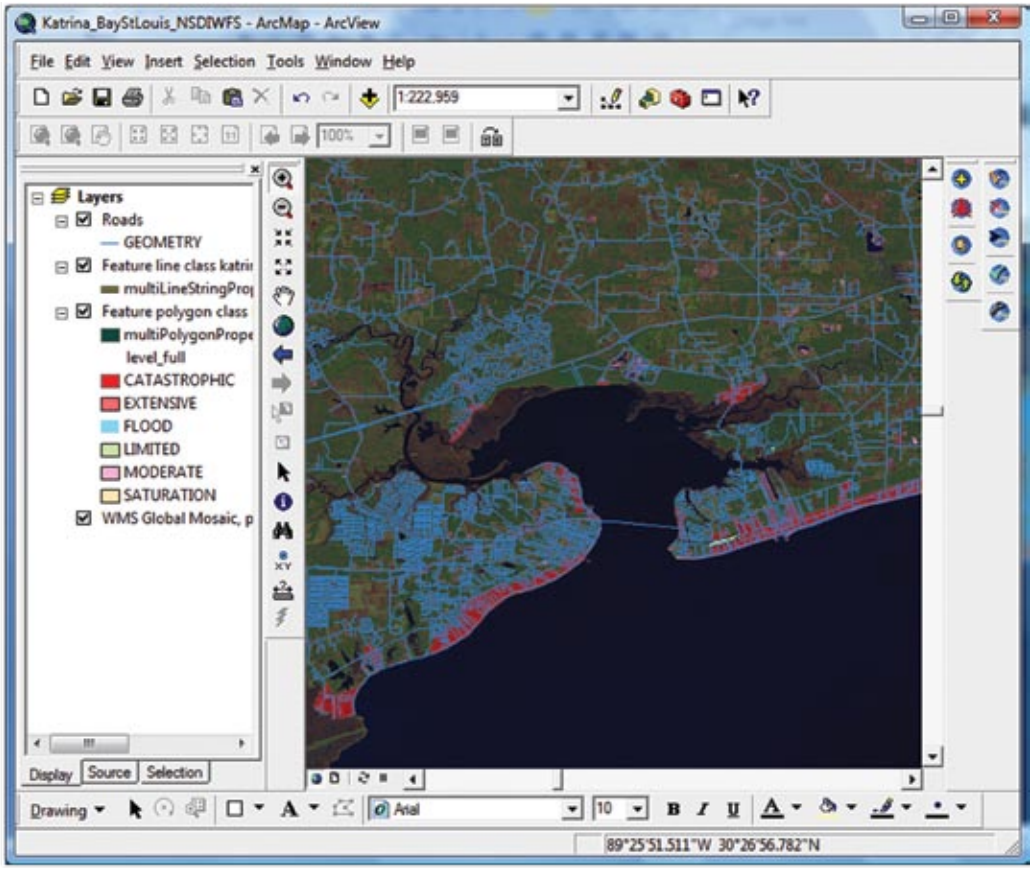
SDI 1.0: GEOINT Revolution

DATA INFRASTRUCTURE ADDRESSES THE PRESSING ISSUE OF GEOSPATIAL INTEROPERABILITY AND USABILITY OF MODERN LOCATION-BASED CONTENT.

BY JEFF HARRISON AND DON MORRIS-JONES



In April 2003, Apple opened its iTunes Music Store online, marking a revolutionary policy and business model shift for distributing and consuming digital music. The result of this shift can be seen on streets, subways and in shopping malls around the world, as people have embraced this new source of digital entertainment. By July 2007, the store had sold 3 billion songs, accounting for over 80 percent of all online digital music sales.

The iTunes phenomenon is a good example of how a new form of digital content dissemination was quickly embraced by users. Can the same type of revolutionary shift happen for digital geospatial information?

In the 1990's, forward-thinking government policies towards high-resolution satellite imagery combined with the emergence of the Internet fueled a 21st century explosion of access to online imagery. Geospatial content is now easily accessed and used in platforms such as Microsoft Virtual Earth and Google Earth.

These days another revolution is right around the corner, powered by new policies endorsing a proven suite of standards for distributing and consuming digital geospatial information called Spatial Data Infrastructure (SDI) 1.0. Based on specifications produced by the Open Geospatial Consortium (OGC), SDI 1.0 is set to address the pressing issue of geospatial interoperability and usability of modern location-based content. In fact, the SDI 1.0 revolution is already underway and deploying cost-effective solutions that challenge traditional GEOINT business models. You probably won't see these solutions at your local shopping mall, but they are critical to mission success and national security.

Spatial Data Infrastructure 1.0 Baseline

Web Features Service (WFS): The WFS implementation specification allows clients to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple WFSs. It defines interfaces for data access and manipulation of geographic features and through these interfaces, a web user or service can combine, use, and manage geo-data. The basic Web Feature Service allows querying and retrieval of features. A transactional Web Feature Service (WFS-T) allows creation, deletion, and updating of features. Gazetteer services are also available through a WFS-G.

Web Map Service (WMS): The WMS implementation specification supports the creation and display of registered and superimposed map-like views (graphical images, such as GIF, JPEG, TIFF and NITFS).

Web Coverage Service (WCS): The WCS specification allows access to geospatial "coverages" (raster data sets) that represent values or properties of geographic locations rather than WMS-generated maps (pictures).

Web Map Context (WMC): The WMC implementation specification is a companion to WMS. It describes how to save a map view comprised of many different layers from different Web Map Services.

Geography Markup Language (GML): GML is eXtensible Markup Language (XML) encoding for the transport and storage of geographic information, including both the spatial and non-spatial properties of geographic features.

Styled Layer Descriptor (SLD): The SLD standard defines the structure of an XML file that applies rendering or symbolization rules to features. An SLD requests a WMS to present a map according to submitted style rules.

Catalog Services (CS-W): The CS-W provides an abstract model and protocol-specific solutions for the discovery of geospatial resources. Through catalog metadata and query interfaces, metadata properties are returned to the requestor, often embedded with links to actual data or services that allow the catalog to act as a referral service to other information resources.

Filter Encoding Specification (FE): FE is used to express a query or filter using a predicate language, or terms and operators, stored in XML elements. FE is used in requests to WFS and queries to CS-W.

The U.S. government defines an SDI as the "consistent means to share geographic data among all users." It goes on to describe an SDI as the "technology, policies, criteria, standards and people necessary to promote geospatial information sharing throughout all levels of government, the private and non-profit sectors, and academia. It provides a base of practices and relationships among data producers and users that facilitates data sharing and use."

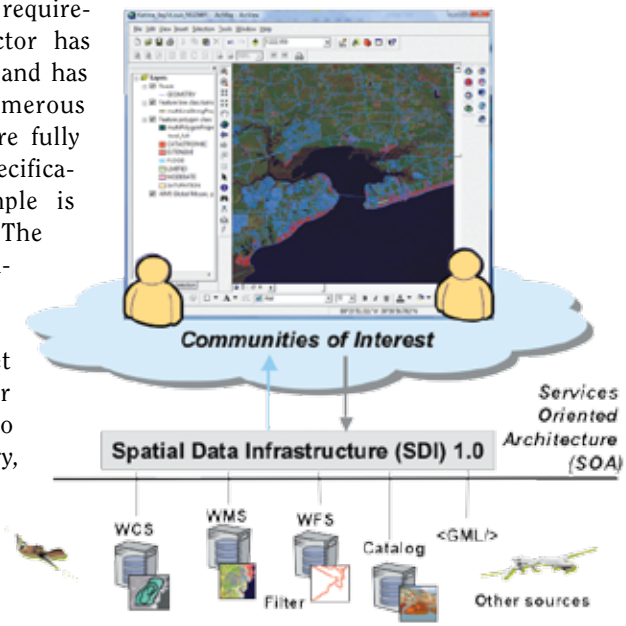
The successful implementation of a net-centric SDI for GEOINT starts with the availability of content and services on the back-end and continues with front-end software clients for the end users. This type of a net-centric environment is dependent on industrywide implementation of these open non-proprietary standards and specifications in software applications, often called standards-based commercial off-the-shelf software (SCOTS). A major push toward commercial embrace is the endorsement of SDI 1.0 by the National System for Geospatial-Intelligence (NSG) as part of the effort to coordinate geospatial standards and promote interoperability.

Faster to Deploy

One of the advantages of OGC SDI 1.0 is the ability for the GEOINT community to leverage agile, market-driven SCOTS solutions to meet analysts' mission requirements. The private sector has embraced OGC SDI 1.0 and has already developed numerous SCOTS offerings that are fully compliant with this specifications suite. One example is CarbonArc PRO from The Carbon Project, an extension for ESRI's ArcGIS 9.2 software that wraps OGC SDI 1.0 into a set of tools that are easy for analysts and warriors to use—providing discovery, consumption and interaction capabilities for the SDI 1.0 baseline directly from the ArcGIS desktop.

By plugging into ArcGIS, CarbonArc PRO lets analysts and warriors use any OGC SDI 1.0 Web service as an integral part of the GIS, including WMS, WFS, WFS-T, WCS, Filter Encoding, Gazetteer, GML, GMLsf and Catalog Services (CS-W). CarbonArc PRO introduces a way to ease existing GIS into SDI 1.0 with minimal expense and disruption. CarbonArc PRO is based on CarbonTools PRO, a product that extends the Microsoft .NET Framework and allows software developers to use advanced geospatial interoperability including SDI 1.0. Such SCOTS products not only enhance mission capability, but also take less time to deploy and cost less than government-only systems developed on a one-of-a-kind basis. Much of the cost reduction and faster deployment times are due to the fact that systems integrators don't need to spend as much time and effort on developing and maintaining custom software interfaces. Another benefit of a SCOTS–based GEOINT system is enhanced reliability, because the product has already been stress-tested during extensive development and use by commercial software developers and users, so the government doesn't incur these costs either.

Perhaps the biggest benefit of SDI 1.0 SCOTS is the ability to take advantage of technology advances by rapidly inserting new software into GEOINT



systems—often called "plug and play." This is important because the product development life cycle for something like CarbonArc PRO is less than a year, while the typical GEOINT program life cycle is much greater, often more than 10 years. By leveraging faster development cycles found in commercial industry, GEOINT systems can be incrementally improved and enhanced over time, instead of waiting years for entirely new system builds.

SDI 1.0 advances GEOINT in many ways, and each specification solves interoperability issues critical to mission success. But SDI 1.0 not only enhances interoperability, it also allows end users to interact in new ways. For example, GEOINT has traditionally been a product-focused, "read only" business. But this one-way model doesn't allow analysts and warriors to affect the content in a way that can be immediately shared in the net-centric environment.

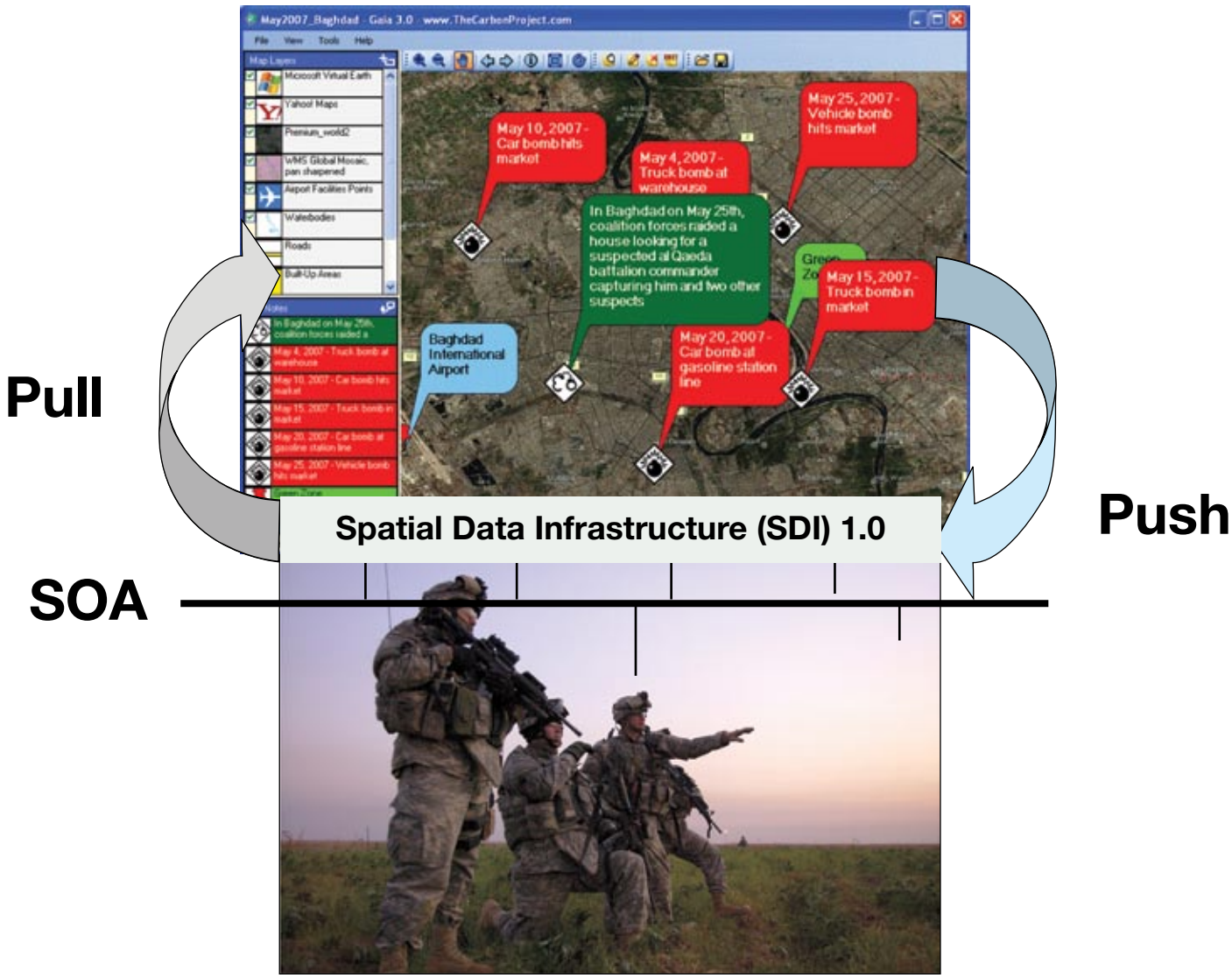
SDI 1.0 breaks the one-way model and lets analysts and warriors interact with the net-centric SDI and affect remote content. This is possible because SDI 1.0 has not only specifications dealing with maps, imagery and metadata, but also two very powerful concepts supported by the OGC Web Feature Service specification—Transactions and Filters.

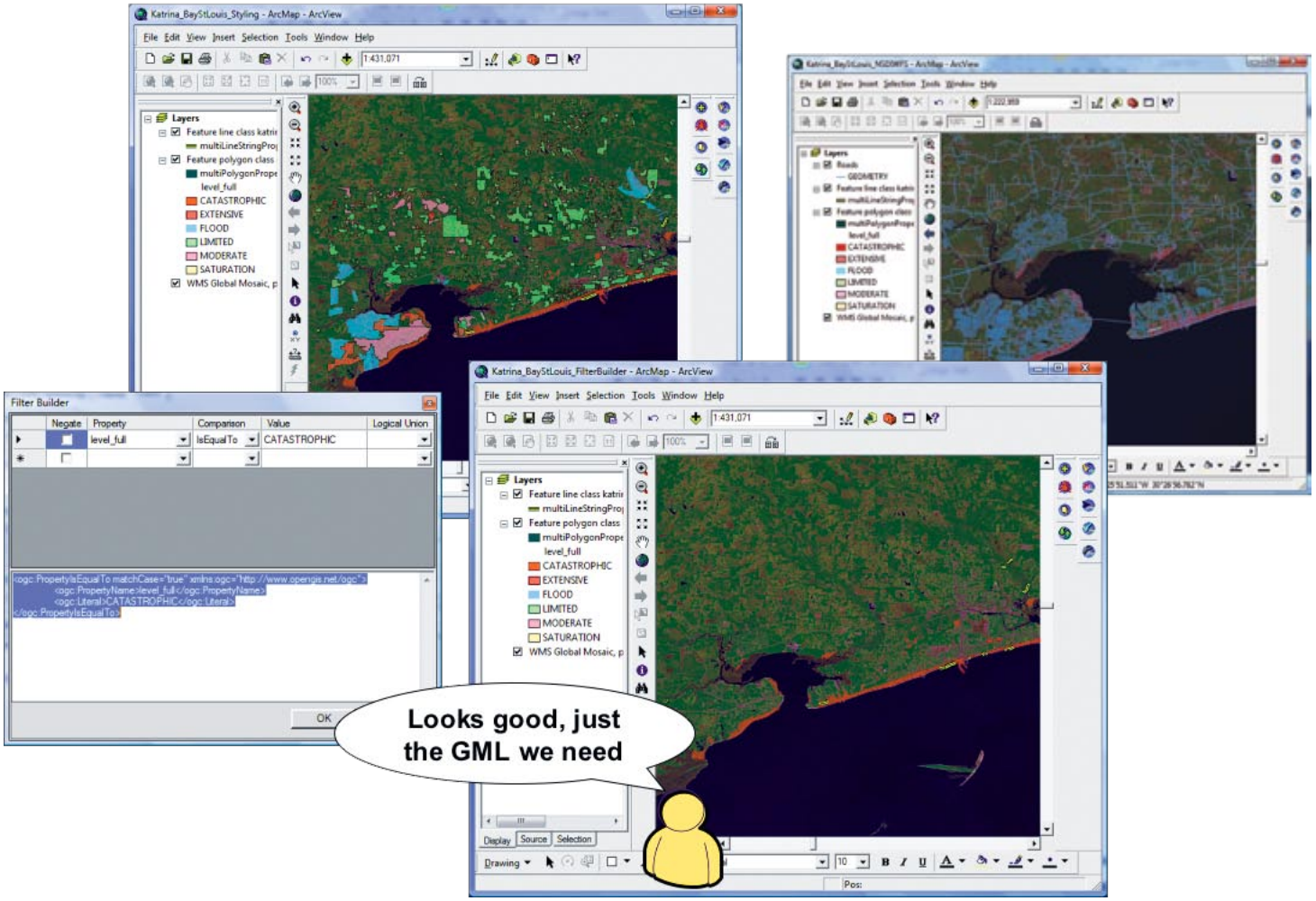
Transactions and Filters

SDI 1.0 Transactions and Filters allow analysts and warriors to selectively pull in mission-critical information and then push out value-added content for reuse by others. This two-way flow of GEOINT makes is possible to interact and share geospatial content; for example, warfighters can add or revise data from the front lines, providing instant updates to the rest of the net-centric SDI.

Filter is one of the most powerful and least understood concepts in SDI 1.0. The basic concept of an SDI 1.0 Filter is to provide a SQL-like spatial and logical language to make advanced data queries possible in a net-centric environment. Filters do this using a series of logical ("AND" this, "OR" that), comparison (is this "Equal To") and spatial (does that road "Intersect") operators. The Filter Encoding (FE) specification, when wrapped up into tools like CarbonTools PRO or CarbonArc PRO, lets analysts and warriors quickly add complex and powerful queries to their GEOINT. This means a big change from the days when GEOINT was delivered as files and CDs.

One example of how a filter could be used to query geospatial content would be an analyst trying to assess areas of catastrophic damage from Hurricane Katrina from a WFS feature layer describ-





ing all damaged areas. Without the filter, an SDI 1.0 WFS will return the complete data layer, overloading the network and distracting the analyst. With the right filter, only areas identified as "catastrophic damage" by the Comparison Operator are returned.

Analysts and warfighters don't only need to pull data from net-centric SDI 1.0 sources. They frequently need to make changes directly to the data, either to enable situational awareness in real-time or simply to keep the data current as they come across new information. Transactions, part of the OGC SDI 1.0 WFS-T specification, is the foundation for this activity.

WFS Transactions describes the way to interact and affect the remote content directly from the end-user. So the transactional capability of WFS means that an end-user can alter the global data view from a remote location using queries based on OGC specifications. SCOTS tools like CarbonArc and others can utilize this capability in a very powerful fashion. The CarbonArc feature editing tools allow ArcGIS users to graphically update, delete or insert Geography Markup Language (GML) features and geometries using ArcMap. The various content changes are managed on the desktop. Once the feature changes are complete they are sent to the WFS, making the value-added content instantly available for others in the net-centric environment.

Finding geospatial data has also historically been a complex and difficult process with significant potential for delays, costly redundant data collection and/or missed opportunities to use and apply GEOINT. SDI 1.0 Catalog services provide a powerful, open method for geospatial data sharing, which encourages a more collaborative and agile GEOINT community. Catalog services standards have evolved significantly in recent years and different SCOTS products vary in the protocols that are supported. CarbonArc PRO supports many of these protocols and additional protocols can be added to further extend catalog service search and filter options. Keyword and regional filter searches allow the analysts and warriors to quickly determine whether or not services have the desired types of data in the correct regional location. Analysts can review available data layers and, if desired, add that data to their SDI 1.0 applications.

Just as forward-thinking government policies towards high-resolution satellite imagery changed the geospatial community forever, new policies endorsing SDI 1.0 are fostering a revolution in distributing and consuming digital geospatial information. You probably still won't SDI 1.0 solutions at your local shopping mall or subway station, but they're going to be critical to GEOINT mission success and national security. ✯

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